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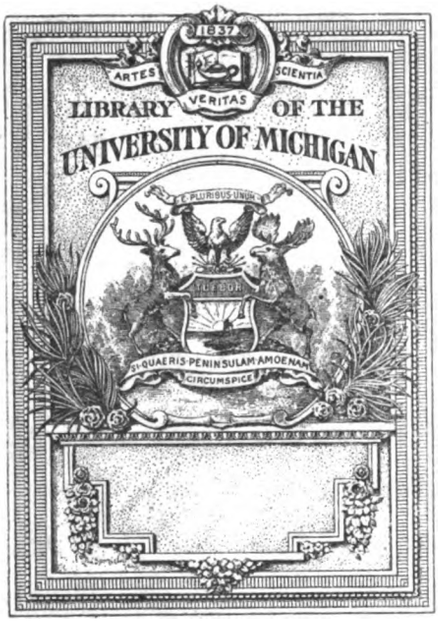

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THE

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NOTES.

Institution's Telegraphic Address. — We are asked to state that from Jan. 1 the telegraphic address of the Institution of Electrical Engineers is "Voltampere, London."

Lectures at University College.—Prof. C. A. Carus Wilson has arranged to give a course of lectures at University College, London, commencing Jan. 20, on "Electric Motors, with special reference to Tramways and Railways." Applications for admission must be made to Prof. Fleming.

Society of Arts.—It is officially announced that the Prince of Wales has intimated his willingness to accept the presidency of this society, and that Sir Frederick Bramwell, Bart., F.R.S., who had been elected to the office on the accession of King Edward, has resigned the presidency in favour of his Royal Highness.

Long-Distance Transmission.—There has just been put into operation in California a high-tension transmission line from the Yuba River into San Francisco. The completion of this line makes available into that city electrical energy developed on the Yuba River and conveyed a distance of 222 miles over the lines of the Bay Counties Power Company and of the Standard Electric Company.

"Wisconsin Engineer."—The December number of the *Wisconsin Engineer*, a copy of which has just reached us, is a very interesting issue. It contains, among other things, papers on the following subjects: "Two Kinds of Education for Engineers," by Mr. J. B. Johnson; "Storage Batteries on Electric Systems," by Mr. Harold Seamen; and "Progress made in Engineering during the Nineteenth Century," by Prof. J. L. Van Ormun. The frontispiece to this issue is an excellent print of the plant of the Edison Electric Illuminating Company at Philadelphia, Pa.

Mond Gas.—Mr. F. H. Keen, a barrister of the Middle Temple, has compiled a valuable little memorandum on the Mond gas scheme. In it is given a summary of the principal provisions of the South Staffordshire Mond Gas Company's Act, 1901, and of some of the matters raised in evidence before the parliamentary committees that dealt with the Bill. It is estimated that the capital expenditure on the scheme will amount to £789,656, and that when the works are in full swing and supplying 84 million cubic feet of gas per day of 12 hours, the annual profit will be £125,000.

Electric Traction on Railways.—The Great Eastern Railway Company are amongst the first to recognise in a practical manner the great part that electricity is sure to play in the railway traction of the future. It is proposed to erect classrooms and electrical laboratories at the mechanics' institute attached to the company's Stratford works, and towards the attainment of this object Lord Claud Hamilton, on behalf of the company, has promised a donation of £1,100. The employés of the company in the Stratford works will thus have an excellent opportunity of getting a thorough electrical training, which they can turn to good account when the time arrives.

United States Bureau of Standards.—A site for the proposed National Bureau of Standards of the United States has been secured just outside the city of Washington. The plans of the buildings which have been prepared contemplate a laboratory and generating equipment, in addition to the usual offices, etc. The bureau, which is already at work in temporary quarters, is authorised to exercise its functions for any scientific society, educational institution, corporation, firm, or individual within the United States engaged in any pursuit requiring the use of standards or standard measuring instruments, including electrical standards for the measurement of resistance, E.M.F., and current; also electrical power-measuring instruments and photometric standards.

Technical Education in London. — A list of successes gained by Technical Education Board's scholars at the London and Cambridge Universities has just been published. From this we see that at the recent London University examinations as many as 11 scholars obtained their degrees—*i.e.*, six were admitted to the degree of B.A., and five to the degree of B.Sc. Of the total number of passes no less than seven gained honours. These results speak well for the good work the technical institutes and polytechnics are doing in London. Four entrance scholarships at Cambridge have also been obtained by intermediate county scholars. We understand that the next examinations for intermediate county scholarships will be held in June and July next. All information relating to the same will be found in the current number of the *Technical Education Gazette*.

Science Teachers' Conference.—Another conference of science teachers has been arranged by the Technical Education Board, to be held in London this Christmas vacation, at which it is hoped a very large number of teachers from elementary and secondary schools and technical institutes will attend. It is to be a two-day conference, opening at the South-Western Polytechnic, Chelsea, on Thursday, the 9th inst. Both on this and the following day there will be two meetings for the discussion of subjects affecting the interests of science teachers. A collection of home-made apparatus for science teaching in schools will be on view during the days of the conference, and the assistance of teachers who have designed such apparatus is specially desired in order to make this section of the work as useful as possible. Applications for tickets of admission should be made to Dr. Kimmins, Park Lodge, Harrow-on-the-Hill, or to Mr. C. A. Buckmaster, 16, Heathfield-road, Mill Hill-park, W.

Royal Meteorological Society.—At the monthly meeting of this society, held on the 18th ult., the Hon. Rollo Russell read a paper, entitled "Further Observations

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and Conclusions in Relation to Atmospheric Transparency." For a number of years past he made daily observations on the clearness of the atmosphere at Haslemere, Surrey, and in the paper he gave the results of the same. The principal conclusions derived from these observations are: Haze and fog are commonly caused by the mixture of currents at different temperatures. These currents may be local or general, high or low. Thick haze or fog not dependent on differing currents is rare, but differing currents frequently come into contact without producing haze or fog, and fairly clear weather under opposite currents is not uncommon. The other papers read were: "Remarkable Phosphorescent Phenomenon Observed in the Persian Gulf, April 4 and 9, 1901," by Mr. W. G. Hoseason; and "The Mechanical Principle of Atmospheric Circulation," by Captain R. A. Edwin, R.N.

Polytechnics and London University. — The London polytechnics are to be congratulated on the fact that out of 42 candidates who were successful in the recent B.Sc. examination at the University of London, no less than 20 received their training in these institutions. A considerable number of the teachers who are teaching at the various polytechnics are recognised "teachers of the university," and are conducting courses of study approved by the university as suitable courses for internal students. The following teachers in London polytechnics have recently been recognised by the Senate of London University in this capacity: Mr. G. Armitage-Smith, M.A., Birkbeck Institution, in mental and moral science; Mr. J. W. Button, A.R.C.S., Battersea Polytechnic, in mechanical engineering; Mr. A. G. Cooke, M.A., Battersea Polytechnic, in electrical engineering; Mr. W. H. Eccles, D.Sc., A.R.C.S., South-Western Polytechnic, in mathematics and physics; Mr. A. Griffiths, D.Sc., Birkbeck Institution, in physics; and Mr. C. F. Smith, Wh.Sc., South-Western Polytechnic, in electrical engineering.

Simultaneous Telegraphy and Telephony.—The *Electrical Review* of New York describes an invention which is now being tried on the Northern Pacific Railroad for the simultaneous transmission of telephone and telegraph messages over the same wire. It is claimed by the inventor, Mr. C. H. Grant, that the new system permits of the sending of the ordinary telegraphic message while at the same time two parties are conversing over the line by telephone. An original system of induction coils in condensers is the salient feature of the apparatus, which on a test over a line 25 miles in length has shown itself to be a success. When both wires are being used, there is no noise of the clicking of the telegraph instrument noticeable which can interfere with the parties telephoning. We learn from our contemporary that the Northern Pacific Railroad Company will soon permanently adopt this double system of telegraphy and telephony, and connect it with its transcontinental lines. The company have ready for service about 115 miles of line, which will be connected in a short time, and the balance of the line to the coast will be finished as fast as the telephone devices can be applied

Nernst Electric Lamp.—We learn that one of the patents used in the manufacture of the Nernst lamp has just been declared invalid by the German Patent Office. What effect this decision will have on the future of the lamp is not at present apparent, but the Allgemeine Elektricitäts-Gesellschaft, which now holds the Nernst patents for Germany, asserts that the patent in question, which is numbered 104,872, only concerns a contrivance for the preliminary heating of the illuminating materials, and does not affect the manufacture of the lamp. On the other hand, Mr. Wilhelm Boehm, a Berlin chemist, at whose instance the validity of the patent was tested, declares that it is the "actual Nernst patent," which has hitherto prevented other persons from making any progress in consequence of the monopoly held concerning the means of heating the illuminating materials. It may be stated, however, that the Nernst lamp as at present manufactured is protected by 14 different patents, and it remains to be seen whether Mr. Boehm's views are founded on fact. We understand that the company intend to appeal to the Reichs Gericht against the decision of the German Patent Office.

Straying of the Lines of Current in Electrolytes.—The "Digest" of the *Electrical World* of New York abstracts an interesting paper on this subject by Pfauhausser. The author states that in electroplating one wants to obtain a uniform deposit on the surface of the plate. This is often not the case when this surface has a very irregular form with elevations and deepenings. It is especially difficult to get a good uniform deposit of an alloy—for instance, of copper and zinc in the form of brass. To accomplish this, one has to use electrolytic baths which stray the lines of current well. He compares the straying of the lines of current in electrolytes with the magnetic stray fields in dynamos. The electrodes correspond to the magnet pole and armature, the electrolyte corresponds to the air-gap. To get uniform electrolytic deposits on special surfaces, mechanical means are sometimes used to advantage. Non-conducting diaphragms are placed between anode and cathode, to deviate the lines of current in the way desired, or for covering a plane surface with a uniform coating; and to prevent the coating from being thicker at the rims than at the central part, a non-conducting frame is placed before the cathode, the open part in the middle of the frame being smaller than the cathode. He discusses the influence of the composition of the electrolytic bath upon the phenomenon of the straying of lines of current. The author next calls attention to the fact that acid solutions stray less than neutral or alkaline solutions, and gives an explanation which is highly theoretical, and cannot well be briefly abstracted. He mentions that practical experiments have shown that the addition of $NaHSO_3$ to the electrolytic bath is a means for obtaining good uniform deposits of copper and zinc together as brass.

Hot-Wire Instruments.—A recently published paper by a Mr. Soulier gives an interesting description of hot-wire voltmeters and ammeters devised by Chauvin and Arnoux. The same is digested in the *Electrical World* as follows: "The special feature of the instruments is the method used for compensating for the variation due to temperature changes and for increasing the deviations of the needle. Several wires of the same material and cross-section as the wire heated by the current to be measured are fixed at one end to the frame of the instrument, and are connected at the other end to the one terminal of a lever, pivoted on its centre. These wires are not in circuit, but are tightened by the action of a spiral spring. Parallel to the bundle of insulated wires there is the real 'hot wire,' connected at one end to the lever mentioned before, and at the other end to another lever which is in connection with the device for increasing the deviation of the needle. It will be seen that when the temperature of the air rises, the bundle of insulated wires compensates for this temperature error of the hot wire. The device for increasing the deviation of the needle acts as follows: When the hot wire varies its length due to the heating of the current, the lower lever, one arm of which is connected to the hot wire, is acted upon, the other arm is connected to a fixed point of the frame by means of a thread and spiral string. A point of this thread is fixed to a cylinder of small radius

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and revolvable around its axis. When the lever is acted upon, the cylinder is turned and the needle connected with this cylinder is deflected. It can be shown that this arrangement is very sensitive. The hot wire used can stand three times the normal current without any other inconvenience except that the zero point of the instrument is changed, but it can easily be restored by means of a screw. Voltmeters and ammeters of this type are described."

A Three-Wire Generator.—We note in the Christmas issue of *L'Industrie Electrique* an interesting device used in connection with the electric lighting plant at La Bourboule, in France, for supplying a three-wire network. The installation in this town has recently been remodelled by Mr. Claret, in order to meet the growing demand for light and power. The original supply was at 120 volts with continuous currents. A waterfall 61ft. high was utilised in laying down the new plant, and from it power is obtained which is transmitted by alternating three-phase currents at 320 volts to the centre of the town. There they are transformed into continuous currents by means of a motor-generator. The generator is of the six-pole type wound to give 240 volts, and in connection with it a device is used so that it can supply the three-wire network with 120 volts between the centre wire and either of the outers. For this purpose the armature is tapped at two opposite points and connected to two slip rings. From brushes on these two slip rings, conductors are led to a choking coil built like an alternate-current transformer. The middle point of the winding on this choking coil is connected to the zero wire of the three-phase system. An alternating current traverses, therefore, this choking coil, but by the arrangement the centre point of the winding is always at the zero potential. This device is somewhat like one used in connection with rotary converters, but we do not know of another instance in which it is applied to a direct-current machine only. With the arrangement as adopted at La Bourboule, the high voltage is led direct to the motor and the motor-generator, so that static transformers are avoided. It would be interesting to know how far this arrangement compares economically with the use of static transformers and a motor-generator. If the latter were used, the zero connection could be taken from the centre of low-tension winding of the static transformers, as has been described before in these columns.

Electric Discharge and Capillary Action.—The *Scientific American* records some recent experiments made by Mr. M. S. Lemstrom to show the effect of electric discharge upon capillary action. In the method adopted in this case a capillary tube is plunged in a vessel of water, and the latter is connected to one coating of a Leyden jar. The other coating is connected to earth, and both are also connected to the two balls of a spark micrometer. There is placed above the tube a metallic point, which is joined to one pole of an influence machine, the other pole of the machine being grounded. This discharge thus passed from the point across the air to the water. When the point is joined to the positive pole, the meniscus is seen to rise along the walls of the tube, and at the same time one or more minute drops of water are formed at the edge. The result is not always the same as regards the number of drops which are formed in the same interval of time, even when the intensity (as measured by the number of sparks) is the same. When the point is raised to a considerable distance above the water this phenomenon is still observed, but the drops cease to form at a distance of 30in., after which the meniscus still continues to rise, however. The quantity of water thus raised depends upon the amount of discharge, the distance of the point from the water, the diameter and length of the tube, and the various resistance of the circuit. It seems to be proportional to the time during which the discharge passes, at least in the first instance. Diluted solutions of various salts act in the same manner as water, but the quantity raised is smaller. As may be expected, the discharge has also an action upon the capillary tubes of plants, and this the experimenter shows by placing above the capillary tubes of the plants a sheet of wire gauze provided with small points. The machine is connected to the gauze and to earth. The author finds that the activity of the plant is increased when the gauze is joined to the negative pole of the machine, in which case, as above, the discharge tends to favour the rise of the sap in the capillary vessels of the plants.

Superposed Current Distribution.—A recent patent granted to Dr. Frederick Bedell in the States describes a system of electrical distribution employing currents of different character, and particularly a constant-potential system employing both alternating and direct currents. According to our contemporary the *Electrical World*, the inventor has discovered that if an alternating current be superposed on a direct current, the line loss will no longer be the square of the sum of the two currents, but the sum of their squares multiplied by the resistance. This involves a large copper economy in distribution systems, or, conversely, a higher efficiency of transmission. For example, if on a direct-current system an alternating-current system is superposed, by doubling the copper four times as many lamps as before can be supplied; or in supplying current over a common conductor to devices such as two incandescent lamps, with one ampere of direct and one ampere of alternating current respectively, the energy received by the respective receiving devices is the same, while the energy lost in the conductor is only one-half the corresponding amounts of energy in case both devices received like currents. Several applications of the system are shown. In the simplest form an alternator is connected at one side to one leg of a direct-current circuit, and from the other collector ring a conductor is run to form a third conductor in the combined system. Lamps are connected between the two direct-current conductors, and also between one of the direct-current and the alternating-current conductor. In a more symmetrical application there are two direct-current generators and two alternating-current generators in opposite sides of a closed circuit. If we assume the form of the circuit to be rectangular, then there will be a main of the working circuit leading from each angle of the closed circuit. In order to secure a maximum of economy, any one translating device in the circuit should be supplied with current of one character—that is, either direct or alternating current. This implies a balance of line losses, and means are described in the patent whereby this condition of balance may be maintained.

Municipal Telephones for Portsmouth.—For a long time the business people and residents of Portsmouth have entertained an intense feeling of dissatisfaction at the monopoly which the National Telephone Company have now enjoyed undisturbed for 16 years in that town. The culminating point in the long campaign against this monopoly was, however, reached this week, when the Corporation received the necessary sanction from the Local Government Board to borrow the money for a municipal telephone exchange. It is to be presumed that in view of the competition of the municipal system in the near future, the company will adopt the same tactics as they have employed at Tunbridge Wells, Grantham, and elsewhere, of immediately reducing their tariff. The Corporation, however, do not entertain any fears on this score, for although they cannot hope in the initial stage of the

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undertaking, on account of the large area to be covered, to give an unlimited service for £3 per annum, as is being done in another provincial town, they have already upwards of 1,200 signed promises from prominent tradesmen who are anxious to become subscribers to the new system, as against only 800 subscribers which the National Company have at present connected to their exchange. The scale of charges as now fixed to come into operation with the opening of the municipal exchange compares very favourably with other municipal systems in this country. It is proposed that a subscriber shall have the choice of three rates—*i.e.*, £5. 17s. 6d. per annum for unlimited user; £3. 10s. per annum, and ½d. for each call originated by him; or £2. 10s., and 1d. for each call. Against the company's present tariff of £10 per annum at Portsmouth these rates are sure to be heartily welcomed by the townspeople. The municipal scheme provides for a central exchange at the town hall, where it is proposed to erect a switchboard for the accommodation of 4,000 subscribers. The wires, which will be laid underground, will cover a radius of 10 miles, embracing such outlying districts as Emsworth, Havant, Fareham, Gosport, and Waterloo-ville. The estimated cost of the work is £26,000, and it is hoped to have the system working in six months' time.

The Monorail.—A few days before Christmas Mr. F. B. Behr delivered a lecture before the Association of German Engineers at Berlin on high-speed electrical railways, with special reference to the proposed monorail between Manchester and Liverpool. The lecture was illustrated with models and views. Dealing with the question of high speeds, Mr. Behr gave his opinion that the ordinary two rail line would only give moderate safety unless the line were perfectly straight without curves. He was convinced that the high speeds proposed were not permissible unless a line could be constructed which theoretically made derailment impossible, and such an express passenger service could never be established and become popular unless the public felt thoroughly convinced that its safety was far greater even than the present service at 60 miles an hour. Speaking on the experiments now being made on the military railway between Berlin and Zossen, the lecturer suggested that the feature of high speed, and especially the creation of a type for the introduction of high-speed railways, was not the principal object in the minds of those who had investigated those experiments. He thought that however successful from an electrical point of view the experiments might be, from a high-speed railway point of view—quite distinct from the electrical working—they could not lead to any final result. Working on a practically straight line, they could never produce a type to be adopted generally for high-speed travelling. If a two-rail line could not be absolutely safe in theory, no experiments could prove it to be so; and further, when he compared the weights and results obtained, he found that the carriage experimented with weighed 94 tons and carried 45 passengers, while it used 3,000 h.p. during the acceleration and 1,000 h.p. on the rest of the journey. These figures were more than double those which would be used on the Manchester-Liverpool line. The carriage sanctioned for this proposed railway weighed 38 tons for 38 passengers, and used a horse-power of only 515. This meant at least double the consumption of electricity per passenger and double the amount generated at the generating station on the Berlin line than would be required for the purposed railway between Manchester and Liverpool.

Tramway Construction.—It is interesting to see how far it pays large tramway undertakings to do their own construction work. In this respect some of the large companies or amalgamations of companies in the United States have found it advisable to do a great amount of their construction work with their own staff. Thus, in the last issue of the *Street Railway Journal* a good description is given of the equipment of the track construction department of the Union Traction Company of Philadelphia. We gather from the illustrations that this company use solid joints for their rails, as it has electrically-driven cupolas in which the metal required for cast-welding these joints can be melted. Another interesting tool is a portable grinder used to smooth down the cast-welded joints after completion. This consists of an electric motor on a hand-barrow which drives an emery wheel by means of a Stow flexible shaft. The power to drive this 2-h.p. motor is, of course, obtained from the trolley wire. In the same article a number of details are given of the gear required for putting together special track work. An interesting adjunct in connection with the repair of the track is the night-light stands, which again derive their energy from the trolley wire. These consist of a series of incandescent lamps grouped together in a powerful reflector, so as to strongly light that area of the street on which track repairs are being made. We notice that the curves on this company's system are all of the spiral form, so as to give easy transition effects. In order to facilitate the calculation of laying-out these curves standard templets have been designed, the use of which is fully explained in the article. The spiral or cubic parabola curves, which are ideal for railway work, have been adopted by many progressive engineers as standard, but one of the reasons, if not the only reason, why they have not been universally adopted is the trouble, time, and annoyance in preparing accurate drawings and making the necessary calculations, and for those not used to higher mathematics such curves are difficult to determine. With the help of such templets and standard tables spirals can be laid out accurately, and calculated with as much ease and rapidity as plain curves. The method employed at Philadelphia may go a long way to make spiral curves universal, and at the same time may save a great deal of gray matter.

Evolution of the Shaft Governor.—At the monthly meeting of the Engine Builders' Association of the United States, held in New York on Dec. 2 last year, Prof. R. C. Carpenter read a most interesting paper on the above subject. We have not the space to follow the author in detail through the steps of the evolution of the shaft governors of steam-engines, but his remarks on the governing of engines driving alternators to be worked in parallel will be of interest to all electrical engineers. He explains how much more difficult it is to get uniform angular motion than to get the uniform revolutions per minute, which could be so accurately given by crankshaft governors. He holds, however, that this requirement, severe as it may seem, will be successfully met by the shaft governor after a certain period of development has passed by. The professor pointed out that the wonderful quickness in action of crankshaft governors is a detriment rather than an advantage when constancy of angular speed is required throughout each revolution. He adds, however, that knowledge of the speed requirement demanded, together with experience and practice, will soon serve to point out to engineers the proportion of flywheel and governor parts necessary to perfectly meet the demands of this service. He further states that the use of light flywheels, which the crankshaft governor has made possible in the past, will have to be modified, and that heavier flywheels must necessarily be used for engines driving alternators. A most interesting discussion, which

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is fully reported in the *Engineer* of Cleveland, took place on this question. From the various speakers, we gather that it is now the practice of the large manufacturers of alternators in America to specify an extreme variation of 4 per cent. in speed between no load and full load for engines driving their plant. With this variation there is no difficulty in driving alternators in parallel, and extreme fluctuations of load from one to the other are avoided. One speaker gave information as to a case in which the engines had worked successfully with an extreme variation of 1 per cent. in speed, but it was elicited that in this instance the alternators were belt-driven and not directly connected. The general opinion of those taking part in the discussion seemed to be that it was a mistake to attempt too accurate a governing of the speed in alternator work, and that perhaps it would be well to add a second device for bringing the whole of the engines back to a constant speed after the main governors had acted. If we remember rightly, this device has been in use for some time on certain of the engines employed at Deptford for driving alternators.

American Submarine Cables.—We have in previous issues briefly referred to the demand of American cable-makers that they should receive increased protection, in order to enable them to manufacture submarine cables in competition with our large English firms. Our contemporary the *Electrical World*, in its issue for Dec. 21, has an article on the subject, in which the reasons for and against extra protection are given. It claims that the Dingley tariff of 33 per cent. on the value should be enforced on the whole length of submarine telegraph cables laid into the States, and that this rate should be enforced until the American manufactories get well to work. If this alteration in the tariff law should not be legal, our contemporary suggests that a law should be passed which should forbid the landing of all foreign-made cables into the United States unless a bonus or subsidy equivalent to 35 per cent. be paid to the Government. The details which our contemporary gives of the necessity for such protection are interesting. In the first place, it claims that all the cablemaking plant would have to be imported, and would have to pay a 45 per cent. import duty, which, with 10 per cent. for insurance and freight, would make the American factory cost about 55 per cent. more than the factory in this country. The next point is that skilled and unskilled labourers receive higher rates in the United States than in England. Then, again, as our contemporary states, copper is exported in large quantities from the States, and although there is no import duty on raw copper, the manufacturer in America has to pay about ½d. per pound—*i.e.*, about £5 per ton more than the manufacturer in this country. As regards the drawn wire, this is said to cost from 10 to 15 per cent. more than in England, and a tariff of 1¼d. per pound on copper wire prevents the importation of the same into America. Guttapercha is imported free in its raw state, but if partially manufactured, it is subject to an import duty of 35 per cent. The jute yarn is said to cost from 25 to 35 per cent. more in the States than in Dundee, and is also subject to an import duty. The iron wire required for the armouring is said to cost almost one-third more in the States than in England, which is practically equal to the import duty. Last of all comes the cable ship, which is a very expensive item, but this, our contemporary suggests, might be got over by the Government owning it, as it would be required afterwards for repair purposes. If an advocate of free trade required any argument at the present day for his belief, he could not do better than go to the article above mentioned. Our contemporary suggests that the submarine cable industry should be fostered by means of a heavy charge against submarine telegraphy, and that this charge need only be in force until the manufactories have got to work. The same argument was applied to the manufacture of machinery, of copper wire, of iron wire, of manufactured guttapercha, and of jute yarn; and yet these industries, which have grown to such an extent that they export largely, are still supported by the protective tariff The natural result is, as shown by our contemporary, tha the manufacturer in the United States has to pay in every case a higher rate for these manufactured articles than we do in England. In spite of this, the manufacturers export the same articles into this country, and after paying the freightage often undercut our firms' prices. It would seem to us that the obvious course is not to impose a new duty on submarine telegraphy, which would hinder the commercial facilities of the States, but rather to reduce the import tariffs on the various articles, which import tariffs, as shown above, are obviously harmful to the American citizens as a whole.

Electricity in Coal Mining.—Mr. W. Gilbert Irwin has communicated a useful article to *Electricity* of New York on the various uses of electricity in coal mining. It seems that at the present time electric lighting for underground workings and electric haulage and electric power for mining machinery, are in wide use in the coalfields of America. In a large degree electric lighting has done away with the use of the ordinary safety miners' lamps, although it has not yet been brought to the desired height of perfection. There are, however, a number of well qualified types of electrical mining machines in use in the United States to-day. In Western Pennsylvania, for instance, machines of both the chain-cutter and the puncher types operated by electricity are now being used with much success, and the keen competition between the electrical firms manufacturing this class of machinery has been responsible for many notable improvements. It is estimated that the average electrical power-driven mining machine will do the work of 12 men. One machine cuts from 50ft. to 100ft. of entry per day. Power for these coal-cutters and the electric lighting is usually furnished from an electric power plant at the mouth of the pit. In many cases the motors are of the multipolar type, having iron-clad armatures and two field coils well protected from injury by the frame of the machine. Again, the introduction of electric haulage in coal mining has reduced the cost of bringing the coal out of the mine to less than 2½d. per ton, and at the same time has increased the output to five times. In several cases of electrically-equipped mines in Western Pennsylvania the output is something like 5,000 tons daily, which forcibly illustrates the benefits of electricity in the coal-mining industry. That this is generally recognised in America is to be concluded from the fact that all the mines opened during the past three or four years are equipped with electric power plants. Another considerable item of expense is removed through the working of the tipple by electricity, while the switches, dumping apparatus, screens, and machinery for loading on the railway cars are all operated by the same agent. Also in the coking fields electricity has displaced the older systems, and is now extensively used for charging the ovens and to operate the automatic coke-drawing machines. All the large electrical manufacturers of to-day devote great attention to the manufacture of motors, dynamos, and other electrical machinery especially adapted for coal-mining purposes, and in the opinion of the author the possibilities in this direction are constantly becoming wider and wider. In this country the same remark applies, as our coal mines were amongst the first supporters of electrical engineering for both light and power.

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MAIDSTONE ELECTRICITY WORKS.

Maidstone, the capital of Kent, is noted, amongst other things, for its strict conservatism. When the electric lighting works were opened just before Christmas, the Mayor, in an interesting speech, gave some facts as to the past history of the municipality. We forget exactly how many charters the town has had, but believe their number to be six, and that a fair proportion of them were revoked

MR. W. A. STEVENS,
Who, with Mr. R. A. Barker, acted as Consulting Engineers for the Maidstone Electricity Works Equipment.

in ancient times owing to the turbulent actions of the inhabitants. The Mayor also stated that in 1839 there were no less than seven coaches a day running between Maidstone and London, while the time taken on the journey was 3½ hours. He added that while there was a more frequent service now with the railways, the length of time spent in getting from London to Maidstone often approached three hours. The reason for this is that when the railways were introduced, the inhabitants of Maidstone opposed the same to such an extent that the town is not on any main line. The history of the town as regards electric lighting is equally discreditable to the town councillors who have held office during the last 11 years. It was in 1890 that the Corporation first tried to get a provisional order for Maidstone, and in the same year a resolution was passed in favour of a provisional order being obtained.

MR. E. E. HOADLEY,
Borough Electrical Engineer to the Maidstone Corporation.

This was not actually got until 1892, and from then until 1899 practically nothing was done. Reports were obtained from various expert electrical engineers, only to be considered and shelved, and several attempts to traffic in the order also came to nothing. Eventually, however, a firm of electrical engineers in Maidstone, who have done a large amount of isolated plant work both in the town and the surrounding district, undertook the arduous task of persuading the Town Council to spend money in carrying out their obligations. The old proverb that "A prophet is not without honour save in his own country" has not proved true in this case, as Messrs. Stevens and Barker not only advised what should be done, but carried the councillors with them in providing ample plant for a general supply throughout Maidstone. A public enquiry was held by the Local Government Board in June, 1900, and after the scheme had been approved by Sir W. H. Preece, the loan was duly granted. Originally it was proposed to have a combined electric lighting and refuse destructor scheme, but the refuse destructor part was subsequently omitted.

The site selected for the works is an excellent one, and is situated in the Fair Meadow, in the north end of the cattle market. It is practically adjoining the river, so that coal can be landed from barges coming up the Medway, and also the water from the river can be used for condensing purposes. Three-quarters of an acre has been reserved for the undertaking. The only drawback which was brought against it was its liability to occasional floods from the rising of the River Medway adjoining, but this danger has been guarded against in the designing of the works. The floor levels have been kept 6in. above the highest flood level recorded for very many years—*i.e.*, that of February, 1900, when the Medway rose 11ft. 4½in. above its normal level — the floor being, therefore, 11ft. 10½in. above it. Those parts of the buildings which are below the floor level are so constructed

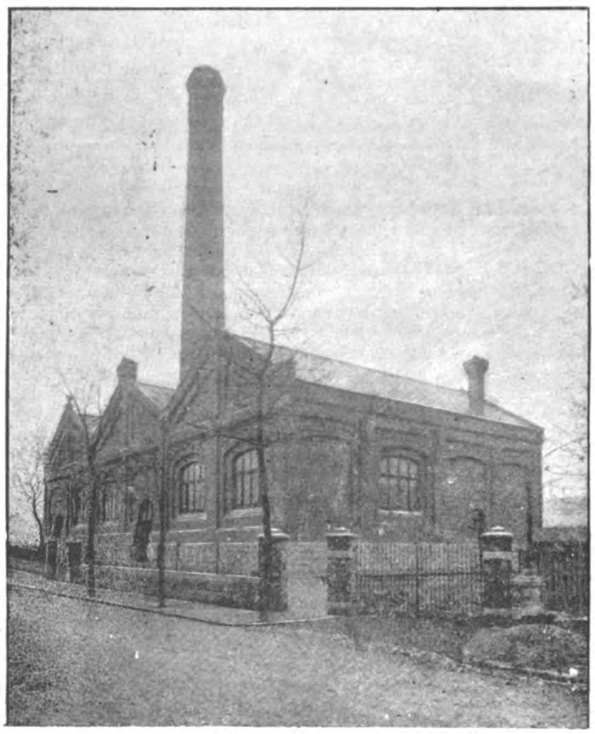

FIG. 1.—View of the Maidstone Electricity Works.

as to be proof against any water entering them except by rising above the floor of the works. The designs of the buildings were prepared by Mr. T. F. Bunting, the borough surveyor of Maidstone, who also superintended their erection throughout. They are divided into three blocks respectively—the boiler-house, engine-house, and accumulator-room, with offices above. Temporary ends are provided on the first two blocks, so that they can be extended backwards towards the river as extensions become necessary. The offices, which lie to the right of the other building and over the accumulator-room, are approached by a separate entrance, which comes opposite the Corporation baths. The buildings, as shown in Fig. 1, are built of brick, and they are in most cases lined with white glazed bricks relieved with brown dados and friezes. A general view of the engine-room can be seen in Fig. 2. The main dimensions of the buildings are as follows: accumulator-room, 37ft. 3in. by 30ft. 4in.; engine-room, 63ft. 6in. by 32ft. 6in.; boiler-house, 52ft. by 31ft. 6in. There is a large pit below the engine-room for a condensing plant.

The chimney shaft adjoins the boiler-house at the south-west corner of the buildings, and is 152ft. high from the ground level. The putting in of the foundation for this

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was a work of some difficulty on account of the large amount of water percolating through the sides of the excavation from the river, which commenced at a depth of 7ft. from the ground, and increasing in volume to the bottom of the hole, which was 22ft. deep The concrete base is 30ft. square and 13ft. thick, and stands some 5ft. down in the solid gault clay, the whole block containing 460 cubic yards, or just over 600 tons. Upon the concrete, composed of six parts of Thames ballast to one of cement, is built a brick foundation 6ft. thick, 22ft. 5in. square at the base. The base of the shaft is square on plan up to 22ft. from the surface, and thence from a stone plinth is octagonal up to the top. The base outside is 16ft. square. The thickness of the brickwork at the base is 3ft. 7½in., diminishing to a thickness of 14in. at the top by 4½in. set off every 26ft. A 4½in. firebrick lining is carried up to a height of 64ft. from the base of the opening, and separated from the main walls by a 2in. cavity. Two flue openings have been provided in the shaft, one being left for future extensions. A copper band lightning conductor has been fixed with five terminals, the lower end being attached to an earth-plate buried in the ground. It was built wholly from the outside. It is faced with Rainham red bricks, the backing being of Godstone gault bricks. The brick foundation and the top 50ft. are built in cement and sand, and the remainder in mortar. The dressings are of red Mansfield stone. The whole of the work on the chimney alone occupied 7½ months, and the cost was £1,873. The chimney is larger than is necessary for present requirements, having been originally intended to accommodate, in addition, the

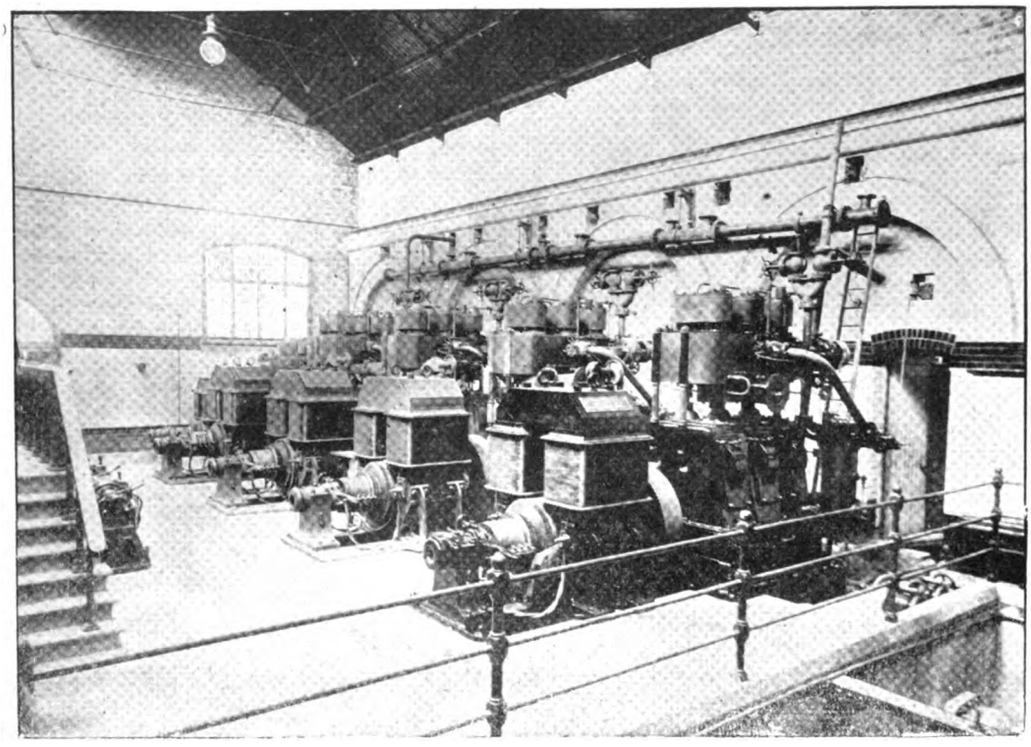

FIG. 2.—The Generating Plant at Maidstone.

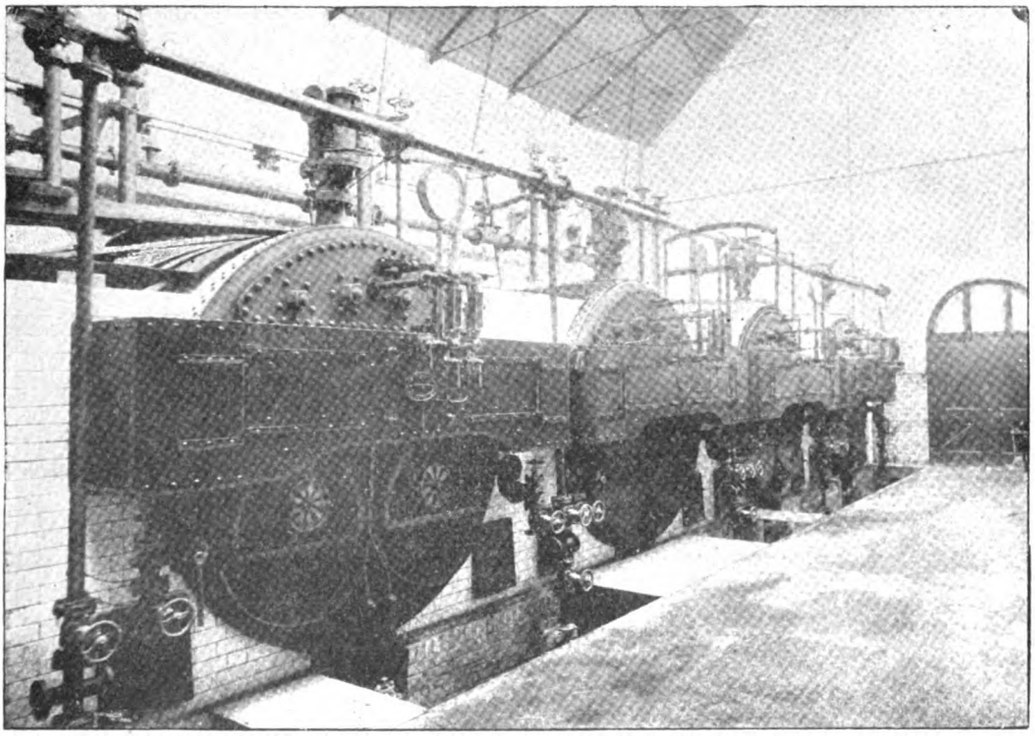

FIG. 3.—The Maidstone Boiler-Room, showing the Four Davey-Paxman Economic Boilers.

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proposed refuse destructor, but it was thought wise to build it as it is in view of any future extensions. The original building contract was £7,551.

The steam generating plant (Fig. 3) in the boiler-house consists of four Davey, Paxman, and Co.'s multitubular boilers of the Economic type, each capable of evaporating 6,000lb. of water per hour at the working pressure of 160lb. per square inch. From the boilers the steam is led to duplicate steam-mains, one of which is in the boiler-house and the other in the engine-house. Pipes connect each engine and dynamo to these duplicate steam-mains, and all the valves are in these branch pipes. In this way no valves are required in the main pipes, and steam can be supplied to the engines through either main, leaving the other available for repairs, if necessary. Duplicate feed pipes are fitted to the boilers, the feed pumps in condenser pit being also in duplicate. An emergency pump is provided in the boiler-room for use in the remote contingency of the condenser pit being flooded.

cast-iron exhaust main, so arranged as to discharge either to atmosphere or to a Cole, Marchent, and Morley surface-condensing plant, situated in the pit at the west end of engine-room. The capacity of the condensing plant is 18,000lb. of steam per hour at 26in. vacuum. The air and circulating pumps, of Edward's patent, are driven by a compound engine. The circulating water is taken from the River Medway, which, as mentioned above, flows close to the station.

The switchboard (Fig. 5) is fixed on a raised platform on the north side of engine-room, approached by steps on either side. It is divided into five sections, each containing two enamelled slate panels, the whole mounted on a steel angle frame and finished off at edges with a polished teak moulding. An electrically-driven clock and two illuminated dial feeder voltmeters surmount the switchboard. The middle section contains the accumulator switch gear, the voltmeters, and all the switch gear required in the middle wire. The two panels to the right contain the

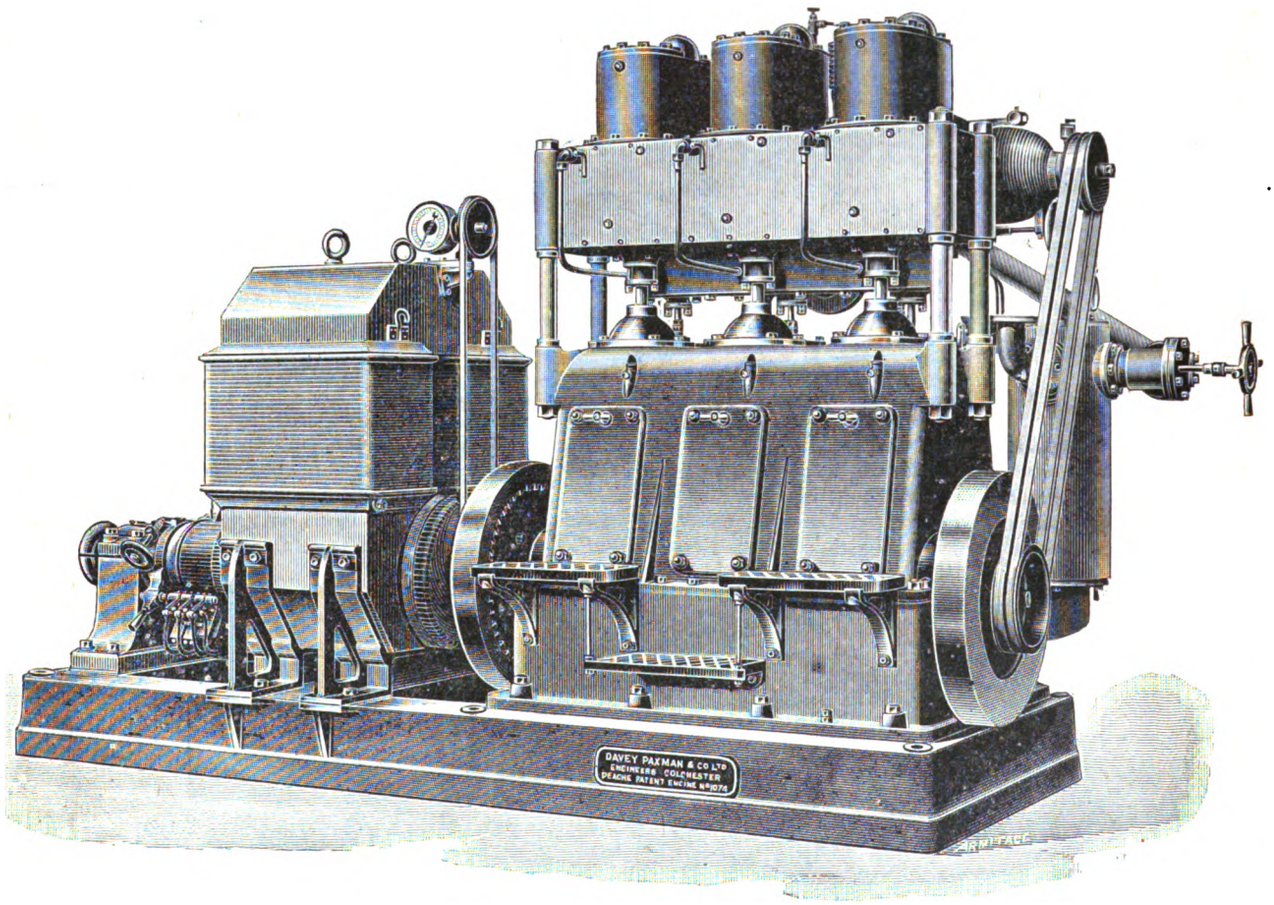

FIG. 4.—View of the Peache-Parker 150-kw. Steam Dynamo.

The generating plant in the engine-house (Fig. 2) comprises four 150-kw. and one 75-kw. steam dynamos. The engines (Fig. 4) are of the Peache three-crank, compound, single-acting, enclosed type, the larger sets developing 240 i.h.p. at normal load and 280 at overload, at 375 revolutions per minute; the small set developing 122 i.h.p. at normal load and 168 at overload, at 420 revolutions per minute. Each engine is direct coupled to a shunt-wound bipolar Parker dynamo. Heavy flywheels are provided in anticipation of a traction load. The field magnets of the dynamos are divided at the horizontal diameter of the armature bore, so that the magnets and armature can be removed by a direct lift. For balancing the load on the three-wire system and for charging the accumulators, a set of balancing transformers and battery boosters are provided. These consist of four separate machines coupled together in line in front of, and parallel to, the switchboard gallery (Fig. 5), the middle machines being the balancing transformers and the outside machines the battery boosters. One spare armature and magnet coils are provided respectively for the 150-kw. dynamos, the balancers and boosters; also a spare line of pistons and valve gear for the engines. The exhaust steam from each engine is carried into a

positive wire instrument, and those on the left the negative. Provision is made on these for six feeders and five dynamos. The switchboard was supplied by Messrs. Kelvin and James White, Limited, of Glasgow, and the instruments are of this firm's make. The field resistances for the five dynamos, the balancers, and the boosters are fixed under the switchboard gallery and controlled by sliding resistance switches fixed on a polished teak rail in front of the switchboard. An electricity meter is fixed in circuit with each dynamo, also one reading directly in ampere-hours in circuit with each side of battery. A portable polarised paralleling voltmeter is provided to plug in sockets fitted over each dynamo main switch.

The accumulator consists of 280 Chloride cells arranged in two batteries of 140 each, and is capable of discharging 100 amperes for five hours or 300 amperes for one hour. At the latter rate of discharge, it will supply over 4,000 8-c.p. lamps without assistance from the dynamos. The cells are erected on two-tier wooden stands (Fig. 6), and the plates are in glass vessels.

The distribution of electrical energy is on the three-wire continuous-current system, with 230 volts at the consumers' terminals. Three-core pilot wires are carried from

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the various feeding points to instruments on the switchboard, which indicate to the switchboard attendant the electrical pressure on the distributors. The feeders and distributors are laid on Callender's solid filling-in system. The copper conductors, insulated with vulcanised bitumen, are laid in

Junction of	Faith-street and Week-street	·32, ·32	square inch.
,,	Ashford-road and Albion-place	·20, ·20	,,
,,	High street and Pudding-lane	·32, ·32	,,
,,	College-road and Knightrider-street.	·20, ·20	,,
,,	Tonbridge-road and Terrace-road ...	·25, ·25	,,
,,	London-road and Buckland-hill ...	·25, ·25	,,

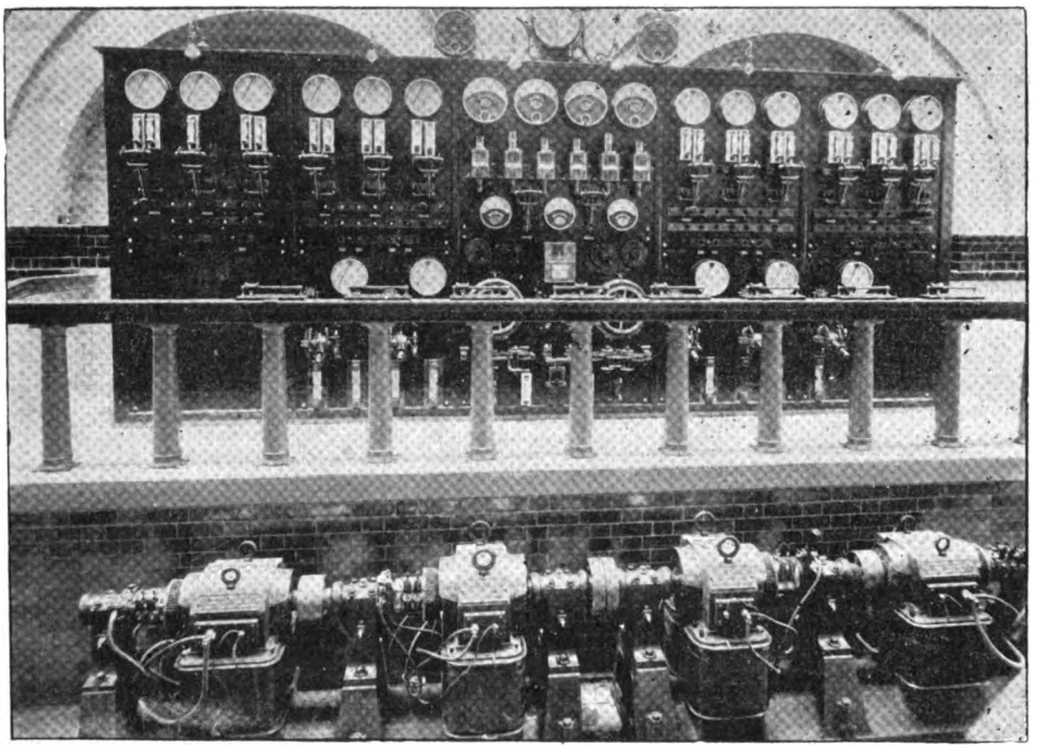

FIG. 5.—The Maidstone Switchboard, with the Balancing and Boosting Set in foreground.

iron troughs and filled up solid with Trinidad bitumen, the top of the trough being protected by heavy tiles. The three-core pilots, the arc lighting mains, and also the services to the consumers are protected by an armouring of two layers of steel tape and laid direct in the ground. In nearly every case the mains are laid in the roadway so as not to disturb the granolithic pavement. Disconnecting and fuse boxes are fixed at various points on the distributors for testing and isolating purposes, and a number of these are of the switch pillar type. From the switchboard six feeders are carried to the following points.

All the feeders contain two conductors only, and two neutral wire feeders are provided. One goes to the top of High-street, and is of ·20 square inch section; the other to the West Borough has ·125 square inch sectional area. Distributing mains are laid in the following streets: High-

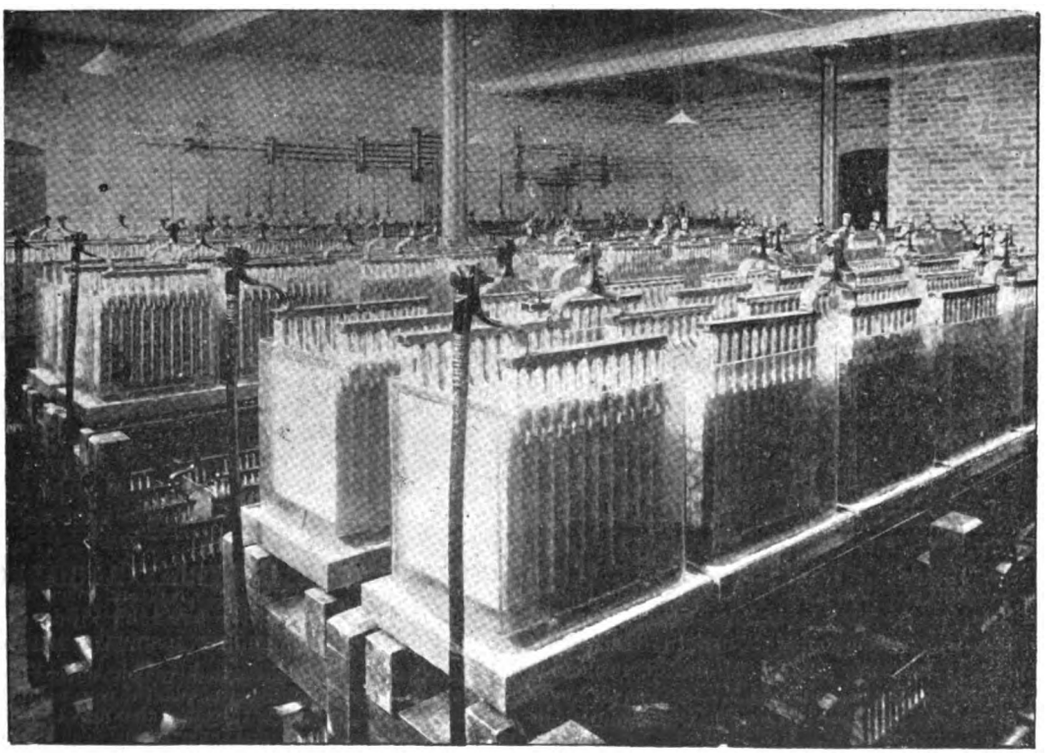

FIG. 6.—The Accumulator-Room at Maidstone, with the Chloride Accumulators.

street, Mill-street, College-road, Knightrider-street, Lower Stone-street, Gabriel's-hill, Week-street, Earl-street, Faith-street, King-street, Ashford-road, Albion-place, Sittingbourne-road, Holland-road, Broadway, Tonbridge-road, Terrace-road, St. Michael's-road, Rocky-hill, London-road, and Buckland-hill. The length of streets in which mains

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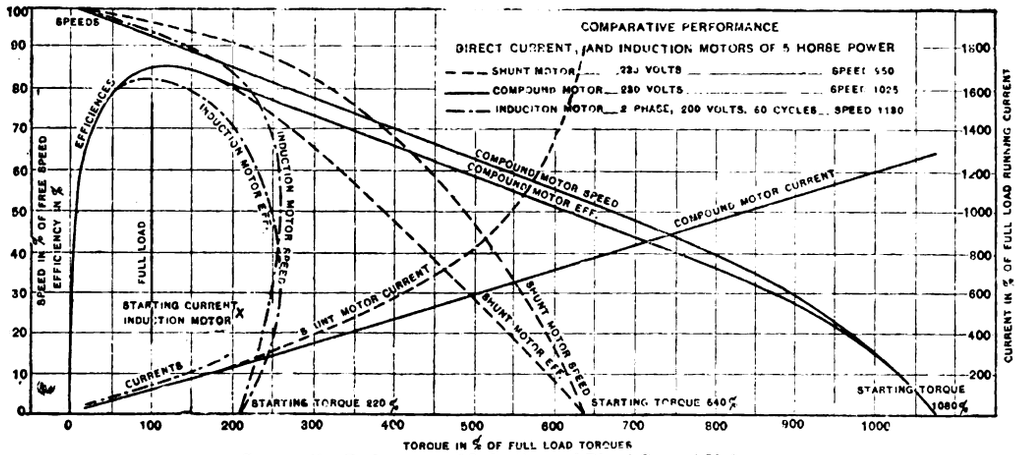
are laid is a little over five miles. As regards the lighting of the streets, High-street, Broadway, part of Tonbridge-road, Week-street, Gabriel's-hill, Lower Stone-street, King-street, Ashford-road, and Albion-place are lighted by 44 Brockie-Pell arc lamps of 1,000 c.p. each. Earl-street and Middle-row are to be lighted by incandescent electric lamps fixed on the existing lamp-posts. All the cables were supplied and laid by the Callender Cable and Construction Company, Limited.

Such, then, are the works designed by the consulting engineers, Messrs. Stevens and Barker, and now handed over to the care of Mr. E. E. Hoadley, the borough electrical engineer. At the opening ceremony, which took place on Dec. 19, reference was made to the introducing of electric tramways into Maidstone in the near future. One scheme for these is to come before Parliament this year. These trams would be worked from the present station. The load already obtained is equivalent to over 9,000 8-c.p. lamps, and there seems every prospect for the undertaking quickly reaching a stage at which it will be self-supporting. Our thanks are due to the consulting engineers for the photographs reproduced above.

ALTERNATING v. CONTINUOUS CURRENT MOTORS.

The interesting diagram reproduced herewith was presented by Mr. Gano S. Dunn in a discussion before the American Institute of Electrical Engineers last November on Mr. C. F. Scott's paper, entitled "Alternating Current as a Factor in General Distribution for Light and Power." proportion to the result obtained. At this point Mr. Dunn exhibited a lantern slide of the curves shown herewith. The motors compared were three 5-h.p. motors. One of them was a plain shunt motor adapted to 230 volts and 950 revolutions; the other was a constant-speed compound-wound motor for the same voltage with a speed of 1,025 revolutions. The third motor was an induction motor of the same voltage, running at 1,130 revolutions at 60 cycles. The data for the induction motor were taken from the publications of a prominent company building such motors; the data for the direct-current motors were taken from tests made on commercial motors of standard rating taken out of the storehouse. In order that the results might be comparable the elements of the curves are all expressed in terms of percentage of full load. At full load the running current of the induction motor is about 10 per cent. greater than the running current of the direct-current motors. At full load the efficiency of the induction motor was about 3 per cent. lower than that of the direct-current motors and at overload rapidly fell off. The efficiency of the direct-current motors, however, was maintained. At full load the shunt motor falls off in its speed about 4½ per cent., the induction motor about 5 to 6 per cent., and the compound motor about 7 per cent. At 100 per cent. overload the shunt motor is superior to either of the other types. When the induction motor is loaded to 2·6 times its normal torque it reaches its breakdown point, whereas both the direct-current shunt and compound machines keep turning, and the shunt motor does not "stall" until 640 per cent. of normal torque is reached, while the compound motor continues until 1,080 per cent., or nearly 11 times normal torque, is reached.



Comparative Performance of Induction and Direct-Current Motors.

Mr. Dunn drew special attention to the statement by Mr. Scott that the induction motor is to some degree an analogue of the shunt motor. In the first place, he said that this analogue is limited to a shunt machine with constant field excitation. By that limitation, Mr. Dunn thought, was really overlooked one of the principal advantages of the shunt motor, which is the possibility of controlling its speed by controlling its field. To this, he pointed out, there is no corresponding analogue in the induction motor. The second point in which the analogue fails is that the speed of the induction motor cannot in any wise be changed by varying the voltage upon its armature. This matter of speed control, he thought, far from being an insignificant element, is very important, and we must not think that in future we shall be contented with constant speed simply because we have been accustomed to it in the past. Multiple-voltage systems are coming into wide use, and only direct-current motors can be used with success on such systems. A four-wire system can give six fundamental speeds, and by modification of these by variation of field strength, or the use of a little armature resistance, 12 speeds of practical efficiency and stability may be obtained. With Mr. Scott's suggestion that any objections which might be brought forward to the use of the induction motors would probably be urged on account of reasons applying to the supply system only, Mr. Dunn disagreed, because to design the system properly to eliminate these objections would cause the cost to go up out of all In work where there is liability to overload, as in rolling-mill work or ironwork of any kind, the liabilities of overload are very frequent and very severe. To get the same service out of an induction motor as from a direct-current motor, a bigger machine must be put in, and the cost will be much greater. Mr. Dunn believed that, while the direct-current motor may require a little more attention, it is cheaper and can do more.

We are indebted to the *Electrical Review* of New York for the above *résumé* of Mr. Dunn's remarks.

SOME PRINCIPLES UNDERLYING THE PROFITABLE SALE OF ELECTRICITY.*

BY ARTHUR WRIGHT, ASSOCIATE MEMBER.

As most power-station managers have now emerged from the trying stage of not having a sufficiency of plant to cope with the amount of business offered them, and have realised that mere largeness of revenue, of lamp connections, or of maximum annual load do not necessarily imply large profits or commercial success, they are now devoting more time to ascertain what steps should be taken to encourage the continuous accession of profitable business, with the result that a great deal of study and ingenuity is being applied to the subject of this paper. With the object of eliciting the latest views on the subject, and enabling us to agree as soon as may be upon the final form to which all sound forms of electricity tariffs should approximate, the writer proposes to discuss some of the fundamental principles which

* Paper read before the Institution of Electrical Engineers, Dec. 12, 1901.

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underlie the whole subject of profitable electricity supply, and to outline a form of rational tariff which will be applicable to the great majority of electricity consumers.

At first sight the subject seems allied rather to mere trading considerations than to the scientific investigation of electrical engineering matters, but it is easy to show that, unless some of the principles involved are thoroughly understood, the design and equipment of an electrical power station might possibly be carried out on altogether wrong lines from an economic point of view. It is also probable that the financial loss incurred by a supply authority disregarding the Hopkinson doctrines of electrical costs would completely annul all the benefits that should accrue from the use of the most efficient modern machinery and systems of distribution, the selection and management of which have hitherto absorbed nearly all the attention of electrical engineers. This statement is completely demonstrated by the actual results at the Brighton power station, whose load factor has been increased from 11 to 17¾ during the last eight years. Had the present load factor existed eight years ago, the then inclusive cost of supplying a unit of electricity would have reduced by a larger amount than if the whole of the actual expenditure on coal, stores, repairs, and wages at the works had been saved. Again, the conditions determining the cost of supplying electricity are such as to justify the anticipation of supplying nearly all the interior domestic artificial lighting in a town, provided that a tariff based on proportionality to true costs is adopted, so that instead of erecting small power stations with the idea of only supplying the few best streets, the design, were these principles recognised, would proceed on the assumption of having to cater for even a larger custom than that of the local gas supply. It is also scientifically interesting to determine the laws which connect the reduction of costs with the improvement of load and diversity factors and the increase of the output, as well as the relative importance of effecting a reduction of the cost by either plant economy or the selection of consumers. Finally, it is obvious that the lower the price at which electricity can be profitably sold, the greater must be the amount of work in store for us in the future.

That the time is opportune for a discussion on electricity costs and charges will be evident when we realise the great confusion of ideas on the subject that at present exists, as proved by the following dozen, out of many other, anomalies. In many towns the supply authorities (1) Instead of attempting to standardise the tariff system, have as many as seven or eight bases for making out their customers' accounts, and do not realise the muddle this will inevitably lead to when the consumers number thousands. (2) After adopting a more or less correct form of sliding scale of charges, deliberately destroy the benefits accruing from such a course by offering the early-closing consumers, or low load factor consumers, the option of a cheaper uniform rate to lessen their accounts. (3) While willing to supply many consumers at much less than what must ultimately be the true cost price, refuse to sell to others at a price which can easily be shown would produce a profit of 50 to 100 per cent. on the cost. Moreover, they frequently show a most pronounced reluctance to do anything which will discourage the consumption by hopelessly unprofitable consumers. (4) Are willing to lower the initial price chargeable per unit in the sliding scale, under the erroneous belief that they are thereby benefiting the average consumer, whereas it can be shown that this is the most unlikely way of doing so. (5) While eager to run their mains in the rich residential districts, hesitate to supply the shopping thoroughfares of the poorer classes, which are generally a more profitable field. (6) Give discounts based purely on the quantity of electricity consumed, irrespective of load factor. (7) Actually discourage the installation of any but constantly-used lamps, by giving discounts on the basis of the load factor of the connected lamps instead of on the actual demand. (8) Discourage the use of lamps, and thereby the employment of their own capital, during the time most people require light by quoting a high evening rate and a low day rate. (9) Agree to an abnormally low initial price per unit being fixed for a power distribution scheme, independent of the power factor of the supply or of the cost of distributing the energy. (10) Adopt a fixed price per unit for public lighting, irrespective of the number of hours per annum such a supply is required. (11) Hope that by making the price uniform and low enough the supply will become so rapidly universal that all necessity for a sliding scale of charges will disappear, forgetting that the mere size of a business will never alter the fact that the standing-by cost of supplying a 6 per cent. load factor consumer will always be five times that of a 30 per cent. load factor consumer. (12) Believe that in any case nothing should be done to displease the large early-closing consumers, who they assume will always be the mainstay of the business, because their custom was so early forthcoming.

This curious state of affairs cannot be due to apathy, to over-prosperity, or to sound reasons of expediency on the part of the supply authorities, as it is only fair to suppose that they are possessed of too much commonsense to allow such causes to interfere with the natural desire to trade on ordinary sound commercial lines, so there seems no alternative but to assume that the reason is to be found in either their scepticism as to the soundness of the Hopkinson doctrines, in their incomplete grasp of them, or in their fear of displeasing their early-closing constituents. Although there is a danger of a lengthy investigation of the subject creating an exaggerated idea of its complexity, the writer proposes to recapitulate a part of what has already been written, in order that the matter shall be now presented in as complete a form as possible. It is obvious that before methods of charging for electrical energy can be properly examined, some approximate idea of the cost of generating and distributing it under varying conditions must be obtained, and no excuse is needed for going rather deeply into this part of the subject. As is well known, Dr Hopkinson first enunciated the correct method of determining the cost of supplying electricity in bulk from a power station under varying conditions, and Prof. Kennedy soon afterwards suggested a method by which the cost of individually supplying the great majority of electricity consumers could be approximately arrived at.

Following generally the lines laid down by these two authorities, the writer proposes to examine the problem as it exists to-day, modified by the realisation of the important effect in reducing costs of what is now termed the *diversity factor* of different classes of consumers, and of the magnitude of business. As a comparatively simple method can be used for approximately determining the cost of supplying nearly 90 per cent. of the consumers of most electric supply undertakings, the writer trusts that his attempts to further develop our views so as to cover most of the remaining 10 per cent. will not intensify the general impression that as the whole subject is such an extremely difficult one, the only practical course is to consider the tariff on the basis of average rather than on individual costs.

The cost of supplying electrical energy from a power station can generally be separated into two very clearly defined groups—viz. : (A) The cost of *getting ready* to supply and distribute energy. (B) The actual cost of *continuing to do so*. These two groups the writer will call, for convenience, *preparation* and *production* costs respectively. The *preparation* costs may be divided into three sub-divisions : (1) The annual cost of the initial capital required to start the undertaking, or the *preliminary* or *formation expenses*. This has generally no very definite relation to the amount of business expected to be done. As the business grows, the annual charge to individual consumers to cover this item of expenditure most obviously rapidly diminish. (2) The annual cost of having to provide and maintain the plant and mains in a condition ready to supply and distribute electricity. These *standing-by costs* vary roughly with the annual maximum load to be provided for. (3) The cost of maintaining the necessary service lines, meters, and attending to consumers' accounts, complaints, and collecting the revenue. These *service costs* are roughly proportional to the number of consumers.

The *production costs*, or the costs of continuing to produce and deliver electricity to the consumer, are those which actually vary with the amount of electricity distributed from a given power station and set of mains. The production cost per unit sold may be defined as the increment of expenditure incurred by making a given set of plant and mains supply an extra unit of electricity. It can only consist of the following items : (1) the inclusive cost of fuel necessary to produce and deliver this extra unit of electricity to the consumer's premises ; (2) the cost of the fuel necessary to keep the steam dynamos running longer per day ; (3) the cost of the extra water and oil used, owing to the longer run of the plant and the greater amount of energy supplied ; (4) possibly some extra wages cost due to stokers and engine attendants having to work slightly longer per day ; (5) the cost of that extra wear and tear of part of the plant which is solely due to the continued running.

As the writer wishes to lay particular stress on the relative smallness of the production costs to those of preparation in most electric supply businesses, it is perhaps wise to discuss one or two of the many methods for determining their approximate values for any completed power station which, the writer will assume, has reached the steady extension stage, when additional plant and mains have to be put down year by year to meet the increasing business. The value of the first four items and their total cost per unit delivered to the consumer can be roughly determined by noting the respective amounts spent on each item during two periods of equal length, such as a month or a quarter, which having approximately the same maximum load, differ considerably in their respective sales of electricity. The difference of the costs of these items for the two said periods, divided by the difference of the respective sales, will give the average production costs per unit sold. In most towns in spring or autumn, two days can be found which will afford a similar opportunity—for instance, the comparison of an early-closing night's costs and sales with those of a late-closing night's costs and sales, or those of a bright with a foggy day's results will do. If the difference in costs and sales are sufficiently large to render possible errors in taking the measurements of coal, water, and stores negligible, and the respective maximum loads require the same number of engines and boilers to be used on the two occasions, a fairly reliable result will be obtained.

Perhaps one of the best graphical and most reliable methods of determining the preparation and production groups of costs is that shown on diagram No. 1, applied to the Brighton power station results of 1900, where the total monthly costs of coal, stores, and labour in the undertaking during the different months are plotted in relation to the varying sales of electricity in these months, the two halves of that year being, for convenience, plotted on opposite sides of the zero sales line. It will be fairly obvious that a straight line run through these monthly costs, and extended to meet the zero sales line, will cut this at a height representing approximately the average total monthly preparation costs on these three items of coal, stores, and labour for each of the two half years. The difference between any month's expenditure on these three accounts and this total, divided by the number of units sold in that month, will give the average cost per unit of continuing to produce electricity during each of the half years, with the omission of the cost of repairs due to continued production, which, being of a cumulative nature extending over years, has to be separately estimated.

As to the most correct method for determining the cost of plant repairs on production account there may be considerable doubt, but as they generally form only a very small proportion of the total plant repairs, and merely include the cost of renewing those parts of the plant which are worn out through *continuing to supply* as distinguished from *continuing to be ready to supply* and consist of such items as extra boiler cleaning, reboring of cylinders, repairs of pumps, brasses, dynamo brushes, and commutators, the writer thinks he is on the safe side when he suggests this item should be taken to be equal to half the total cost of repairs to plant during the last three or four years, divided by the number of units sold during that period.

If station managers were to determine by some such method the actual production costs, many would be surprised at the smallness of the figure. From the writer's experience, he finds that the only items

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of cost that are appreciably increased by continuing to produce electricity from a given plant for another hour or so are those for fuel and water, and that in the usual power station neither the cost of stores, labour, or repairs are measurably affected by thus prolonging the running hours of the plant. This is probably due to the cost of these items depending chiefly on the number of engines, boilers, and steam-pipes that have to be put in commission to meet the day's maximum load, and not on the number of units the plant has produced. It will be remembered that Dr. Hopkinson's original estimate of the total production costs in a power station in the Midlands, with coal at 10s. per ton having presumably a calorific value of about 11,000 B.T.U., was a third of a penny.

Having arrived at the approximate value of the total production cost per unit delivered to the consumer, taken over a complete year, the analysis of the debit side of the revenue account of an electric supply undertaking can now be completed. If the production cost multiplied by the total number of units sold be deducted from the whole of the charges on the debit side of the revenue account, the total preparation charges will remain. From the total preparation costs must now be deducted the service costs, which can be separated without much difficulty, leaving the total standing-by cost of keeping the complete system in a state of readiness to supply electricity whenever it is required. If this be divided by the mean of the last two years' maximum load lasting half an hour on the distributing mains, the annual standing-by costs per kilowatt demanded (off the mains) will be obtained. That it is proper to take the mean of the last two years' maximum loads in determining the standing-by costs will be seen when it is remembered that in an expanding business such as that of electrical supply, the plant and mains actually laid down at the end of any year have not probably been available for supply purposes during the whole of that year. As the revenue is derived from electricity taken from the distributing mains, it is the maximum load taken from these, and not from the power station, which is the true

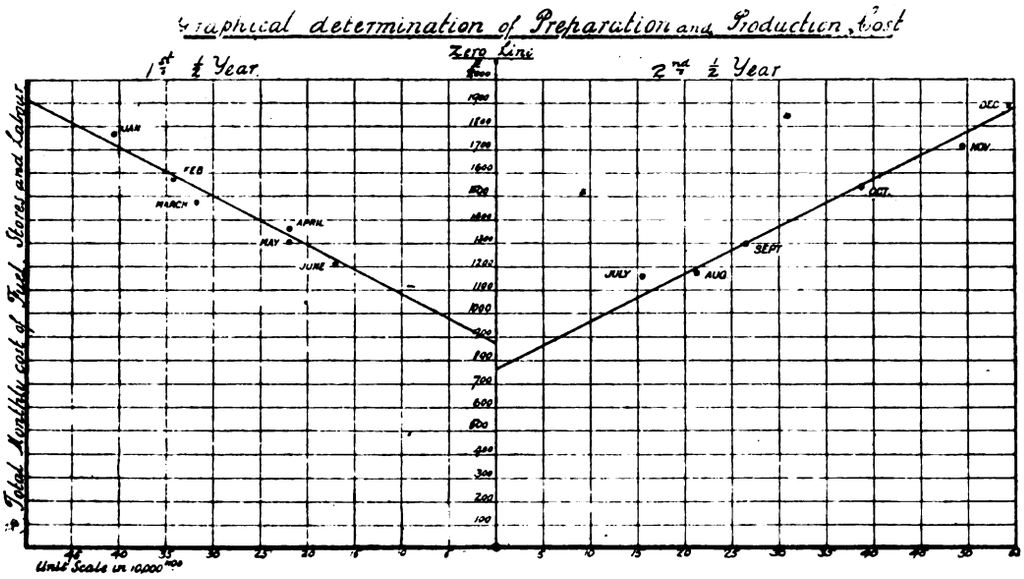

DIAGRAM I.

factor in determining the annual cost per kilowatt supplied to the body of consumers as a whole. In the matter of loss in distribution which is here involved, it is interesting to note that the fuel consumed in magnetising transformers is in practice purely a standing-by loss, and that the losses due to copper resistance of transformers and of feeders and mains form a production cost which has to be allowed for in their calculation. The graphical method above described, however, automatically differentiates sufficiently for practical purposes between all such kinds of preparation and production costs. In the item of preparation, the bare cost of money must be included, just as much as the cost of superintendence, repairs of buildings, of mains, etc. The cost of money may be taken to be that minimum rate of interest which business men insist upon getting for its use, added to the amount which has to be put aside annually for the redemption of the capital or ultimate renewal of the plant and mains. A capitalist would probably be justified in saying that he would be losing money if he did not at least receive annually 3 per cent. on his investment for interest, and 2½ per cent. for redemption or antiquation of plant from the time he put his money into the undertaking, and in all probability, until electrical undertakings are looked upon with the same confidence and treated by Parliament on the same equitable lines as railways, gas, or waterworks undertakings, the average capitalist will require an additional 1½ per cent. for money loaned to companies to provide for the many disabilities with which it has been seen fit to embarrass the infancy of our industry. A capitalist, in the writer's opinion, would not be justified in stipulating that, beyond paying for all repairs out of revenue, and the creation of an adequate redemption or antiquation fund, a further provision for depreciation and reserve fund should be debited to the revenue account, as these extra provisions ought to be provided out of the profits when the undertaking has emerged from the struggle incidental to its early years.

Recapitulating, we can now place all the items on the debit side of the revenue account into their proper divisions—viz.: (1) The total cost of *producing* the units of electricity, consisting of fuel, stores, and running repairs of plant. (2) The total inclusive cost of *preparing* for the supply of electricity, consisting of standing-by fuel, stores, labour, salaries, standing-by repairs of plant, and all other repairs, such as those to mains, buildings, etc., management, office expenses, insurance, taxes, etc. The cost of money, consisting of 3 or 4½ per cent. interest on the whole of the capital, less house service capital, and, say, 2½ per cent. for redemption of capital or antiquation of plant. (3) The service costs, consisting of interest on the cost of laying-on the house services, the maintenance and cost of reading meters, wages of collectors and consumers' clerks, and repairs of meters and other house service apparatus.

There is one other item of charge which has to be met by the revenue—viz., the loss unhappily incurred in this country in being compelled, for various reasons, to supply some consumers at less than the actual cost of supplying them. This loss, which in many stations is a very heavy one, must be debited against the revenue account.

Although we can thus obtain a fairly accurate analysis of the various items making up the cost of supplying electricity as a whole from the mains, yet before a true profit and loss account can be prepared we must determine the cost of supplying the individual consumers, and to do this many further considerations have to be taken into account. In the first place, how should the standing-by charges be divided among the consumers having widely varying requirements as to the amount of plant and mains required for their indvidual service? The writer thinks most power-station engineers will now agree that it is fair to debit each consumer with the same proportion of the total standing-by charges, as the amount of plant required for his supply during the evenings of the winter months, when the station experiences its annual maximum load, bears to that which would be required to supply the consumers should they all make their maximum demands simultaneously. As to the most practical method of determining the amount of plant, etc., so required by each consumer there are many opinions. Theoretically the best way of determining this data is no doubt some means by which every consumer's daily load curve can be taken and studied, but as this is commercially impossible, the writer is convinced that the next best way is to follow Prof. Kennedy's suggestion of supplying each consumer with a maximum demand indicator, and to make its rate of recording sufficiently sluggish to prevent the registration of any call for current for only a few minutes' duration. In a purely lighting business the majority of the consumers will make their maximum call for plant during the two or three hours in the winter days during which the whole of the plant is most heavily loaded, so that by taking the mean of the six winter months' maximum records so measured, a fairly accurate estimate of the proportion of the total plant required by each consumer can be obtained.

Another consideration is, How should proper allowance be given for the well-recognised fact that all consumers do not make their maximum demand for current during the same hours of the evening? A fair allowance for this general diversity in the use of the plant and feeders is best made by dividing the annual standing-by costs per kilowatt demanded off the mains by the ratio of the total of the consumer's individual demands in kilowatts during the month of maximum load to the maximum load taken off the distributing mains in that month, and debiting each kilowatt demanded by the consumer at this new rate. The above ratio, which has obviously a most important effect in reducing the preparation costs per kilowatt demanded by the consumers, may in a general lighting business be as high as 1½, and in a motive-power supply business the particular diversity factor among the motors can be much higher. For the purpose of clearness we will take an example in figures. Supposing the sum of all the consumers December demands has been 1,500 kw. and the maximum coincidental demand off the mains has been 1,000 kw., then the diversity factor is 1½, and in apportioning the total of the standing-by costs among the consumers it must be divided by the 1,500 kw. The case of a power station supplying both the business and residential districts of a town will illustrate the importance of the general diversity factor As two such districts would probably not make their maximum demands simultaneously, the total amount of plant required would be consider ably less than that necessary for the sum of their demands.

In the third place, how much, if any, should those consumers, who,

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DIAGRAM II.—STEPNEY BOROUGH COUNCIL ELECTRICITY WORKS.—APPROXIMATE REVENUE ACCOUNT FOR PERIOD ENDING SEPT. 30, 1901.

—	Year ending Sept., 1900. £	s.	d.	Per unit	Year ending Sept., 1901. £	s.	d.	Per unit	Month of Sept., 1900 £	s.	d.	Month of Sept., 1901 £	s.	d.
Fuel	1,537	1	8	1·01	1,801	16	9	·59	170	1	3	127	0	8
Stores	274	0	5	·18	148	4	6	·04	15	7	2	12	6	6
Repairs, plant, and buildings	53	4	11	·03	97	14	7	·03	7	8	7	4	19	8
Repairs, mains	20	7	4	·01	42	8	6	·014	3	3	7	1	16	10
House service maintenance	27	1	2	·02	91	18	6	·03	2	16	3	37	7	9
Salaries & wages	1,248	18	5	·82	1,718	5	0	·57	125	2	9	128	8	10
Rates and taxes	175	15	0	·12	189	7	7	·06	7	8	4	12	0	0
Miscellaneous expenses	512	13	5	·34	346	8	4	·11	39	18	9	17	9	5
Interest	2,208	5	3	1·45	2,788	15	7	·92	177	2	10	250	0	0
Sinking fund	169	6	9	·11	67	5	8	·02	9	11	0	9	12	6
Net profit	—			—	—			—	—			158	2	0
	6,226	14	4	4·09	7,292	5	0	2·42	558	0	6	758	4	2

—	Year ending Sept., 1900. £	s.	d.	Per unit	Year ending Sept., 1901. £	s.	d.	Per unit	Month of Sept., 1900 £	s.	d.	Month of Sept., 1901 £	s.	d.
General sales	2,684	17	9	2·74	5,198	1	1	2·53	369	3	6	583	2	11
Street lamps	1,034	14	10	1·84	1,542	8	10	1·57	99	16	4	153	12	7
Meter rents	78	15	5	2·44	142	15	1	2·23	9	8	10	14	19	1
Sundry receipts	43	2	7	—	63	12	1	—	4	9	0	6	9	7
Net loss.	2,385	3	9	—	345	7	11	—	75	2	10	—		
	6,226	14	4	—	7,292	5	0	—	558	0	6	758	4	2

Units sold year ending—	Max. load provided for.	Total cost per KW. minus coal.	Units sold—	Load factor.	Years.
Dec., 1900... 366,639	..... 350 kw.	..... £13·4	.. .. Sept., 1900... 37,775	..... 12 per cent.	 1900
Sept., 1901.. 722,282	..... 500 kw.	.... £10·95	... . Sept., 1901... 71,756	..... 16·45 per cent.	 1901

by reason of their never making a demand for current at the time the station's maximum load is on, and who therefore do not necessitate the supply authority putting down extra plant and feeders for their supply, be debited for standing-by charges? This is surely a case of determining the cost of a by-product, and the writer thinks it ought not to be treated as costing anything except on account of production and special service costs, and is fairly met by offering such consumers (who usually only form a very small proportion of the total number) the option of renting a time switch which will put the demand indicator only in circuit during the hours the station plant is heavily loaded with the lighting business. It may be argued that it is hardly fair to use other consumers' plant without giving them some allowance, as a case might happen when the day load might exceed the winter lighting peak, as has already resulted in Montreal from the energetic efforts of Mr. Brown and his staff to get a big day load for his water-power

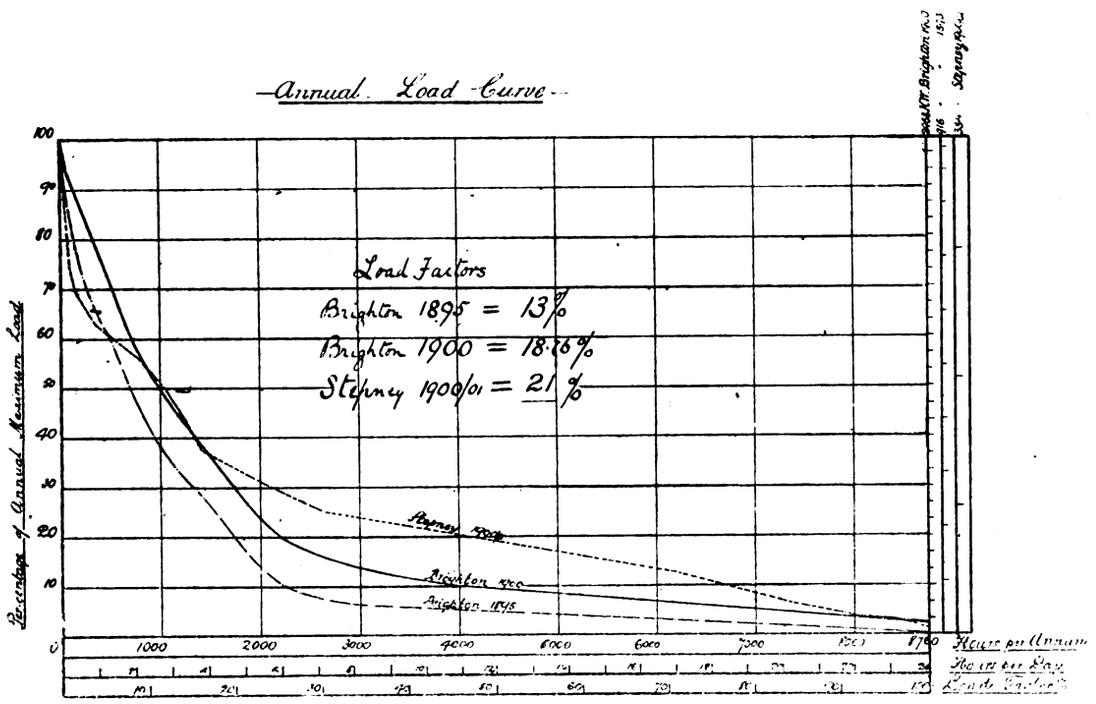

DIAGRAM III

station, but anyone visiting Montreal will be convinced that the above result, though startling, is neither the normal nor final state of the electrical supply business in that city, and is due to the temporary neglect of the profitable field of private lighting, which part of the business in Montreal is apparently negligible at present. So much profitable business can be done by the night supply of electricity for artificial lighting in the majority of cities, as to always ensure very much larger plant and copper being required for this load than for one of power to be only used in the daytime; hence the writer feels that the night users of the investment ought to be debited with all the standing-by costs, as it is their load which renders the expenditure necessary.

Again, how can due allowance be made to consumers, the intermittent or momentary character of whose use of electricity requires special consideration on the ground of such a class having necessarily a very much higher diversity factor among themselves than that of consumers whose demand for current is fairly constant during the evening from dusk until their closing time? This consideration applies as much to the users of electricity for motive power and heating purposes as it does to the lighting of the occasionally used rooms of private residences, hotels, etc. The standing-by costs per kilowatt of supplying this class of user is as much less than that of the 4 to 8 per cent. load factor regular consumer as the class diversity factor of the former is greater than that of the latter class, and a very fair idea of the proper amount of plant required to supply them in the aggregate can be obtained by measuring their demands by indicators designed to have a sluggishness of registration such that any load or increase of load has to be maintained for at least an hour to be fully registered and that if maintained for any less period the registration will be less. The use of sluggish demand indicators for all classes of consumers will automatically allow to the intermittent light and power users the discount they are entitled to on account of the probable larg diversity factor of such classes, and at the same time will register the true demand of all longer maintained loads. It is probably safe to assume that the *class diversity factor* of any large body of consumers will be roughly proportional to the shortness of the time during which they maintain their maximum demands, and it is an interesting problem in the theory of probabilities to determine the proper amount of discount to give on account of shortness of duration of demand.

It may at first sight appear that this method of employing sluggish demand indicators for the purpose of automatically giving a lower rate to intermittent consumers will also benefit the most undesirable class of consumer, such as the occupants of early-closing offices, who might only require a supply for one or two months in the year, and then possibly only for, say, half an hour at a time, and whose diversity factor cannot certainly be greater than unity. On further consideration, however, it will be seen that the cost of the supply of electricity

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to the very small minority of consumers *who never use their maximum demand for more than half an hour at a time* can be made so small by the use of a storage battery charged during daytime as to mitigate the rigid application of the usual Hopkinson law of costs to this class. In fact, a storage battery reduces the conditions of supply to such consumers to conditions more or less similar to those governing ordinary gas supply, in which the effect of the load factor on costs is small, and it is quite probable that the inclusive cost per unit to such lighting consumers can be considerably reduced by this means. There are, in fact, a limited number of consumers the nature of whose demand is within the economic capabilities of a storage battery, and we may consider them to the above extent.

Before going into the question of deciding the best form of tariff to adopt, the following notes on comparison of financial results may be useful: (1) It will be evident that only comparisons of the standing-by costs based on *yearly results* are useful, and should be made on the basis of their relation to the mean maximum load in kilowatts we may expect to have to meet in the year in question. (2) As most of the production costs can be determined after two or three months' or quarters' readings are available, monthly comparisons of them are then possible on the basis of units sold, and calculations can be based upon a constant price and an average quality of coal. (3) Comparison of service costs must be made on the basis of the number of consumers connected, and can be compared monthly, quarterly, or annually as desired. (4) The cost of plant repairs, being of a cumulative nature, can only be compared after three or four years' results are available. (5) Capital costs, being roughly in proportion to the maximum load provided for, the length of streets supplied with distributing mains, and the number of consumers connected, cannot be properly calculated solely on the basis either of units sold or on the maximum load in kilowatts with which they have no simple relation. (6) Undertakings with similar load factors and outputs cannot be properly compared unless the general diversity factors are assumed to be the same. As an example, no proper comparison can be made between the returns of an electrical undertaking supplying the business portion of a city, where the diversity factor may be as low as unity, with another undertaking supplying the residential portions where the diversity factor may be higher than 1·5, notwithstanding the possible equality of the load factors at the power stations. (7) Comparisons cannot be fairly made between electricity supply undertakings owned respectively by municipalities and companies. In the former case, no proper charge is generally made for town hall expenses, legal assistance and the borough surveyor's services, or for those of the members of the electricity committee, who act in the same capacity as company directors, and although municipal electrical undertakings have frequently to put up with troublesome labour clauses in their specifications, have to alter their charges to please prominent constituents, and to suffer from the frequent changes of management generally inseparable from municipal ownership, they are not burdened to nearly the same extent as commercial companies in the way of street work, raising of capital, or in the delays consequent on service of statutory notices.

The author wishes to lay particular stress on the futility of comparing anything but annual results in the matter of preparation costs, revenue returns, and load curves, and invites attention to the form of monthly return cards shown in Diagram II. he has adopted in the supply undertakings he is connected with, also to the method of plotting the annual load curve of a power station such as that shown in the diagram for the Brighton results in 1895 and 1900, and for the past year at the Stepney electricity works in Diagram III. This form of plotting the station working is, in his opinion, the most useful form station managers can employ. It is obtained by mechanically adding together the number of hours during which any given load from the distributing mains has been supplied during the year. From such a curve, with variable scales, can be determined various useful data, among which are: (1) The load factor at which any proportion of the total plant has been used; this is equal to the abscissa at the given load. (2) The relative importance of the production costs to the preparation costs for any given load; this is drawn by the ratio of the abscissa to a given ordinate. (3) The total cost of producing electricity at any given load; this is proportional to the sum of the abscissa and the ordinate. (4) The number of units sold annually at a given load; this is equal to the abscissa multiplied by the ordinate. (5) The maximum losses economically allowable in the feeders. (6) Only from such a curve can be determined what proportion of the plant should be supplied with full equipment of coal-saving apparatus, such as condensers, economisers, etc.

Unless some idea of the form of this annual load curve is known, it is quite possible for an electricity undertaking to be laid out on wrong lines. It must be obvious that all the peak of a curve should be supplied from plant put down, having in view rather the lowness of capital costs, of standing-by coal, and the small amount of labour required, consistent with thorough reliability of service, than economy in coal on production account. As the Brighton curve represents the general lighting business which may be expected in an average English town, the exceedingly poor load factor of more than half the capital in such businesses becomes apparent from its study.

From the accompanying analysis of last year's Brighton results it will be seen that nearly half as much coal was used in keeping the plant in a position to supply as was used in actually producing the current, although the average cost of coal per unit was only ·72d.—a very moderate figure, considering that the price paid was over 25s. per ton. From this fact may be inferred how important it is to carefully study the best means for reducing the heavy stand-by coal losses in the case of a lighting supply plant, and the danger in assuming the whole of the coal bill is due to the actual *production* of electricity. From the same analysis will also be seen that the bare cost of supplying any one individual consumer in Brighton with electricity in the particular year under study was £9. 13s. 4d. per kilowatt, or 6s. 2d. per 32-watt lamp demanded by the consumer, and ·6d. per unit consumed, plus the service cost, which ought to have been covered, but was not half covered by the meter rental. A profit and loss account, embodying the above principles drawn up in a complete form, is shown for the Brighton results in 1900.

ANALYSIS OF CHARGES TO REVENUE ACCOUNT OF THE BRIGHTON ELECTRICITY UNDERTAKING IN 1900.

Account.	1.	2.	3.	Total.
	£	£	£	£
Coal	7,920	3,231	—	11,151
Oil, water, and engine stores	310	1,020	—	1,330
Wages at works	—	5,355	—	5,355
Repairs to buildings	—	885	—	885
Repairs to machinery and plant	1,085	588	—	1,673
Repairs to mains	—	1,376	—	1,376
Repairs to meters	—	—	1,013	1,013
Fuse replacements	—	—	101	101
Salaries of permanent staff	—	1,375	1,202	2,577
Current expenses	—	464	—	464
Rates and taxes	—	1,237	—	1,237
Insurances	—	145	—	145
Printing and stationery	—	317	—	317
Law expenses	—	11	—	11
Interest and sinking fund	—	18,312	1,160	19,472
	£9,315*	£34,316†	£3,476	£47,107

1. Production costs, or those items incurred by continuing to supply, after the plant, etc., have been provided and got in readiness, and which vary with the number of hours the lamps are used.

2. Preparation costs, or those items which do not vary with the length of time the lamps are used.

3. Service costs, which are in proportion to the number of consumers, and independent of their use of the lamps.

* Or $\frac{6}{10}$d. per unit sold.

† Or £9. 13s. 4d. per kilowatt demanded by the consumers.

(To be continued.)

SOUTH SHIELDS CORPORATION ELECTRICITY WORKS.*

BY JOSEPH A. JECKELL, A.I.E.E.

(Continued from page 913, Vol. XXVIII.)

OFFICIAL TRIALS OF MCLAREN'S 1,000-I.H.P. TRIPLE-EXPANSION SURFACE-CONDENSING ENGINE, COUPLED DIRECT TO A 500-KW. ALTERNATOR SUPPLIED BY MESSRS. RICHARDSON, HARTLEPOOL, HELD AT SOUTH SHIELDS CORPORATION ELECTRICITY WORKS, APRIL 30 AND MAY 1, 2, AND 3, 1901.

Description of load	¼ load	½ load	¾ load	Full ld.	20% ovr
Duration of trial	2 hours	6 hours	6 hours	6 hours	2 hours
Volts	2,129	2,100	2,130	2,133	2,130
Kilowatts	130·2	257·2	381·8	507·8	593
Meter at start	83,328	74,488	76,304	79,007	82,105
Meter at finish	83,580	76.025	78,583	82,035	83,302
Difference	252	1,537	2,279	3,028	1,197
Kilowatts (by meter)	126	256·1	380	504·5	598·5
Boiler pressure $\frac{\text{lb.}}{\text{sq. in.}}$	170	167	165	166	165
H.P. receiver ,,	159	159	159	158	158
M.P. receiver ,,	8	24	38·6	59·2	75
L.P. receiver ,,	−15·4in.	−7·5in.	+1·3lb.	6·7	11·5
Vacuum (inches of mercury)	27·8	27·4	27·4	27·2	26·9
Revolutions per minute	124·5	123·7	124·2	123·9	121·7
Mean eff. press. $\frac{\text{lb.}}{\text{sq. in.}}$—H.P	23·05	37·17	45·82	49·2	48·75
,, ,, ,, M.P.	7·22	12·35	18·39	25·14	32·42
,, ,, ,, L.P.	2·85	5·175	8·09	11·90	15·39
I.H.P., H.P.	103·3	165·5	204·9	219·4	213·6
,, M.P.	78·6	133·5	199·6	272·1	344·8
,, L.P.	77·4	139·7	219·3	321·6	408·7
Total I.H.P.	259·3	438·7	623·8	813·1	967·1
Total steam (including) jackets	6,527	33,748	48,509	65,570	26,472
Steam per hour	3,263·5	5,625	8,085	10,928	13,236
,, I.H.P. hour	12·6	12·8	12·95	13·45	13·7
,, E.H.P. hour	18·7	16·3	15·8	16·1	16·7
,, kilowatt-hour	25·1	21·9	21·2	21·5	22·3
E.H.P.	174·5	344·6	511·6	680	794·6
Combined efficiency	67·3 %	78·6 %	82·0 %	83·6 %	82·2 %
Temperature of discharge	81	99°	103	106°	111°
Temperature of circulating water inlet	56	54	52°	56°	—
Temperature of circulating water outlet	75	91°	90°	91°	—

Engine constants, H.P. =0·036, M.P. =0·0874, L.P. =0·2182.

* Abstract of paper read before the Newcastle Local Section of the Institution of Electrical Engineers.

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Steam-cylinder sight-feed lubricators are used to all the high-pressure cylinders. These lubricators are fixed so that they can be worked from the floor and close to the engine stop-valve handle. They have been found to be very satisfactory—a great deal better than the lubricators which have a condenser attached. All the oil from the engine is filtered and used over again.

Considerable trouble was experienced in obtaining a really good, strong, serviceable filter, as most of the filters on the market are made in too weak a manner. Most of them have thin sheet-iron bodies, with a large number of soldered connections, but the life of these is very short. All the engines are well able to do their guaranteed output, and have to do an emergency load of 20 per cent. above the normal. Some of these engines have been running over four years, and are now in a condition to do considerably more than their normal load when called upon.

Alternators.—There are two 100-kw., two 200-kw., and two 500-kw., the first four being made by Messrs. Ferranti, one of the 500-kw. by Messrs. Siemens, and the other 500-kw. by Messrs. Brown-Boveri, through their English agents, Messrs. T. Richardson and Sons, of Hartlepool. All these alternators are of the iron-clad enclosed type, with revolving fields and stationary armatures. They have proved exceedingly satisfactory. No alternator has broken down on circuit. Since the station started, four years ago, there have been only two failures, and these were two coils burnt out while the plants were being run up for testing. The author has reason to think that this is a rare, if not unique, experience in the generation of high-tension current. These alternators generate current at 2,000 volts, and the exciters are direct-coupled to the alternators. This combination of plant—viz., triple-expansion engines and iron-clad alternators—seems to be an exceedingly convenient and advantageous one, seeing that a low steam consumption is obtained, together with the superior standing qualities of the iron-clad alternators over those with copper armatures. The alternators are invariably run in parallel, and, as can be readily understood, no difficulty has been experienced in doing this. This is because all the engines have three cranks, that all the engines are made to run at the same speed, and that all the moving parts of the alternators are heavy. No case has been experienced where an alternator has dropped out of parallel. The alternator bearings of the Ferranti plants are oiled by forced lubrication. The oil is pumped through the bearings by a glandless pump driven by an eccentric attached to the shaft. These glandless pumps have given great satisfaction, there being no glands, which in oil pumps are frequently a source of trouble. The pumps send the oil into the bearings with a pressure of 10lb. The bearings of the Siemens alternator are oiled with rings. These, too, have proved very satisfactory. A bridging cord is provided so that in the event of a coil burning out in an armature, that coil can be bridged over temporarily and the machine put on load if necessary. A coil can be bridged in a quarter of an hour, whereas the coil could not be re-wound under 24 hours at the very least. The idea is to have a machine which will stand short-circuiting if necessary, with sufficient self induction to prevent current being generated, which would be detrimental. The advantage of an armature enclosed in a watertight case has been shown when a steam joint has blown over the alternator, while it was running, with no damage at all to the machine.

Rectifiers.—Rectifiers are used for street-lighting, and have proved to be very satisfactory. Lamps run on rectified circuits seem to keep wonderfully good, the maintenance on them being very small. The light is steady, and it is a very rare thing to have a lamp stick owing to the undulations in the current. The points that want to be looked to are, first, the cables feeding the rectified lamps. Rubber cables were first used. These were single cables, both cables being laid in one cast-iron pipe. Single cables were used because it was not necessary to make any joints in them to connect on the arc lamps; moreover, concentric rubber cables had not proved a great success for this purpose. This may have been owing to the fact that when a rectifier is started up, it is not certain which way the current will go. A reversing switch is therefore provided, with an indicator, and if it is found that the current is in the wrong direction the reversing switch is thrown over. Obviously, therefore, it seems that there may be at times an enormous pressure on the cable when the direction of the current is suddenly reversed; more especially might this be the case in a concentric cable. These rubber cables, however, have not proved to be a success. After some two years' working they have failed, in not only one place, but along the whole line. Probably this is partly due to the phenomenon known as "osmosis," seeing that the negative lead was in many cases far the worse; but the lamp lead had also broken down, and this seems to point to some other cause. Not infrequently it was found that there were 10 faults in as many yards. This seems to point to the fact that some other cable instead of rubber should be used for rectified circuits. Rubber cable is naturally much more convenient for connecting on to the switches in the lamp-posts, and it would be well nigh impossible to use anything but rubber cable for connecting from the switch to the lamp. With regard to the rectifiers themselves, the one thing to be borne in mind seems to be to give them the very best attention, and to keep them absolutely clean. There was one station where rectifiers were placed in a sub-station, without attendance, and the author was of the opinion that such a method would be the reverse of satisfactory, as was found to be the case. If there are several rectifiers in the station it would be a very convenient method to run them separately off one plant, because if anything occurred to slow up one of the other plants, the arc lighting would not suffer: whereas should a temporary short come on the mains when all the machines were running in parallel, rectifiers as well, the rectifiers would probably all drop out of step, and this would give additional trouble which might easily be saved by running them all from a separate machine.

Switchboard.—The switchboard is of the well-known Ferranti type. It is divided into two halves, with inter-connectors between these two halves. Synchronising arrangements are attached to each half, and are also provided so that the two halves of the board, if necessary, can be synchronised together. This switchboard seems to work very well, and is apparently a very safe and solid arrangement. Duplicate oil fuses are used, so that if it is necessary to renew a fuse a new fuse can be put in place and the old one withdrawn. A jack cord is provided so that any circuit or machine can be bridged across to another panel if necessary in the event of the failure of an ammeter or switch. The switchboard at South Shields is erected on top of a platform, the platform being made of stone and concrete. The switchboard attendant stands on a rubber mat; there is thus no fear of fire, and it is as safe an arrangement as can well be imagined. A strong teak pair of steps is used for the attendant to stand on when he is doing anything on the top of the board. This may seem a very small item, but in so many places packing-cases put up temporarily are used for this purpose, which may slip, and even if they only rock the man at work may be inclined to put out his hand and seize hold of some part of the switchboard to steady himself. Unfortunately, he will very probably get hold of something that is alive, with, possibly, uncomfortable results to himself. This type of switchboard not having a back, as the slates composing it are built into the wall, there is not the danger there is in many boards, where the space behind is too often used as a receptacle for all sorts of material, and where loose cables are often in evidence. In view of the regretful accidents which have occurred in high-tension working, it is extremely essential that every means should be taken to make the working of high-tension boards as safe as possible. This type of board is too well known to need further description, but it should be mentioned that this board has been in use for four years without a single arc or accident of any kind occurring on it.

Pumps.—There are two sets of pumps used, one set for feeding the boilers and the other set for lifting the water from the river into the overhead tanks for circulating. The feed pumps that were first used were of the single-cylinder direct-acting duplex type; they were made in the neighbourhood, and were not altogether satisfactory. The present pumps which are used are compound duplex pumps, made by Messrs. Worthington and Co., and give satisfaction. There is also a larger pump by Messrs. G. and J. Weir, of Glasgow; this is of a very well-known type, and gives every satisfaction. These pumps draw from duplicate hot-wells and deliver into the boilers by a ring main. As the engines are surface condensing, a certain amount of grease comes into the hot-wells. It may be mentioned that the high-pressure steam-chest drain and cylinder drains are run to waste, the jacket water all being brought back into the hot-wells. A grease extractor was inserted in the feed pipe, between the feed pump delivery and the boilers. This acted very well, except that it had too much work to do, and it has been found to be convenient to put frames into the hot-wells, on which is coarse iron netting, to which is fastened ordinary cocoanut matting This cocoanut matting has proved to be most efficacious in extracting the grease from the water, and therefore the grease separator not having so much to do, does its work better. It may be noted in passing that, as electric light engines are so frequently stopped and started, and have to stand frequently so long without being turned round, much more cylinder oil is required than in the same size engines at sea, which are run continuously, and therefore the grease extractor, which is sufficiently large for a given amount of horse-power on board of ship, is not probably large enough for that given amount in an electric light station. The circulating pumps had to lift the water from the river and deliver it into a tank with a 25ft. head; the lift from the river varied from 1ft. to 18ft., according to the tide. Direct-acting single-cylinder pumps were used for this purpose at first, made by the same makers as the original feed pumps, but these were found to be extremely uneconomical, and in a further extension compound Worthington pumps were used. A flywheel compound pump, by Messrs. Carrick and Wardale, is now in course of erection. The Worthington compound pumps have given very considerable satisfaction, but there are details in their construction which can be considerably improved. The long levers to the piston rods might well be solid instead of being screwed together; in fact, the author has had to substitute solid arms for those originally supplied, as the former very soon became loose. These arms are keyed on to the rocker arm, and this key is very liable to come loose. There seems no reason why the end of the rocker arm should not be squared, and the arm fastened on with a nut and split pin, when there would be no fear of it coming loose. There is no method of adjustment provided in case the rocker arm wears in the bracket. It would be very little extra cost to have the bracket split and provided with adjustable bushes. All the pumps exhaust into a separate condenser, with an alternative exhaust to the atmosphere. Separate condensers are by no means an unmixed evil, but in this case it was necessary to save the water. The circulating water is pumped, as before mentioned, to overhead tanks; it then flows down by gravitation through the condensers, a complete duplicate service being provided—viz., duplicate pumps, duplicate tanks, duplicate pipes—and every plant is connected on to each range of pipes. The pumps can also pump direct to the engines. Of course each pump can pump to each tank and draw on either suction. Some trouble has been caused by the suctions filling up, and a length of flexible rubber hose, with a copper strum at the end, is now being fitted to each suction so that this may be lifted up at low tide by a block and tackle and cleaned. Mussels, when quite small, have been drawn in through the strum, and have been found to be a considerable source of annoyance by getting in under the non-return valves. In any system of this sort it seems advisable that means should be provided to lift the strums, so that in the event of a sudden stoppage they might be more or less partly cleaned so as to pull through. The low tides at South Shields come at a time when the load is heaviest, and with an 18ft. lift, should a number of jelly fish, sailors' beds, or other articles get over the strums, there is considerable difficulty in getting the pumps to do their duty. The steam-traps are all drained into a separate pipe, and the hot-well discharge pipe is led direct into the main hot-wells,

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This has been found convenient in case a trap has to be blown through a good deal. The traps used throughout are Geipel's, which have proved convenient and satisfactory. It has been found advisable to connect them to the steam-main by copper pipes with a good bend, so that the expansion and contraction does not strip the thread off the brass union of the steam-trap.

Boilers.—The boilers used are of the simple marine type, 160lb. pressure, wet back. The first three were 10ft. 6in. long by 11ft. diameter, with two furnaces. The latter ones are 10ft. 6in. long by 14ft. 6in. diameter, with three furnaces. The heating surface of the first size was 1,000ft., and the heating surface of the latter 1,900ft. Iron chimneys are used, one to each boiler. By these means there is no fear of the chimneys becoming choked. The height of the chimneys for the first boilers was 40ft. from the furnace grate, and for the larger boilers 60ft. All these boilers have a remarkably good draught—in fact, so good that many engineers have with difficulty been persuaded that there was no forced or induced draught used. These boilers have an efficiency of 10lb. of water, from and at 212deg. F., when using good Northumberland steam coal. If this boiler was chosen, it would seem extremely advisable that the very best boilers should be obtained. Owing to the shape, the strains are somewhat considerable, and whereas a really good boiler of this type gives very little trouble, ordinary boilers may give a great deal. They want very careful handling, and should be fitted with some means of circulating the water when getting up steam. Steam should not be got up under 24 hours, if it can be helped, when the boiler is quite cold, and it has been found to answer to take 48 hours. As in many other cases, care and attention seem to be well spent on these boilers. Of course, they are not boilers that could be used inland very well, seeing that owing to their diameter they could not be sent by rail. They should certainly be made with no centre circumferential seam, and should be hydraulic riveted at both ends, but it is comparatively few places that have the apparatus for doing this work. In the larger size of boilers it is almost impossible to get the plates thoroughly closed together owing to their thickness unless hydraulic apparatus is used. There is certainly not very much room on the top of these boilers for the valves, and in this way they are not so convenient as Lancashire boilers, in which the shape affords facilities for a nice bend from the stop valve of the boiler to the main steam ring.

Pipes.—In the first instance a ring main was used for the main steam-pipe, but the author is no advocate of ring mains. If steam is sent round one side of the ring main, the other side being kept cool, it causes expansion on the one side and not on the other, whereby the joints are started. If both legs are used, then there is an abnormal amount of condensation. The steam-pipes which were used were of lap-welded steel, the lap being in the neutral axis, the flanges being wrought steel, screwed on and riveted over. The joints are made with Taylor's corrugated packing. By-passes are provided in all the valves over 7in. diameter. The valves used were of the Hopkinson straight-through type. Considerable attention has been paid to drain the steam ring, and this has been found to be money well spent. The pipes are coated with slag wool and covered with planished steel; this makes a good and workmanlike job. The feed pipes to the boilers are of copper, and in duplicate. A connection is made to the bottom of the boilers, so that the feed pumps draw water from the bottom and discharge it in through the feed check valves in order to circulate the water when raising steam.

Cranes.—There is a 10-ton crane spanning one bay of the engine-room, and a 15-ton crane spanning the other. One small point may be mentioned in connection with these, and that is the advisability of having the bearings of the wheels carrying the crane on the girders made so that the cap can be taken off, and the bearing, which should be adjustable, taken out without lifting the crane. This is one of those small matters which can be done without extra expense, and saves a great deal of time when a repair has to be made. It is rather curious how few crane makers make their cranes with this arrangement.

Distribution Plant.—The system of distribution which was first adopted was by means of transformers placed in cast-iron tanks in the streets. These transformers were connected up by means of two ring mains conveying high-pressure current from the generating station. Each ring main consisted of $^{19}/_{16}$ concentric rubber cable. Where any extraneous district away from the rings had to be served, the high-tension cable for these districts was connected to the rings by means of a high-tension disconnection box (Fig. 3). Both the transformers and the high-tension box were of Ferranti make. The transformers allow of the high-tension circuit being kept intact and the transformers disconnected, or the ring could be broken at any transformer, or the transformers could be placed on either side of the ring. The same applied to the circuits jointed on to the ring main. The transformers fed the low-tension mains, which were connected to the transformers in a similar way to the high-tension mains. These transformers were exceedingly convenient, and enabled any district to be served with comparatively little capital outlay. The disadvantages became apparent when a large number of lights became connected in one area. When this arose, a large number of low-tension mains were required, and in case of a fault occurring, a system of this sort does not lend itself to conveniently test either the high-tension or low-tension mains. The fact that pavement covers have to be lifted when any transformer or high-tension box is examined is a distinct disadvantage in a crowded thoroughfare, more especially on a wet night, when faults have an inconvenient habit of occurring; but for outlying districts this seems a very convenient system to adopt. Practical experience shows that care should be taken that there is some means of conveniently sealing the ends of the cable brought into the transformer tank. When these were rubber it did not materially matter, but when it became necessary to lay larger cables rubber, on account of its cost and otherwise, became undesirable. It is also desirable to see that arrangements are made so that the transformer can be lifted out or put into the tank without the danger of short-circuiting the low-tension mains; this certainly was a danger in the earlier transformers put down. Care should also be taken that the low-tension plugs from the transformer on to the low-tension mains make good connection; several cases occurred where, owing to the contact in these cases not being good, extreme heating was noticed; if porcelain handles are used, it is well to see that they are not too tight a fit or else they may crack if the metal through them heats a good deal. The way in which the joint of the transformer lid is made, though apparently a small item, deserves consideration. The most convenient method found was to have studs screwed into the tank, and gunmetal nuts to fasten down the lid, a convenient number of gunmetal starting bolts to be provided. The method of making the joint first was by means of lead wire, but though this was effectual in keeping out the moisture, it was found dangerous because when the transformer lid was lifted the lead wire sometimes adhered to it, and would then hang down and would be liable to make contact with the high-tension connections inside the tank, which, if it did, it might cause an exceedingly unpleasant shock to the persons lifting the lid. White lead and oil has been found by the author to be as useful in making this joint as anything. The eyebolts

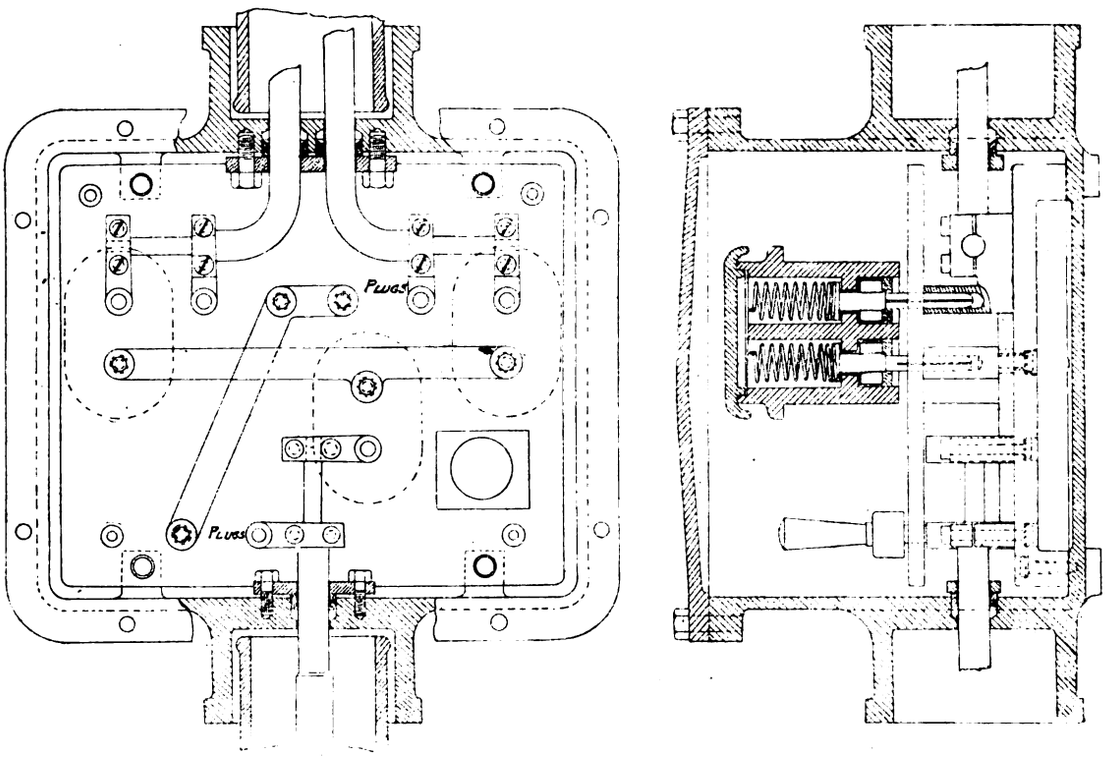

FIG. 3.—H.T. Junction Box, South Shields.

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with which the lid is lifted had better have the handles insulated, so that if the lid were accidentally to come in contact with the high-tension connections, the men holding the lid would not come to much harm. In the latter form of tank the high-tension connections were so arranged that it was practically impossible for this to occur; this, of course, is the better plan if it can be so arranged. Some transformers are given to humming, and considerable annoyance was occasioned in some places by this. Of course, it is necessary to have the connection between the cables and the tank made in the best possible manner; this naturally applies both to the glands round the cables and the connections on to the conductors. Makers are a little inclined to forget that these tanks have to be used outside, and that apparatus generally wants to be of much stronger make when used outside than when used in works. Steel glands have a knack of rusting and causing a considerable amount of time to be spent on them when used outside, whereas they might be an exceedingly nice job in the works. With regard to the high-tension box, many of the same remarks apply as to the transformer tanks. The gentlemen in the drawing office who design apparatus are a little inclined to forget the circumstances under which the apparatus will be used in actual practice. It has been found convenient that in the case of concentric cables the outer connection should invariably be a ring connection. When the transformers and high-tension boxes were first used, a pot of calcium chloride was placed in each to absorb the moisture. In the case of the high-tension boxes the rubber cables which were first used commenced to deteriorate inside the box; the cable remained invariably good outside. This deterioration took the form of hardening of the rubber (plate and samples), and then it cracked. The cause of this appeared to be either due to excessive dryness in the box, owing to the calcium chloride, or else due to destruction to the rubber by static discharge. This static discharge would generate ozone, which itself is very detrimental to rubber. In order to obviate this the bottom of the box was run up with compound, so as to cover the ends of the cable. Where this was properly done no trouble arose, and it would seem as a general rule exceedingly advisable to make arrangements so that the ends of any cable, whether hydroscopic or non-hydroscopic, could be covered up with compound. Care should be taken that the compound is of the very best quality, and free from moisture and other impurities. Good compound is very expensive, and, therefore, there is a tendency in some cases to use cheap compound, but this is generally found to be a very expensive and disagreeable expedient. In one case the rubber became hard and cracked where no calcium chloride was used, though in this case the rubber was not as bad as in some of the others.

(To be continued.)

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE ARMSTRONG-ORLING SYSTEM OF WIRELESS TELEGRAPHY.

SIR,—Your explanation of the attitude you have assumed in this matter is the key to the situation: You are annoyed at the withholding (for the present) of the details of the "Armorl" system—for reasons which the inventors consider good and sufficient—and your displeasure finds expression not only in a captious criticism of a part of the apparatus which has since been disclosed, but also in an attempt to throw discredit, not only upon the inventors—which alone is a strange enough part for exponents of progress to play—but also upon others who happen to be associated with them. Your criticism of opinions was not asked, and becomes an abuse when such opinions are distorted in the manner that seems to be your custom—which suggests an attempt to retire from an untenable position.

You have alleged that I was unaware that E.M.F. could exist without current, and when informed of your error, you have not the grace to withdraw your *ex parte* statement, but retort that I could not see the difference between the two, and apparently do not now. Perhaps you will be good enough to quote the passage in my letter from which this lack of perception is apparent.

In your editorial reply to my last communication, you arrive at an equally baseless conclusion in an attempt to justify your comments. You state that I admit "that the apparatus will work even if a current is not passing." In the first place, you are not accurate, for the reference in my letter was to what you had pointed out; and secondly, and what is more to the point, I have not expressed the opinion that a current was necessary in order that the apparatus should work. Perhaps you will kindly explain this misstatement, and also point out any inconsistency that may exist between the statements that (*a*) the apparatus can be operated when there is no current so long as the necessary difference of potential exists, and (*b*) that a current having an E.M.F. of $\frac{1}{300}$ volt is sufficient to actuate it.

In conclusion, I would observe that you have not explained your object in comparing the Armstrong-Orling apparatus with an electrometer, nor dealt with the inconsistency pointed out, neither have you proved the alleged absurdity in the comparison made by the inventors of their receiver with the telephone, both of which are ultimately dependent upon E.M.F., seeing that a current cannot exist without difference of potential.

In this connection I commend to your notice an article by a contemporary (dated 20th inst.), whose steel you will not disdain, in which the inventor's comparison is not ridiculed.

It is, indeed, surprising that any person should undertake the criticism of apparatus ostensibly for the instruction of the public before having first acquainted himself with the subject under consideration, and so become possessed of more than the little knowledge of the danger of which all are aware.—Yours, etc., THE ONE REFERRED TO.

Dec. 27, 1901.

[Our correspondent is evidently determined to push this matter to the bitter end. He must remember that the "Armorl" receiver was not on view when we visited the offices of the syndicate, and that our criticisms, whether captious or otherwise, have necessarily been confined to the laboratory experiment shown us, and to the explanations of the same by the syndicate's experts. He asks us to quote the passage in his letter which shows lack of perception of the difference between current and E.M.F. We quoted it last week, and it reads as follows: "In the 'cross-examination' to which you refer, your representative, who appeared to be unaware of the great sensitiveness of electro capillary apparatus, was told, in reply to one of his questions, that an E.M.F. of $\frac{1}{300}$th of a volt was sufficient to actuate this class of apparatus, and that a current having a voltage so low as this is sufficient to actuate the Armstrong-Orling apparatus." Thus in almost consecutive lines it is first stated that E.M.F. actuates the apparatus, and next a current does it. Perhaps it will explain our position a little more clearly if we state that, assuming an E.M.F. of $\frac{1}{300}$th of a volt was applied to the terminals of both a telephone and an electro-capillary electrometer of equal internal ohmic resistance, the current passing through the latter would be an almost inappreciable percentage of that through the telephone. The electro-capillary electrometer action is not due to current passing, but the audible sound in a telephone is, or, more exactly, to a variation of magnetic action due to a variation of current. Hence there can be no fair comparison made between the two pieces of apparatus. Once more, our correspondent must be fair to the telephone, and remember that Mr. Evershed's experiments with a Grove-Bell telephone showed that this instrument gave audible signals with $\frac{2 \cdot 9}{10^6}$ amperes. As the resistance of this type of receiver is about 200 ohms, this corresponds to $\frac{1}{1720}$th of a volt. The question of "our annoyance" and also of "our unasked criticism" is dealt with in our leading article.—ED. *E. E.*]

FORTHCOMING EVENTS.

FRIDAY, JAN. 3.

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. Paper: "The Uses of Exhaust Steam," by Mr. John Buley.

SATURDAY, JAN. 4.

Royal Institution.—At 3 p.m., Prof. J. A. Fleming on "Sound and Music and Singing Flames" (Lecture IV.).

TUESDAY, JAN. 7.

Royal Institution.—At 3 p.m., Prof. J. A. Fleming on "Electric Oscillations and Electric Waves" (Lecture V.).

THURSDAY, JAN. 9.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Discussion of the Technical Reports on the Institution Visit to Germany, 1901, by the Committees on Traction, Light, and Power, Manufacturing, and Telegraphs and Telephones.

Royal Institution.—At 3 p.m., Prof. J. A. Fleming on "Waves and Ripples in the Æther" (Lecture VI.).

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TO CORRESPONDENTS.

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1902.

In welcoming the new year, it is with greater pleasure than we have been able to do for at least two years past, inasmuch as to the careful student there seems to be signs of the end of a war which has descended into what is merely a state of brigandage. With the advent of peace ought to come the making of a true balance-sheet, the determination of who has to foot the bill, and then a time of commercial prosperity. Attention has been called in various directions to the amount of work indicated by application for Bills to Parliament. This method is of comparatively slight service, and gives no indication of the enormous demands which will spring up in every direction as soon as a permanent peace is assured. Bankers are probably the best judges of the activity that will come, and in confidence will say that they are sure of almost unthought-of developments in every direction. The electrical industry ought in the short time at its disposal before the possible demand comes to analyse its position, to see from whence is to come the capital for extended business, to put the works in order for an increased output; for it will be impossible to sympathise with an industry which has no foresight, and is found incapable of meeting a demand which close examination shows to be more than probable. To our readers our heartiest greetings, wishing each and all perfect health and great prosperity, combined with peace to the nation and a closer comradeship with our Colonies.

THE ARMSTRONG-ORLING CONTROVERSY.

Our columns have been enlivened during the past two or three weeks with an interesting discussion of the "did" and "didn't" type. The gentleman who signs himself "The One Referred To" returns this week once more to the subject, but in his haste to gain a point considers it argument to suggest we "are annoyed." If he had said we were amused, it would have been nearer the mark, for nothing lately in the "planting a company line" has been more amusing than the antics of this syndicate, or whatever it calls itself. We have had the opportunity of reading most of the laudatory notices which appeared in the daily Press, also of sending a member of our staff to examine one detail only of the system, and we have read what other technical papers have had to say on this detail. Our correspondent commends to our notice an article in an esteemed contemporary, whose steel we do not disdain, nor do we fear any more than we do that of our correspondent himself, who is perfectly justified in giving his views so far as he is not unjust to others who are equally justified in giving their opinions. We have carefully read the article referred to, and if our correspondent finds any hilarity or satisfaction out of what is said therein he must be easily pleased. The article in question says: "We merely give the *inventor's statements* of the results obtained. . . ." [All the italics are ours.] "We understand *them* (the inventors) to say . . . is a very sensitive and simple apparatus, and appears to be well adapted. . . . We imagine it *could* be made an exceedingly sensitive receiver, more so even than the telephone, though, *of course, that could only be settled by experiment.* We should *hardly believe* that it could be a conveniently portable instrument. . . ." Now, if all these "coulds" and "shoulds" and "hardlys" give a satisfactory character for this new system it certainly will make its mark, but to ordinary trained intelligence, which reads between lines as well as words only, the character given is not of surpassing excellence. No; our contemporary is too intelligent to let itself go before seeing a complete apparatus at

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work, not merely under laboratory conditions, but as a practical apparatus, though we do not deny but that scientific men can often gain a fairly accurate knowledge of the practical character of an apparatus even from laboratory experiments. So far as we gather, no scientific journalist has seen the real apparatus, but only patent drawings and heard descriptions from highly interested parties. The non-technical Press has been shown transmission experiments—and according to the reports, successful experiments—but the very men who may be supposed to understand these experiments have been carefully excluded from any view of the complete apparatus used. We have said that, so far as the reports in the non-technical papers are concerned, the results show nothing out of the common, nothing superior to what is easily obtainable by well-known methods, and nothing to induce financial people to speculate, except by the exercise of a superabundant amount of faith in what is said, and hope, that the statements are, like the published weekly receipts of the railways, well within the mark. We quite agree with Pope's dictum, that "a little knowledge is a dangerous thing," and this, we presume, is what our correspondent had in mind in writing his last paragraph, but in his case the words are wrongly used. What he or his syndicate practically asked us and our technical contemporaries to do was to instruct the public as to the value of a new system of wireless telegraphy, and we were asked to do this without an opportunity of examining the most important part of the apparatus, but were expected, we presume, to accept its exceedingly great merit because its inventors said it was good. The inventors may be perfectly right in their estimation of its value; we are sure they are perfectly wrong in the manner adopted to convince technical experts, and through them the non-expert public, as to these merits. We will venture upon an opinion—namely, that the inventors cannot at the present moment produce an apparatus that will steer a torpedo in Southampton Water, nor will they within six months, or six years, construct an apparatus so to do upon the lines of the instrument shown in the patent drawings as illustrated in the technical papers. The fanciful accounts that have appeared in the untechnical Press upon this one point alone are sufficient to make us cautious in accepting verbal statements about the efficacy of an apparatus which is not shown in work to those who, at any rate, are supposed to have some knowledge of these matters. While we should go far in pushing the claims of a new invention which seemed even in the laboratory to contain the elements of practicality, it is our duty—nay, our privilege—to recommend the utmost caution when the public is inundated with notices which contain internal evidence of being written by those who are not experts. We commend a thoughtful attention to one of Goethe's axioms. He says: "I with difficulty believe the necklace to be very valuable of which only one or two pearls are allowed to be visible, or that genius to be very great which shows itself in two or three specimens." If the paragraph quoted by our representative on p. 807 in our issue of Dec. 6 is a sample of the pearls to be shown by the syndicate, our difficulty of belief in the great value of the complete necklace is almost approaching the infinite.

REVIEWS.

The Practical Electrician's Pocket-Book and Diary, 1902. Messrs. S. Rentell and Co., Limited. Price 1s.

The 1902 volume of this handy little book is now in our hands. The preface draws attention to the fact that any hints or suggestions concerning practical work connected with electrical matters which readers consider would still further add to the usefulness of the book will be received by the editor with great pleasure, as well as any corrections or errors should they be noticed. In this respect the editor of the pocket-book is to be commended, and we know from personal experience that he does take great care to remedy any defects which may be discovered. The great difficulty in compiling a book of this kind is to know what to leave out, as if all the information available is included, the book becomes too large to be carried about, and hence fails in its purpose. We hold that such information as is given on p. 153 as to horse-power required to drive various types of machines is certainly necessary. Such information is most useful when preparing estimates for the electrical equipment of workshops. Also the information as the voltages and the system of supply of the various electric lighting undertakings in the United Kingdom is exceedingly valuable. The hints to installation attendants are in the same category. We think, however, that there are certain portions of the matter which might, perhaps, be left out with advantage, as we do not think that in a pocket-book of this kind there is any need to describe in detail such things as the various types of boilers or even of electricity meters. With regard to the table given on p. 97 as to the carrying capacity of electrical conductors, we notice that the editor is still working to a uniform current density of 1,000 amperes per square inch. Surely it would be better now for all such books to adopt the current-carrying capacities fixed by the Institution of Electrical Engineers, which are based on uniform heating. Another matter which we think might usefully be added is more information respecting the variation required in the number of lights provided according as the colour of the decorations in a room is varied. To those interested in the installation of electric light in buildings nothing could be more useful. We have one case in mind in which, although the workroom was provided with a number of lamps, rather more than is indicated in the rules given in the book before us, the illumination was much too small because all the girls in the room were working on black material. We can recommend this pocket-book and diary to young electrical engineers.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

443. I have a three-phase generator connected in star group, with a common return to the junction of the star. The generator gives 100 volts between each line and common return and 100 amperes per phase. Two lines supply incandescent lamps only, and the third supplies arc lamps. How am I find the angle of lag, the self-induction, and the true power generated?—M.

444. What is the best and cheapest way of getting the "testing constant" of a meter—*i.e.*, the relation between the revolutions of the spindle and the reading on the dial?—J. C. R.

ANSWERS.

Question No. 437.—What is the cause of flat places forming on dynamo commutators, and is there any way of preventing them? I have had the commutator of one of my dynamos turned several times to get rid of these flat places, but they always come again in a short time.

Answer to No. 437 (*awarded* 7*s.* 6*d.*).—The question asks, "What is the *cause*?" as if there was but one! The

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number of things which may produce flats is almost legion. One of the most frequently met with is slackness in the commutator somewhere. This may be due to the whole commutator being slack on the shaft. Perhaps the hole in the commutator centre is worn slightly oval. Then twice in a revolution the weight will cause a jar, and a consequent partial break of circuit, and sparking will ensue just there. The remedy is to have the commutator taken off and its centre bushed and well keyed on. Or the slackness may be in the commutator strips, and the turning up may itself be making this worse. For suppose the strips were not exactly of the correct angle, but slightly too small at the inside, then when the commutator was full size they might be all right, but as it got turned away the slackness would grow greater and greater. The remedy is simply to keep on tightening up the cap of the commutator. In many modern machines micanite is used as the insulator between commutator strips, and unless this is of good quality it is apt to be very soft, and to alter in size actually when heated, owing to the binding material softening. This is a frequent cause of bad flats coming, as it causes slackness. The policy of putting in a little cheaper material so as to save a little or a part, which is but a small item in the whole, seems in this case distinctly penny wise and pound foolish. Want of symmetry in the armature winding was once a frequent cause, but designers very rarely make an unsymmetrical winding nowadays, so that this cause may be neglected in modern machines.

A break in the armature winding will very soon produce a bad burn on the commutator, owing to the destructive sparking which ensues when the broken coil comes to the brush. In this case, no amount of turning up will do any good. A short-circuit will also cause bad sparking, but as the whole short-circuited part generally burns out, it entails more repairs generally than the removal of a flat merely. A bad connection between commutator arms and armature wires is equivalent to a partial break of circuit or to a want of symmetry in the winding, and the sudden change in the current value at this point will cause sparking and flats. The remedy is, of course, to have the connections sweated well in.

The fault may not be in the machine, but in its foundation. The writer remembers testing a small motor-transformer which was mounted temporarily on a not very stiff foundation, and got very bad flats. On turning up the commutator and setting the machine down better, the flats entirely disappeared. Want of balance in any part of the machine will also cause flats due to vibration of the whole. In multipolar machines a want of symmetry in the various fields may cause trouble, but this is generally shown as sparking all round in a most destructive manner.

All flats have a cause; the difficulty is sometimes to get at the cause! But the great majority of cases may be put down to causes which come under the heads mentioned above.—T. C.

Answer to No. 437 (*awarded* 7*s.* 6*d.*).—Flats on a commutator may be created by various faults. One chief cause which is often overlooked is a bad joint in the driving belt. If then the jar on the dynamo pulley occurs always when the brushes are on the same sections, a flat will be the result, owing to the current being wholly or partially broken at the moment of the jar through the jumping of the brushes. The cure for this will be the adoption of an endless belt, or the making of a smooth good butt joint in the belt. A second cause of flats lies in a badly and loosely built commutator. Owing to the action of centrifugal force, and the expansion of the segments through heating, an uneven surface will obtain on the commutator, and the brushes will be continually jumping, and flats will then be formed. This can only be cured by having the commutator securely tightened up by means of the end rings or holding bolts. When a commutator is properly built, it should be possible to smartly tap any one segment without any fear of depressing it. Somewhat akin to this cause are flats due to lack of homogeneity in the sections; if one section is of softer material than the other, this section will rapidly wear and thus cause a flat. Flats may also result from the vibration of the machine, or from rapidly fluctuating loads. The writer has often noticed that the commutator of a dynamo charging accumulators has a great tendency to develop flats.

What is, however, the chief cause is a loose or imperfect connection. In order to obtain sparkless commutation, it is essential that the armature coil short-circuited by the brush should have a current flowing in it equal in value and direction to the current flowing in the series of coils it is about to join. Now, such a current will only obtain if the fringe of the magnetic field, which the coil is at the moment of time cutting, is dense enough to generate an E.M.F. sufficient to cause such a current to flow. Now, this E.M.F. will be the same for each coil of a symmetrically wound armature, and, therefore, if R is equal in each case, $C = \frac{E}{R}$ will be the same for every coil. If, however, there is a dirty or imperfect contact in any one coil, the value of R will be enormously increased for this coil in comparison with its values for other coils, and consequently the value of C will be altered, and sparkless commutation will no longer be obtained; the result will be a pitting of the section, which will rapidly wear and form a flat.

If then flats form on a commutator, it is advisable to seek the cause in the following manner: (1) Observe if there is a bad joint on the belt which causes the brushes to periodically jump; if so replace with an endless belt, or remake the joint. (2) Examine for any other source of periodical vibration and remove the same. (3) Test for an earth on the armature and installation. (4) Test for a broken connection in the coil connected to the defective section. (5) Examine whether the armature or commutator is loose on the shaft. (6) Test the commutator to see whether the sections are securely held together.

By proceeding in the above order, all the tests are made first which do not necessitate the taking apart of the machine. If, however, the fault is not found by any of the above six tests (7) unsolder the coil, examine whether the lug is loose in the commutator blade, and remake all the joints. This will probably cure the whole matter. Even in the best-made armatures it is quite possible that a dirty joint may be made, or that the joint, whether brazed or soldered, is not sound throughout its entire length, and if so, the continual passage of the current through this joint will cause it to become defective and to require renewal. Of course, all joints in the coil must be examined, and if a bar-wound machine, those at each end of the armature. It is possible to find the imperfect joint at times by running the machine with full load for a short time, when the defective joint will be found to have become considerably hotter than the rest of the windings; but owing to the great heat conductivity of copper, this test is not very reliable. If this does not remedy the fault, it will be found necessary to replace the section owing to its being of a softer nature than the others, but since the use of hard-drawn copper sections is almost universally adopted, this is very unlikely, although in the old days of cast-copper sections the want of homogeneity was a most frequent fault.

After finding the fault and remedying it, the commutator must be turned true in the lathe and polished with glass-paper.—M.

Answer to No. 437 (*awarded* 5*s.*).—There are numerous causes of flats on commutators, some removable and others inherent in the design of the machine. To the former class belong want of tightness in the commutator plates, incorrect width of brush or material of brush, uneven rotation of the armature through want of sufficient flywheel action or want of balance in the engine parts a break or short-circuit of one or more sections of the armature, or connections to earth at one or more points on the winding. To the second class belong want of symmetry in the armature winding, causing different sections to be at different angular distances from their commutator plates; also unequal resistance of various sections through the presence of numerous soldered joints of different quality.

To determine which of these causes is giving the trouble in any particular case, it would be well to proceed somewhat as follows: (1) The armature should be examined for symmetry of winding. If it is a smooth-core armature, the want of symmetry might be due to the use of thick

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driving horns at certain points on the periphery; and if the flats are found to occur at sections wound close to these horns, this explanation would be the correct one, and the armature would require rewinding to put it right. Again, by closely examining the connections to the commutator all round the armature, it may be found that the peripheral distance between two connections is not the same at all points of the periphery (Fig. 1), or that certain connections are crossed before reaching the commutator (Fig. 2), either defect leading to flatting. If the armature is a slotted one, the fact that there are more commutator plates than slots would indicate an unsymmetrical winding.

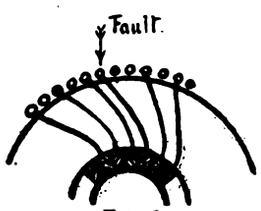

FIG. 1.

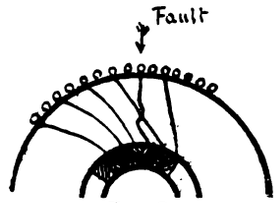

FIG. 2.

Though armatures with this want of symmetry are in common use and seldom give the least trouble, yet sometimes the arrangement leads to slight flatting of every second or third commutator plate, and if the flats occur in this way, at regular intervals all round, they may very probably be due to this cause.

2. The armature should be tested for faults to earth by means of a detector or bell circuit, and if any such faults exist, the armature will have to be partially or wholly rewound in order to remove them.

3. In order to test for partial or complete short-circuit, and for sections of abnormal resistance, a current should be passed through the winding from one point to a diametrically opposite point, and the volts from section to section should be compared by connecting a sensitive galvanometer across every two neighbouring sections in turn. The throws obtained at the various sections should not differ by more than 10 per cent. if all is in order.

4. Want of sufficient tightness in the commutator would be shown if, after turning it up quite smooth, and running it at full speed with the brushes raised for an hour or two, it were found that some of the plates had risen and the surface was no longer perfectly smooth.

5. If the flats occur more or less uniformly on all the plates alike, it would point to the fact that the machine had too few commutator parts and too many turns per section—*i.e.*, too many reactance volts per section—for sparkless running, or it may sometimes indicate that the brushes used are too wide and cover too many sections. Where the contact density permits, narrower brushes should therefore be tried.

6. Uneven turning moment is an occasional though not common cause of flatting at one or more points of the commutator, through a sudden increase in angular velocity at certain points in the revolution. Such speed variations would, however, generally make themselves noticeable by flickering of the lights, and would on that account alone have to be suppressed by the addition of heavier flywheels or improved balancing of the engine.—Q.

Answer to No. 437 (*awarded* 5*s.*).—Perhaps if I mention some of the cases of flats on commutators, and the means taken to remedy them that have come under my notice, they may be of some service to the enquirer.

1. A two-polar, compound-wound, direct-driven dynamo, fitted with copper brushes, giving 200 amperes at 100 volts, gradually developed a serious flat on the commutator shortly after being installed. The brushes were carefully adjusted, the commutator kept perfectly clean, and there was nothing the matter with the armature. The flat became worse until there was a hollow in the commutator $\frac{3}{16}$in. deep. The armature was put in a lathe and the commutator turned up perfectly true, and after replacing it in position no more trouble was experienced. Careful enquiries were made to ascertain the cause, and it was found that the armature had been lying about unpacked for a month before being fixed in position. The commutator had been resting on one of the blocks supporting the armature, and the weight on that one part had caused a depression of one or two segments of the commutator. Whilst working, this depression caused sparking every time it passed under the brushes, thereby making the place gradually worse.

2. A 110-volt, 150-ampere, four-polar, shunt-wound machine, belt-driven, fitted with a special combination of copper and copper brushes, kept developing flats on the commutator, though the man in charge kept turning it up. On examination, the reason was found to be that the armature wires were connected to the commutator segments by means of set screws, several of which were found to be very loose. These loose screws were in the same positions as the flats on the commutator. The armature wires were well sweated on to the commutator segments, and no more flats developed on the surface of the commutator.

3. The commutator of a 100-volt, 300-ampere, two-polar dynamo, belt-driven and fitted with copper brushes, was always more or less in an unsatisfactory condition, flats continually developing and the brushes sparking badly. The fault in this case was due to lack of cleanliness. Copper dust was allowed to settle on all parts of the machine, and the brushes were rarely trimmed. The spaces between the commutator lugs, leading to the armature connections, were in some cases packed with copper dust, and of course, as these lugs were uninsulated, the armature coils connected to these places were practically short-circuited. Absolute cleanliness was insisted on, and the armature was frequently blown through with the bellows. The results were very satisfactory, the commutator kept in good condition, and there was no sparking at the brushes.

4. A four-polar machine, compound-wound, belt-driven, fitted with carbon brushes, and giving 200 volts and 280 amperes, gave a good deal of trouble because of the bad condition of the commutator. The commutator was frequently cleaned while the machine was running by means of sand-paper, but the brushes sparked violently, the carbon blocks getting occasionally in places red hot, and the commutator surface became very uneven. Whilst the machine was stopped I had the commutator cleaned with sand-paper, rubbing backwards and forwards from the bearing end to the end connected to the armature windings. This method cleaned the surface perfectly—superior to the other method of cleaning whilst the machine was running. The machine now runs sparklessly, and the commutator always presents a bright appearance. The reason of the failure of the first method of cleaning the commutator seems to be that the dirt was not removed altogether from the surface of the commutator, but simply formed rings of dirt round the commutator.

To conclude, the cause of flats forming in dynamo commutators may be faulty armature connections, defects in the armature winding, not a perfect uniformity in the hardness of the copper segments used in building up the commutator, bad condition of brushes, or lack of cleanliness. I think it is best to avoid any lubricant for the commutator, for the average attendant puts too much on, thus blackening the commutator. I have seen the commutators of dynamos blackened and the brushes choked with dirt simply through too liberal applications of vaseline.—W. A. T.

Answer to No. 437 (*awarded* 5*s.*).—The formation of flats upon dynamo commutators may be said to be due to irregular commutation. Apart from a continual cutting up of the commutator by steady sparking through bad design, these causes of flats may be classed under two heads—viz., mechanical and electrical. By experience, I find that most of them are due to the former—*i.e.*, mechanical defects of any part of the machine whose function it is to impart the necessary motion to the armature core, together with winding and commutator. Any of the following causes will produce one or more flats, nearly always reappearing in the same position after the commutator has been turned: (1) Core plates slack on spindle or spider. (2) Commutator loose on sleeve or spindle. (3) Slackness of the bush in front dynamo bearing, if machine is direct coupled, will always cause flat to appear on commutator at end of stroke of engine. To prove this, put engine on end of stroke, and flat will be just leaving brush. (4) If belt driven, the pulley, if

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worn slack on feather, will produce flats more or less. (5) Brush-holders worn loose on spindles and having too little tension, allowing them to rock, will have a similar effect. In fact, anything that will conduce towards producing an uneven motion of the commutator past brush surface will cause flats to appear. If dynamo is heavily loaded, or there happens to be an earth on mains, the effect will be more marked.

Taking the second heading, or electrical deflects, we get the following: (1) A leakage between any of the low-potential turns on armature or between two commutator segments. This would soon be noticed on account of great heat produced in conductors attached to same. (2) Imperfect connections or joints in armature conductors or commutator lugs. (3) Leakage to earth on any of the commutator segments or windings will cause abnormal sparking.

But I think that "F. G. A." would do well to look for mechanical defects, as the others would be more easily noticed.—J. H. C. WICKETT.

Question No. 438.—Why do small toy series and shunt wound motors run equally well on direct and alternating current circuits?

Best Answer to No. 438 (*awarded* 10*s.*).—It is well known that the torque on a motor shaft depends on the current in the armature, the number of surface conductors on the armature, the field strength, and the number of poles. Hence, in a given motor, the torque is dependent on the product of the numbers representing current in the armature and field strength. The field strength varies with the strength of the exciting current, and though it is not exactly proportional to it, it may (if we neglect the lagging due to self-induction or magnetic inertia) be taken as increasing whenever the exciting current increases, and *vice versâ*, so that the two reach their maxima practically together. In the case of any series motor, whether a toy or not, the current in the magnets and in the armature is the same, and, therefore (when the motor is supplied with *alternating* current), the maximum of current in the armature is reached at the same time as the maximum of current in the field—*i.e.*, at the same time as the maximum of magnetic field strength. Hence the curve of torque will always be positive as the two zero values fall together, and the two curves are always either both positive or both negative (see Fig. 1). Hence a series motor of any kind will run

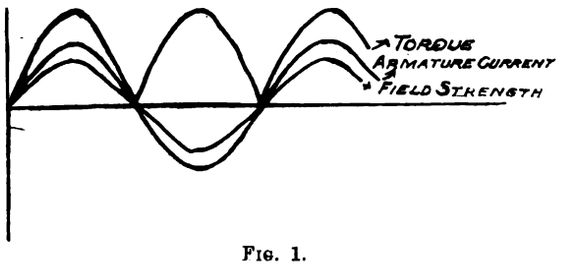

FIG. 1.

on an alternate-current circuit fairly well, because it has a torque always in one direction; and the only precautions which have to be taken are that the fields must be laminated, so as to prevent eddy currents due to the large number of magnetic reversals, and that the air-gap should be fairly small to prevent undue magnetic leakage.

In the case of a shunt-wound motor the conditions are altogether different, for the motor consists of two circuits in parallel, and each of these has its own self-induction and resistance. Now, the current in a circuit with self-induction is not in phase with an alternating E.M.F. applied to the circuit—*i.e.*, the current reaches its maximum later than the E.M.F. does, and the difference between them depends on the relation of resistance and self-induction.

If R be the resistance of a circuit, and L its self-induction, and n the periodicity of an alternating E.M.F. applied to the circuit, then the current maximum lags behind the E.M.F. maximum by a part of a period which is given by the ratio

$$\frac{\cos^{-1}\dfrac{R}{\sqrt{R^2+L^2(2\pi n)^2}}}{2\pi}$$

That is, if the whole period be treated as equivalent to an angle of 2π radians, the "angle of lag" is given by the numerator.

It is very unlikely that the value of the numerator would be the same for both armature and field in a shunt motor of any size above a mere toy. The "angle of lag" for the shunt is practically certain to be much greater than that for the armature, and as the phase of impressed E.M.F. is the same for both, there will be an angle of lag between the armature current maximum and the maximum field strength which depends on the field current. The curve of torque will still be the product of momentary values of these (see Fig. 2).

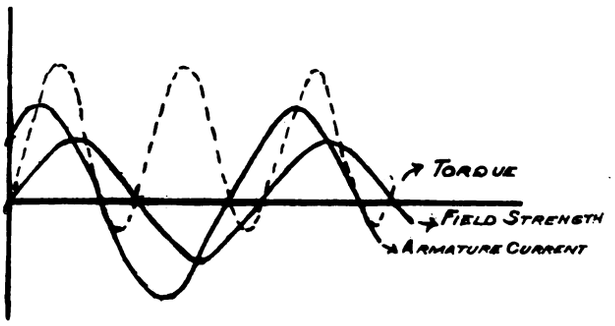

FIG. 2.

Here there is a negative torque for part of each period, and if the angle of lag between the two constituents is greater, the negative torque becomes greater and the positive less, so that finally in the limit there would be no resultant torque at all, the one curve reaching a maximum when the other is at zero. Further, to reverse the magnetism of a shunt machine many times per second would cause tremendous voltages due to the huge self-induction, and probably no insulation would stand it. In the case of toy shunt motors, however, the self-induction of the field is comparable to that of the armature, which usually has a good deal of wire on it; hence the angle of lag would be small and the torque nearly all positive, and, further, the self-induction is also small, and therefore the difficulty of reversing does not enter in so much. So that a very small shunt motor would run quite well, or quite as well as a series motor, on an alternating-current circuit.—T. C.

Answer to No. 438 (*awarded* 5*s.*).—Though many types of toy motors will run on either continuous or alternating currents, they are almost always less efficient and give out less power on the latter than on the former, and can, therefore, not be said to work equally well on both supplies. There is, on the face of it, no reason why any continuous-current motor should not work on an alternating supply of suitable voltage, and it is only because of sparking troubles and low power factor that it is impossible to satisfactorily employ them in this way, except in the smallest sizes. The fact that motors specially designed for alternate currents (induction motors) can be constructed more cheaply than continuous-current ones, and that they avoid the use of commutators and their attendant troubles, is a further and strong objection to the use of continuous-current motors on alternate-current mains.

The simplest way of considering the forces causing rotation of a motor armature is to treat the armature as an electromagnet, whose winding forms poles, N′ S′ (Fig. 1), of such polarity that they tend to move round towards the magnet poles, S N respectively, in the direction of rotation. As soon as poles S′ N′ have moved round slightly (nearly half a circle in a two-part commutator armature, but less as the number of commutator parts is increased), the current in the whole or a part of the armature is reversed by means of the commutator, and the poles S′ N′ are thus brought back again to the vertical line. This process is repeated continuously, and, aided by the inertia of the armature, causes uniform rotation. So long as the relative polarity of S′ to N and N′ to S remains unchanged, the fact that all the poles are reversed many times a second would not, in itself, affect the running of the motor, all the impulses still tending in one direction. If the motor is series wound, and if the magnets are of small section or are laminated, so that no appreciable eddy currents are induced in the iron, it may be assumed that the magnet flux is in phase with the armature current (or

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armature polarity) when the motor is connected to an alternating supply. Therefore, though a higher voltage will have to be applied to the terminals in order to get the same torque and speed, the motor will certainly rotate but it will only work satisfactorily at the commutator so long as the volts and amperes dealt with are quite small.

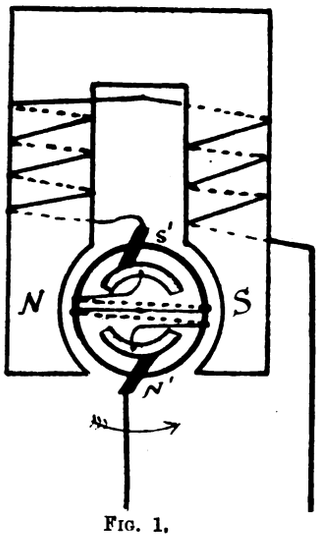

FIG. 1.

If the motor is shunt wound, the higher self induction of the shunt winding relatively to that of the armature winding will usually cause the shunt current (and magnetic flux) to lag behind the armature current when connected to an alternating supply, and this would interfere disadvantageously with the relative polarities of armature and field at certain points in the revolution, and so reduce the working torque.—Q.

Answer to No. 438 (*awarded* 5*s.*).—It is not surprising that a series dynamo used as a motor runs equally well when supplied by direct current and by alternate current. Suppose a motor running in the indicated direction when its poles are as shown on Fig. 1. Now let us inverse the current. Then (1) the polarity of the field magnet is inversed; (2) the positive brush, which at first was 6, is now 6_1—that is, the current is inversed in the armature

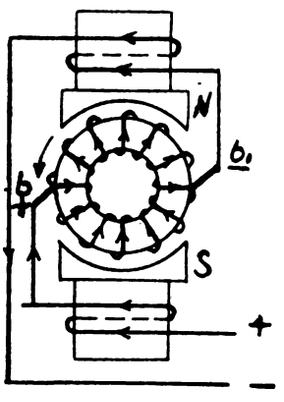

FIG. 1.

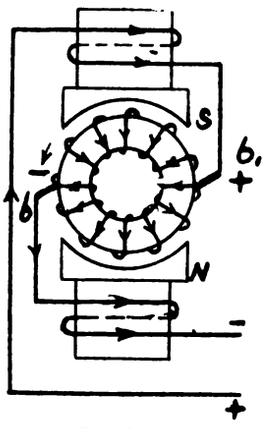

FIG. 2.

too. Then, since both the polarity of field magnet and the direction of current in the armature are inversed, the direction of rotation does not change, and remains the same as before. That shows that a series motor has only one direction of rotation *when the current in the armature cannot be inversed independently of the excitation*, and the consideration of the sketches shows that the direction of rotation for such a motor is inverse of the rotation of a generator giving the same current. (To inverse the running of a motor, series switches inversing the current in the armature only are used.) Hence we deduce that a series dynamo is able to run as a motor when supplied by alternate current, and that is true as well for a toy dynamo as for an industrial machine. But there are some inconveniences limiting the employment of these very simple motors in supplies by alternate current. These dynamos have a considerable self-induction, which causes an important lag of the current, and, therefore, a decrease of its effective intensity, and we know that the torque is proportional to the square of the effective current in the armature; besides, if the field magnet is built of cast iron or cast steel, the alternate current produces a considerable leakage by hysteresis and eddy currents, consequently these pieces must be built of soft sheet iron. All these leakages contribute to decrease the efficiency of these motors, which have a low specific power—that is to say, a low power by unit of weight. However, they have an advantage: they are almost the only alternate motors having a notable torque when starting; besides, the speed is entirely independent of the frequency (depending only on the effective current and voltage), and are asynchronous motors. For these reasons these motors are sometimes employed for lifts in a supply by alternate current.

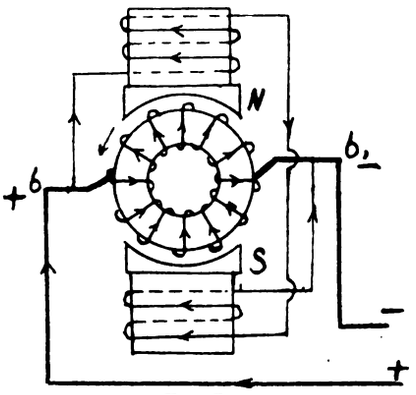

FIG. 3.

Let us see what happens when we inverse the current in a shunt motor, the current in the armature being not independent of the excitation. Suppose Fig. 3 a shunt motor running in the direction shown in the sketch, and let us inverse the current (Fig. 4). Then (1) the polarity of field magnet is inversed; (2) the direction of the current through the armature is inversed, too. Then, the direction of current being inversed both in the excitation and in the armature, the direction of current remains the same as before. Hence, for a shunt motor, there is only one direction of rotation, and the figures show that this direction is the same

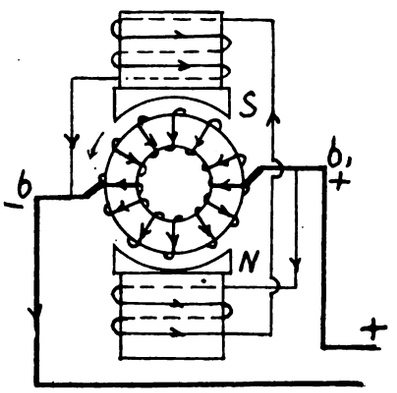

FIG. 4.

as for the same machine working as generator giving the same current. Therefore, a shunt motor is able, theoretically, to run equally well when supplied by direct current and alternate current. But in these dynamos the armature circuit and the field winding especially have a very considerable self-induction still higher than for series motors. This self-induction produces a considerable lag of the current, which has only a feeble effective value. If the field magnet is not built up of soft sheet iron, there is also great leakage by hysteresis and eddy currents. Consequently, the torque when starting has no notable value, and for industrial dynamos is not sufficient to produce work. That prevents absolutely the employment of these motors in practice. However, in toy dynamos the self-induction may be small, and as these motors give no output, that explains their running when they are supplied by alternate current.—H. A.

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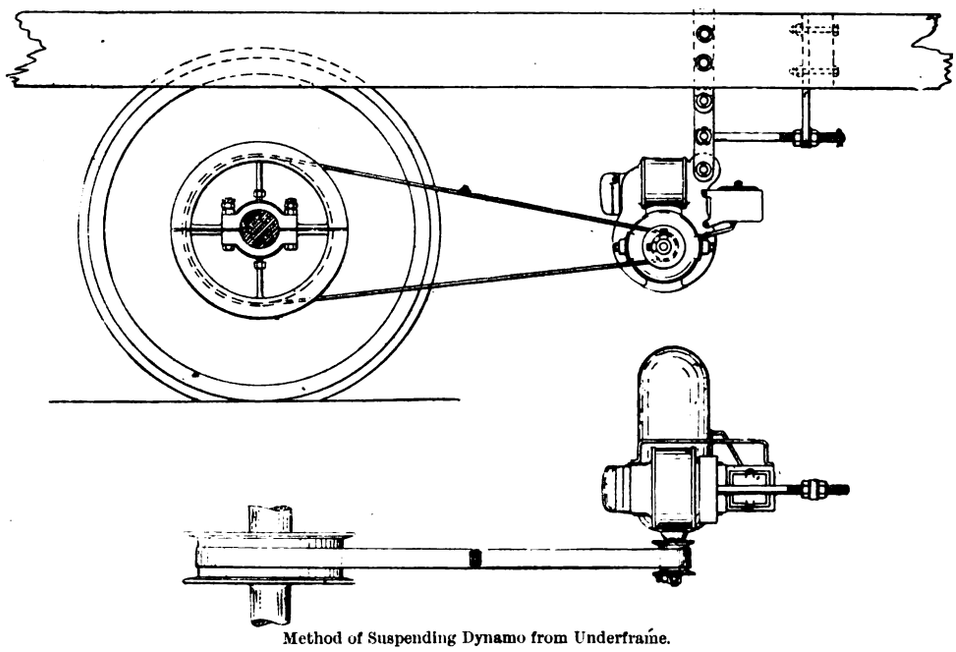
TRADE NOTICES AND NOVELTIES.

Electric Lighting for Railway Carriages.

We received recently from Messrs. J. Stone and Co., Deptford, London, S.E., a copy of a pamphlet descriptive of the firm's latest improved system of electric lighting for railway carriages. It is a very handsome production of its kind, being excellently printed, illustrated, and bound. When the Stone system of lighting railway carriages was first introduced a detailed description was given in these columns, but since then the system has found such universal favour that we have no hesitation in refreshing the memory of our readers on its distinctive features. We reproduce herewith two diagrams from the pamphlet, showing the method of suspending dynamo from underframe. Referring to these diagrams, it will be seen that the dynamo is suspended in such a way that its pulley is at approximately the same level as the pulley on the axle, from which it is driven direct by means of a belt. In this manner the vibration or vertical motion of the axle is prevented from being transmitted to the dynamo. However the speed of the train may vary, after a certain predetermined limit has been reached the dynamo always runs at a uniform speed, and consequently maintains a constant output. This result is obtained by suspending the dynamo by means of an adjustable link in such a manner that the former is free to swing towards or away from the driving pulley on the axle. The suspending link is adjusted so that the driving belt draws the dynamo out of the diagonal position in which it would naturally hang, thus putting a definite tension on the belt just sufficient to transmit power equivalent to the amount of electricity required. Hence, when the pull on the belt (owing to increase in speed of the train) exceeds the weight on the belt, due to the one-sided suspension of the dynamo, the latter will be automatically drawn towards the driving pulley on the axle, thus allowing the belt to slip, whilst the armature will continue to revolve at its normal speed. The suspending link being provided with an adjusting screw allows the tension on the belt to be varied when required. A mechanical governor of special design makes connection between the dynamo and accumulators so long as the train is in motion. On slowing down or stopping, the lamps are supplied from the accumulators only, these being divided into two batteries, each battery acting as a regulator to the other, and since the accumulators are always in circuit with the lamps, an absolutely steady light is thus obtained. The lubrication of the dynamo bearings is effected from a large oil reservoir, the supply being controlled by a small lever automatically operated by the magnetism of the dynamo, so that the oil is allowed to pass to the bearings only while the train is in motion. Besides the description from which we have taken the above particulars, the pamphlet before us contains much information that is of interest. Thus we are told that the first public trial of the system in England took place on the London, Tilbury, and Southend Railway in 1895, since when the whole of the old and new coaches on this line have been fitted. Nor has the success of the system been confined to this country, a large number of railways in all parts of the world having adopted it. The advantages claimed are, of course, enumerated, while figures are also given as to the power absorbed and annual cost, including interest on capital outlay, compared with other systems of lighting.



Method of Suspending Dynamo from Underframe.

Bremer Arc Lamp Patents.

It is reported in the German technical papers that the English and American patent rights for the manufacture of the Bremer arc lamp has been acquired by Mr. George Westinghouse for the Westinghouse Electric and Manufacturing Company, Limited. It will be remembered, doubtless, by some of our readers that the promising results obtained with this lamp, as detailed by Prof. Wedding before the Kiel meeting of the Verband Deutscher Elektrotechniker, were given fully in our issues of Aug. 17 and 24, 1900. The essential novelty in the lamp consists in the incorporation with the carbon used for the electrodes of a considerable percentage of non-conducting metallic salts, such as calcium, silicium, or magnesium compounds, whereby a far higher efficiency is obtained than with the ordinary type of arc lamps. So far as mechanical details are concerned, it may be mentioned that the electrodes in the Bremer lamp are inclined at an angle relative to each other in the form of a V. As the carbon is consumed, the length of the arc is automatically regulated by the weight of the carbon and auxiliary weights attached to the same, thus obviating the necessity for any special mechanism. The lamp in its state of development at the above-mentioned date was shown to combine simplicity of construction and regulation with high efficiency. But at the same time certain weaknesses in the mechanical construction of the lamp were pointed out, which have probably since been remedied. The specific consumption for two lamps tested without globes relative to the hemispherical intensity of light obtained amounted, roughly, to 0·1 of a watt. In other words, three times the amount of light, as compared with the ordinary type of arc, was obtained for the same consumption of energy. A continuous-current Bremer arc lamp, taking 12 amperes at 45 volts terminal potential, consumed only 0·13 of a watt per candle-power. The æsthetic effect and penetrative power of the lamp are also highly satisfactory, due to high percentage of orange rays. In Berlin the lamp has already found considerable favour, and German engineers seem inclined to the opinion that in its perfected state it will greatly stimulate the use of electricity for fogs, public lighting, etc., both on account of its high efficiency and superior penetrative power. Bremer arcs have been installed round the offices of the British Westinghouse Electric and Manufacturing Company, Limited, Norfolk-street, Strand, London, W.C., where their effect can be appreciated at night. There are also several other small installations of the lamp in London.

The Brush Diary.

We have again received from the Brush Electrical Engineering Company, Limited, a copy of the little pocket diary, such as for years past they have circulated amongst their customers and trade connection. In fact, this diary has come to be quite an institution in the profession. While it always serves to remind its user of the Brush Company, he is not compelled in consequence to carry round with him a small edition of the company's catalogue. In fact, only a small insertion notifies the public the origin of the gift. This diary finds its place in the waistcoat pocket of most electrical engineers.

Producer Gas and its Applications.

Messrs. W. F. Mason, Limited, engineers, Manchester, have published under the above title a series of articles by F. J. Rowan, A.M.I.C.E., which have appeared in the *Iron and Coal Trades Review*. The pamphlet is well illustrated, and sets out in a very interesting manner the merits of Duff's patent "continuous" gas producer. From a list given there appears to be a good demand for these producers, a large number being under construction for various firms in the United Kingdom and in America. Messrs. Mason, Limited, also make Duff's patent forced-draught furnace, Dunnachie's patent gas-fired kilns, refuse gasifiers, cremators, ovens, stoves, disinfectors, etc.

Diaries.

"The 'News of the World' Almanac and Encyclopedia for 1902," always a good sixpennyworth, published by the "News of the World," Limited, 30, Bouverie-street, E.C., is in every respect as useful and is arranged in the same manner as the previous issues. The same may be said of our old friend the diary of the Gloucester Railway Carriage and Wagon Company, Limited, Gloucester, which gives, as in previous years, a list of directors, items of interest in the town and neighbourhood, etc.

Ink-Pot.

The International Electric Company, 55, Redeross-street, Barbican, E.C., describe themselves as telephone-electric-light-engineers upon a porcelain insulator constructed so as to serve as an ink-pot, the receipt of a sample of which we hereby beg to acknowledge.

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LIVERPOOL OVERHEAD RAILWAY FIRE.

The following is a condensed report of the Board of Trade enquiry, which was held by Colonel Yorke and Mr. A. P. Trotter in Liverpool on the 27th ult. into the circumstances attending the recent fire on the Liverpool Overhead Railway. As our readers know, the fire occurred in the Dingle Station. The extension of the line to this terminal station from the Herculaneum Dock is through a tunnel which is, roughly, 800 yards long. The station itself is considerably below the street level, and is approached by inclined subways. These preliminary facts will make it clear in what way the smoke accumulated in the station and stupefied those men who unfortunately lost their lives. It is to be noted that out of the six men burned to death four were officials of the company, and that they lost their lives in the attempt to extinguish the fire. In fact, the evidence at the enquiry shows that all the staff of the company displayed great heroism under very trying conditions.

The first witness who gave evidence at the enquiry was a signalman named **William Owen.** He was in charge of the signal box at Dingle Station at the time, and set the road for the train to arrive at 5.32 p.m. He noticed the train going up Dingle tunnel, and all went well until it was about 80 yards or so from the platform, when suddenly the train pulled up. The driver, Ashbee, switched on for the purpose of restarting the train, and immediately there was a flare at the back end of the train. The train was made up of three coaches. The driver then switched off and switched on again, and there was another flare at the end of the train. In reply to the enquiry of the guard, Maloney, "Why don't you try one motor?" witness heard the driver answer, "I know my work." Shortly afterwards the driver switched on again and there was another flare up behind, which continued. Maloney shouted out to witness to telephone to the generating station to cut off the current, and the message was sent. By this time five minutes had elapsed since the train first stopped. After switching off witness saw Ashbee leave his driver's box and go to the rear of the train. He never saw him again. Maloney, the guard, leaving the train went to fetch a bucket of water, and when passing the signal box on returning witness handed him a chemical fire extinguisher. Maloney then went toward the train and witness never saw him again, but heard him shout for the current to be cut off. Witness could not say whether or not the current was cut off. The fire developed into a big blaze. Remaining in his signal box witness saw two passengers come along from the train, and certain officials went into the tunnel to render help, amongst them Randells and O'Brien, both of whom were killed. Witness ultimately went into the tunnel, but was stopped by the smoke and heat. He sent two lamps into the tunnel by Randells and O'Brien to light the way for passengers to come out, and himself helped two passengers over the cross-over road. He got as far as the front coach, but the heat and smoke were intense and he could get no further. To the best of his belief all the passengers got out of the train; they had only to go up the slope on to the platform, up the staircase and out, and they would have been safe. After a little time witness finally left his box. He did not think that at this time the sleepers could have caught fire, or they must have suffocated him. On reaching the street he lost consciousness. Witness went on to remark that all the afternoon an awful wind was blowing up the tunnel, and that made the fire spread. In reply to Colonel Yorke, he said he had never seen anything like this before on he Overhead Railway.

George Gough, a youth of 16, train booker in the same signal box with Owen, said that after the electric lights in the station had gone out, he took one lamp himself and gave another to O'Brien, and went down to the burning train. They met passengers coming from the train. One refused the hand lamp witness offered, saying that he could find his way. Witness lighted three other passengers to the bottom of the staircase. He heard Randells twice tell passengers to make their way upstairs as soon as they could, but several of them paid no attention. If they had all gone off when first told, they would have escaped. Witness afterwards guided five more passengers to the bottom of the staircase, and, returning again, found O'Brien lying partly unconscious. He led O'Brien to the staircase; then hearing a shout from the permanent way, returned crawling on his hands and knees, and found a passenger on the line. Him also witness led to the platform, about half-way along which the passenger said he could go no further, and gave witness a note to deliver, which unfortunately he had lost. Witness then escaped himself, becoming unconscious when he reached the top. He had stood under a water-tap before doing what he had described, and drenched himself.

The witness was complimented by **Colonel Yorke**, who said he deserved great credit.

Wm. Shuttleworth, booking clerk, deposed as to the suffocating nature of the smoke, and said some of the passengers were cut off by a barrier at the top of the staircase, but it was only 4ft. 6in. high, and he could not understand why they could not have climbed it except on the supposition that the persons were partly suffocated by the smoke.

Traffic-Inspector Lenthall was next called, and stated that he was going to the Dingle Station to catch the 6.20 train, when he was met by volumes of smoke coming out of the tunnel. Witness afterwards explained to Superintendent Thomas of the fire brigade where he could best get at the fire, and a hose pipe was run to the train from the Herculaneum end of the tunnel.

Richard Orford, foreman at the Herculaneum Station, deposed that when the train came up the only thing he noticed about the train was that the insulation was smelling, as it sometimes did with the overheating of the resistance coils. Maloney, the guard, said to him, "She's humming, isn't she?" That meant that it was smelling. It was not a frequennt occurrence. He heard the telephonic message go through from Dingle Station to the generating station to cut off the current. That was the first intimation to him that anything was wrong with the train.

Charles Cunliffe, foreman driver, gave evidence to the effect that the driver, Ashbee, was in a fit condition for his work when he went on duty.

Alfred Ingham, motor and carriage superintendent, stated that the train in question, when it was delivered to the company in 1894, consisted of only two coaches, but in 1897 it was converted into a three-coach train by the introduction of a third coach between the two motor coaches. Since that date the three coaches had always worked together. Turning to the question of the motors, he stated that the armature and the field magnets at the south end were rewound in 1897. Since that time the mileage run had been 26,911. The train was thoroughly overhauled in May of last year. The north end armature was rewound in February, 1896, and the field magnets were rewound in September, 1899. The train had been overhauled since 1896 some 12 times; the last occasion was on Nov. 26 last. On the Saturday previous to the accident witness saw the motor under the train. He made a superficial examination at the time. It was reported to him that the brakes were bending, and they were let out and adjusted. He did not examine the motor with any particular care, however. He had never known a case of a burning armature setting fire to a part of a train. His attention, therefore, had not been drawn to this source of danger. The average mileage per armature on the Liverpool Overhead was about 35,000. In reply to further questions from Colonel Yorke, witness stated that he received no complaints about the motor at the rear of the train within the last month.

Mr. S. B. Cottrell, engineer and general manager of the company, then gave evidence. He agreed that as all the electric lights went out there must have been a very bad short-circuit. The automatic circuit breakers were set to go at 160. One might go off half a dozen times in a journey. He admitted that he had never anticipated the armature catching fire and setting fire to the train. The motors were nine years old, and, witness added, if they were altered now they should adopt the iron-clad type as a more up-to-date motor. They had never had any serious breaking out in the driver's cab. Referring to the sleepers, witness stated that the nearest point between the sleepers and the train was 18in. When he was at the station at nine o'clock the sleepers had just caught fire. The Dingle Station had always been equipped with suitable hydrants and with proper length of hose to cover the whole station ground in case of fire. This hose was systematically run out for periodical inspection. Dingle Station was also equipped, as all the stations on the Liverpool Overhead were, with chemical fire extinguishers. The station was lighted by electricity and duplicated by gas. At vital points the gas was burning all day and night. A spare train was usually kept at Dingle for an emergency, and both station foremen were trained drivers, so they had a stand-by both of train and drivers. Randells had been with them from the opening of the railway, and was a thoroughly reliable man. He could not account for Randells going along the four-foot to the dead end of the station instead of leading the passengers along the platform and up the stairs unless he thought there was safety at the air-shaft. He was a man of intelligence. Replying to further questions, witness said there was no reason why the train should have been stopped at Herculaneum Station. On a damp day it was quite common for the insulating material to get damp and for heat to be generated. The insulating material would then smell just as an ordinary dynamo would. Continuing, Mr. Cottrell said his directors were instructing him to relay the platform with stone instead of wood. Further than that, he was eliminating all timber about the station. The signal cabin he was building entirely of brick as far as possible. It had a wooden top before, and now it would be brick. He would put up iron barriers instead of wooden ones, and even the wooden handrails would be replaced by iron rails. He calculated that the length of the interval between the first flashing from the rear of the train and the time when the fire had arrived at a serious state was about 12 minutes. He considered that in this 12 minutes all the passengers had time to get away from the station. The reason the flames advanced so rapidly was because the wind was blowing a hurricane up the tunnel. On an ordinary day he did not think the fire would have spread at all. The total loss of life was four servants of the company and two passengers.

The enquiry then terminated, and Colonel Yorke and Mr. Trotter subsequently proceeded to the company's carriage works to inspect the motor in question detached from the coach.

LEGAL INTELLIGENCE.

ELECTRICITY METERS.

Alleged Infringement of Patents.

The following is the full text of the judgment of the Court of Appeal, delivered on the 20th ult., in the case of Chamberlain and Hookham, Limited, *v.* the Mayor, etc., of Bradford. It will be recollected that the action was one for alleged infringement of the plaintiffs' patent (No. 4,225 of 1887) relating to improvements in electricity meters, and that they appealed from the decision of Mr. Justice Farwell in the Chancery Division that there was no infringement of the patent by the defendants. As briefly announced in our last issue, the Court of Appeal have affirmed this decision.

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Lord Justice Romer read the judgment of the Court as follows: This case has been argued by counsel on behalf of the plaintiffs at great length and with much detail. The effect of their discussion of minute points arising in the case, coupled with the many difficulties involved in their elaborate consideration of electrical and magnetic laws, has been, in our opinion, somewhat to obscure an otherwise fairly simple and intelligible case. We think that when the pith and substance of the questions involved in this appeal are sought for, they can be readily understood and be shortly stated and determined. And we propose in this judgment to avoid all details that are not necessary to be mentioned, having regard to the grounds of our decision, and to briefly state what the merits of the case, in our view, are, and why we think that the appeal fails. In the first place, it is important to consider how matters stood with reference to the subject of the plaintiffs' invention immediately prior to the patent. The principle on which the plaintiffs' electricity meter, and also the defendants' meter, were subsequently constructed was then well known. It had been pointed out that such meters might be made by means of a motor and brake worked and used in the manner subsequently adopted in substance in the meter of the plaintiffs and in that of the defendants. In particular, Mr. Siemens had published his design of an electrical meter, in which he employed the motor, with a brake effected by wings revolving in a fluid. With reference to this design it was publicly pointed out by Marcel Deprez that it was wrong in principle to use the last-mentioned kind of brake, inasmuch as the resistance varied, or tended to vary, as the square of the velocity, whereas it ought to vary directly as the velocity. In other words, he stated with reference to these meters what has been called the straight-line law, and he recommended the employment as a brake of a disc rotating between the poles of a permanent magnet—that is to say, the brake subsequently employed in the defendants' meter—and the use of which, in reference to the plaintiffs' machine, was referred to by the patentee (Mr. Hookham) in his specification. But to make such a meter as was thus made known to the public a good practical machine up to commercial requirements, a difficulty had to be overcome—the difficulty of friction. Mr. Hookham surmounted the difficulty chiefly by the use of a special commutator, a very ingenious contrivance; and this was, in our opinion, the most important part of his invention. Now, so far as the commutator is concerned, the defendants' machine in nowise employed the same means of overcoming the difficulty as those adopted by Mr. Hookham. The defendants' machine indeed proceeded, far more than the plaintiffs' did, on the lines of Mr. Siemens's machine as corrected by Marcel Deprez. In the defendants' meter Mr. Siemens's commutator was used, with a very ingenious modification. So far, then, as the commutator is concerned, and, indeed, so far as the machines generally are concerned, apart from the question as to the permanent magnet used by the defendants, which we are about to mention, the two machines are, in our opinion, substantially different, though both are based on what was published and known prior to the date of the plaintiffs' patent. It appears to us, therefore, that the plaintiffs must fail in this action, unless they can establish that the defendants have infringed the patent by reason of the use of the permanent magnets employed by the defendants on their brake. Now, the plaintiffs contend that they have claimed by their specification, and are entitled under their patent to, the sole right to the use for the purpose of electricity meters, in connection with either motor or brake, of any permanent magnet having large polar surfaces closely fronting each other, so as to form a narrow slit in which the armature or disc revolves. But it appears to us, for the reasons we are about to state, that the plaintiffs fail in this contention; and that the claim (Claim 3) in their specification did not extend to cover the use of every permanent magnet having large polar surfaces, with a narrow slit between them, but was limited to what has been called a compound or built-up magnet—that is to say, to an arrangement of bar magnets, or of other equivalent magnets (though differing in shape and configuration from bar magnets), with pole-pieces having surfaces of the above-mentiond kind. And this being so, what the defendants are doing is not within the plaintiffs' claim. Now, in the first place, we may point out that it would be very difficult for the plaintiffs to say that their Claim 3 was a valid claim, if that claim was so extensive as to cover what the defendants are doing with their brake. For the defendants are using the knowledge given to the world by Marcel Deprez. They are taking his brake for the purpose indicated by him. He pointed out that it should be made by a disc revolving in a permanent magnet. Now, the magnet used by the defendants is not of a form or shape unknown at the date of the plaintiffs' patent. On the contrary, the evidence is that the defendants' magnet is of a common kind. Nor, indeed, do the plaintiffs say that a magnet like the defendants' was unknown at the date of the patent. What they say is that Mr. Hookham discovered that certain shaped magnets, covering a large number of well-known magnets (including the defendants'), were peculiarly well suited, by reason of their possessing constancy and power, for use in connection with brakes. But it is not easy to understand how this discovery could entitle the discoverer to prevent persons from using known magnets for the purpose of Marcel Deprez's known brake. But it is not necessary for us to decide whether Claim 3 would have been valid if it had been more extensive in its operation than, in our opinion, it is. It is sufficient for us to say that the patentee may well have shrunk in making his claim from risking its validity by making it broader than it is. We will now turn to the body of the specification. That deals with the use of permanent magnets as an alternative in the place of electromagnets, which the patentee fully describes. No drawing is given of any permanent magnet. We have, therefore, to depend entirely upon what is said in the specification in order to ascertain what the patentee is claiming in respect of permanent magnets. The first mention of permanent magnets is at p. 4, line 39, where he refers to their use in reference to the removal of bars from such magnets for the purpose there indicated. Then comes the important description (at p. 5, line 2 and *seq.*). The patentee there speaks of "a number of bar magnets being substituted for the electromagnet represented in the drawings, though I may use magnets of other shape or configuration," and he adds, that in all cases he wants the pole-pieces of a certain shape. This appears to us to point to an arrangement of magnets with certain pole-pieces. If the patentee had really intended to claim for the use of every magnet having pole-pieces with large surfaces and small slit, he ought to have made that clear. But he has not done so. And, indeed, his object being (p. 5, line 3) to make permanent magnets "very powerful and very constant," if he thought that he had effected his object solely by the form of the pole-pieces we should have expected him to state this, and also to inform the public within what limits, as to size of surfaces of the pole-pieces and distance apart, the pieces should be in order to be effective in power and constancy. But he has not done so. He has said he "prefers" a certain ratio to be observed, but he only gives that ratio by reference to a minimum, and the evidence shows that his ratio would cover a large number of magnets well known at the date of his patent. If he was not describing his pole-pieces as an adjunct to his "arrangement" of magnets, but was contemplating a claim apart from that arrangement, he was in a position of considerable difficulty, having regard to public knowledge at the time of his patent, in reference to the use of permanent magnets with a disc to form a brake in electricity meters. For in this case he would not be claiming the use of some new combination or arrangement of magnets, or of some new magnet invented by him, but would be claiming the use of every known magnet which happened to have poles with what he calls "large" surfaces, and which formed between them what he calls a "narrow" slit, merely because he had discovered that they possess valuable qualities with reference to a use which might well be held known. It appears to us that it would not be fair as against him to hold that he intended to make such a large claim, which might have made it invalid, unless he had clearly indicated such an intention. In our opinion he has not indicated such an intention. And if as against him we should not have held such an intention shown, we ought not to hold it now in his favour, because it suits his present purpose to seek to cover what the defendants are doing But we think that an examination of the wording of Claim 3 itself strongly confirms our view that his claim was not so large as he now contends it is. He only in terms claims the use of permanent magnets "arranged as described with" (which we think means "accompanied by") "very large polar surfaces," etc. And the claim is further covered by the last words, "substantially as herein described, and in part illustrated by the accompanying drawings." So far as the drawings are concerned with magnets, they show and describe only an electric magnet, and the description in the body of the specification of his permanent magnets is (as above mentioned) with reference to a number of bar magnets being substituted for the electromagnet represented in the drawings, though, as he says, "I may use magnets of other shape and configuration." Whether in any case the patentee's description of his magnet is sufficiently clear to support a claim for it we need not consider, having regard to the conclusion we have come to, that his claim, at any rate, does not extend to cover the defendants' magnet as used on their brake. For these reasons it appears to us that the defendants' machine is no infringement of the patent, and it is unnecessary for us to consider the other points taken on behalf of the defendants, some of which were dealt with by Mr. Justice Farwell in his judgment. The appeal must be dismissed with costs.

COMPANIES' MEETINGS AND REPORTS.

METROPOLITAN DISTRICT RAILWAY.

Details of the Electrical Equipment.

On the 23rd ult. two extraordinary meetings of the shareholders of this Company were held at the Westminster Palace Hotel, S.W.—firstly, for the purpose of authorising the raising of capital to complete the Whitechapel and Bow Railway, and, secondly, to approve the promotion of the Metropolitan District Railway Bill and the Brompton and Piccadilly-circus Railway Bill in the next session of Parliament. Mr. R. W. Perks, M.P., the new chairman of the Company, presided.

Speaking on the resolution authorising the Company to raise the amount of the subscription to the Whitechapel and Bow Railway, the **Chairman** remarked that they had had exceptional difficulties to deal with, in the construction of the line, in the shape of sewers, water-mains, gas-mains, etc., and he ventured to commend their experience in this shallow-line railway to the attention of the very sanguine engineers who had been advising the London County Council that they could construct shallow tramways in London at about one-half, or less than one-half, the cost which practical people who had to perform that work had found to be really the case. He further remarked that with the opening of this line in April or May next, they hoped to recover permanently in the East-end of London some of the traffic which had been temporarily diverted from them in the West-end of London, by the serious competition of the Central London and the electrical tramway lines. The Tilbury Company, in their Bill of this year, were proposing to adopt electrical traction on their line right away down to Barking.

Mr. L. H. Isaacs seconded the resolution, which was carried unanimously.

A special general meeting was then held to consider the promotion of the two Bills named above.

The **Chairman**, in moving the resolution for the approval of the Metropolitan District Railway Bill, explained that nearly the whole of the Bill dealt with the important questions which arose in connection with electrical traction, which, he hoped, would be shortly intro-

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duced upon the railways. He proceeded to trace the progress of events in connection with the electrical equipment of the Underground from as far back as 1888, when Sir Edward Watkin first introduced the subject at one of the shareholders' meetings. Incidentally, he mentioned that Sir John Wolfe Barry had resumed his old position as consulting engineer of this railway. In addition, as this Company was working in close unison with the traction company, they would have the benefit of the advice of that company's consulting engineer—Sir Alexander Binnie. Referring to the decision of the Board of Trade as to the adoption of the continuous-current system of working, the Chairman said they were much indebted to the Board of Trade for the promptitude with which they made their award, when they got the report from the tribunal to which this question was submitted. He went on to state that this Company had made two distinct propositions in the direction of unity to the Metropolitan Company. They recognised that the Inner Circle system was one which could only be efficiently worked in the interests of the London traveller by the unison of the two partners. One of the two propositions was this: that in place of the duplication of electrical plant for the generation and supply of electrical current, each company should take its supply from the great generating power-house which was about to be erected at Lot's-road, Chelsea. The Metropolitan Company invited, a few days ago, tenders for the construction of a large power-house at Neasden. He had informed Colonel Mellor (the chairman of the Metropolitan), at a meeting a day or two ago, that this Company would be prepared to supply from their own generating station at a lower rate than the Metropolitan Company could possibly generate their current for the operation of their railway electrically. It seemed to him to be a waste of money for the Metropolitan Company to spend £300,000 or more in the erection at Neasden of a duplicate power-house. The other proposition was with regard to the Bow and Whitechapel undertaking, which had been constructed for absolute cash, and which was now the property of the London and Tilbury Railway and the District Railway, that the Metropolitan Company should become, if they desired, their partners in that undertaking on precisely the same conditions as this Company. In that case certain trains from Barking or Southend and the East of London would pass over the District Railway away to the west, and certain portions might pass by Aldgate Junction by the Metropolitan line to King's Cross, Baker-street, Paddington, and beyond. He trusted that those explicit offers would meet with the favourable consideration of the proprietors. So long as he remained in office he could not for a single moment recommend the proprietors to consider the extremely one-sided proposition which the Metropolitan Company had made, that there should be a temporary fusion under one manager of the two undertakings. On the other hand, he would like to remind them and the Metropolitan proprietors of the offer which was made by the traction company to the Metropolitan, and which, he thought, was rather summarily dismissed about six months or a year ago—namely, the proposals made by the traction company that they should undertake the leasing and the working of the Metropolitan Railway, giving the proprietors of that undertaking 3½ per cent. guaranteed on their ordinary stock, and all prior charges properly protected. Referring more particularly to the equipment of the Inner Circle for electric traction, the Chairman said that notices to treat had been given for the whole of the lands required for the power-house at Chelsea. The borings would be sunk next week, and the contracts had been largely let by the traction company for the machinery required for that power-house. The power-house would be of such a character as to generate a supply up to about 60,000 kw. It would be the largest power-house ever erected in this country, and it was intended to supply, not merely the District Railway, but several other railways which might be worked in close association with it. They thought it would take from 18 months to probably two years to build the power-house, and therefore they had to look forward to that period of patient waiting and economical administration before they would be able to see the full reward of the enterprise into which they had entered. They were not going to have overhead trolley wires carrying a current which they thought would be dangerous—a voltage of 11,000 volts. It would be better, they were of opinion, to adopt a system of sub-stations through which their current was carried from the power-house, and where it was reduced by transformers and rotary converters into a safe and ordinary current of about 550 volts. He admitted that the Ganz system had the backing of Sir W. Preece, but that gentleman did not come to the tribunal to explain his reasons in the witness box, and he somewhat modified his opinion in the parliamentary committee-room. They would run the railway upon the principle of what was called the multiple unit. The trains would probably be 60 in number, and would consist of seven coaches, three of which would be motorcars and four what were called trail cars. The carriages would be 50ft. in length. The total length of the trains would be 350ft., and would seat 338 passengers. They would be so constructed that in the slack hours of the day they would be divisible into two sections, and run in short lengths. They were constructed with a motorcar at each end and one car in the middle, so that they could go forward and backward without reversing the engine. The service would be accelerated. The average rate of running now was about 10 miles per hour; they would undertake to run at least 15 miles per hour, and the trains would have a carrying capacity of at least 70,000,000 passengers per annum, and with the same capacity in rolling-stock they would be able to carry about 30 per cent. more. They were working in friendly relationship with the London and North-Western, who had running powers over their line from Earl's Court to Mansion House, and they had come to an agreement with that company to haul forward their trains by electric motors if the North-Western Company did not elect to run their own trains by that method. They hoped also, by means of their arrangements with the Great Western and the Great Central, with whom they were now entering into an agreement for a junction at Harrow with their railway, to develop a very considerable amount of goods traffic through to the East-end of London over this line and over the Tilbury. That goods traffic could be hauled forward without any difficulty by means of the electric engines to which he had alluded. It had not yet been definitely decided what the system of fares would be. An accomplished employé of the Tilbury Railway left London a week ago for New York to study the problem. Also the Board had not at present decided whether they would have one entire class or two classes, but the shareholders might take it that the traction company and this Company would not recommend three classes. It would not be the policy of the directors to alienate the working-class traveller of London. They thought he was a valuable element of the travelling community. At present he provided about 10 per cent. of the travellers of the London Central Railway, and the Board thought that if the tube could carry the working-man and make a profit at low rates it ought to be possible for them to do so with no lifts. Continuing, the chairman said that, as a company, they would have very strenuously to oppose the new railway projected by the Central London from Hammersmith to the City. There was a second railway promoted under the auspices of the United Tramways Company to the City, and that was to have a line along the Strand and Fleet-street. However, they thought they could hold their own against these competitors, although they would try to persuade Parliament that it was only just to this undertaking that as they were forced to go away from Fleet-street and the Strand on to the Embankment it was not fair to allow a rival to take charge of those thoroughfares. Having described the Bill under consideration, and explained that the additional capital asked for was £250,000 in ordinary or preference stock, he concluded by moving the approval of the same.

Mr. Isaacs seconded the resolution, and it was carried unanimously.

The **Chairman** then moved the approval of the Brompton and Piccadilly-circus Railway Bill.

Mr. Isaacs seconded the resolution, which was agreed to *nem. con.*

A vote of thanks to the chairman closed the meeting.

PROVINCIAL TRAMWAYS.

Mr. Andrew Beattie presided over the ordinary general meeting of the shareholders in this Company, held at the offices, Cheapside, on the 20th ult.

In moving the adoption of the report, which recommended a dividend of 6s. per share on the ordinary share capital, the **Chairman** said that the year ending Sept. 30 last had been rather an eventful one in the history of the Company. When they met last year the directors reported that the Corporation of Portsmouth were about to take over their tramways undertaking, and now that had become an accomplished fact, and before they met again they would be giving up Cardiff. Reviewing the history of the Company, he said the profits had risen from £10,990 in 1891 to £34,205 in 1899, and if they had still retained Portsmouth last year they would have been £37,000. That was a very creditable history. For the Portsmouth undertaking they had received altogether £216,801. As against that, they had charged to Portsmouth £169,976, so that they had received a surplus of £55,000. That was unique in the history of tramways purchased by local authorities. This satisfactory result was in a great measure due to the exertions of their managing director, Mr. J. Barber Glenn. Their undertakings at Plymouth and Grimsby had also been successful. They were in delicate negotiations with Cardiff at the present time. The Corporation were going to take over the lines on Jan. 1. The premises, rolling-stock, etc., had yet to be valued, but they had made arrangements for the permanent way. They knew exactly what it would cost, so that they had arranged at Cardiff for the permanent way with the local authority at a certain amount. They had appointed gentlemen to value the rolling-stock, horses, and premises there, so they did not know exactly what they would get from Cardiff until those returns came in. They hoped, however, to be able to amicably settle the matter without going to arbitration, so that would save a great deal of money both to the Cardiff Corporation and the Company.

Mr. J. S. Comrie seconded the motion, which was carried unanimously.

On the motion of the **Chairman**, seconded by **Mr. Comrie**, it was resolved: "That the directors be authorised to acquire, if they see fit, the Portsmouth and Horndean Light Railway Order, 1898, at the purchase price of £2,500."

BUENOS AYRES NEW TRAMWAYS.

On the 30th ult., at the offices, Eldon-street, the ordinary general meeting of the shareholders in this Company was held under the presidency of Mr. R. J. Davis.

In moving the adoption of the report, the **Chairman** referred to the fact that the accounts covered a period of 21 months to Sept. 30 last. This lengthened period was occasioned by the special resolutions which constituted the Company's financial year as from Oct. 1 to Sept. 30. Turning to the balance-sheet, he stated that the £5 preference shares at Dec. 31, 1889, 30,000 in number, had been added to by 3,000—the result of the consolidation of the 15,000 preference shares of £1 each, which represented 15,080 £5 ordinary shares after they had been reduced by cancelling £4 per share on £60,000, The £5 ordinary shares, which at Dec. 31, 1899, were 15,000 in number, thus disappeared from the balance-sheet. The 1,000 new ordinary £1 shares now appearing for the first time in the balance-sheet were duly issued under the March, 1900, agreement, by which these shares were entitled to a dividend only out of five-sixths of the balance of profits after £6,600 had been paid in non-cumulative dividends to the preference shareholders. As to the capital of the Company, the liabilities were reduced by £128,785, of which £60,000 was the amount agreed to be written off ordinary shares, and £68,785 was the amount of interest

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due to the holders of the £100 debentures at Dec. 31, 1899, agreed to be foregone. On the assets side there had been written off £128,785, comprising £90,854 loss on working to Dec. 31, 1899, £2,199 the cost of reconstruction, and £35,731 representing depreciation of concession and plant. The amounts of the prior lien bonds and of the £100 debentures remained the same, and the interest on the former still stood at 6 per cent., but the holders of the £100 debentures, who received no part of their 5 per cent. interest due after Aug. 1, 1894, began to receive 3 per cent. as from Oct. 1, 1900, and this would be increased to 4 per cent. as from Aug. 2, 1903. The item of "sundry creditors, London," £47,293, comprised amounts due to La Capital Tramways Company and the traction company for loans and work done, about £44,000; debenture interest, etc., accruing but not yet due to be paid, and coupons due but not presented; and current expenses not yet paid, £1,750. The sum of £1,520 against "sundry creditors" was due to contractors and others for work done. The revenue account showed that for the 21 months, after paying or allowing for interest on the prior lien bonds, the £100 debentures, and advances and expenses, was £7,932. In these circumstances the directors had agreed to forego all fees to Sept. 30 last. The present position of the Company was that the horse portion of the concern was worked as from Dec. 1, 1900, by the Grand National Company and the electric portion as from the same date by La Capital Traction Company, and the joint net receipts were paid into a pool, of which the Company received a quarter.

Mr. H. A. Trotter seconded the motion, which was agreed to.

At an extraordinary general meeting held afterwards, resolutions were passed authorising the Board to issue conversion bonds and permitting any director under certain specified condition to be appointed to any office under the Company or to be interested in any contract or dealing with the Company.

COSTA RICA ELECTRIC LIGHT AND TRACTION.

The ordinary general meeting of the proprietors was held at Winchester House, Old Broad-street, on the 23rd ult., Mr. W. F. Lesse, the chairman of the Company, presiding.

The **Chairman,** in submitting the report and accounts for approval, announced that for the year ended June 30, 1899, the profit and loss account showed that the net earnings in Costa Rica were £3,810; for the year ended June 30, 1900, the net earnings in Costa Rica were £6,886; while for the year under review they amounted to £8,974, thus showing a continuous and satisfactory increase. Having dealt with the electric lighting and the growth of that branch of the business, he pointed out that since the last balance-sheet the number of incandescent lights installed had increased up to June 30 from 4,951 to 6,896 of 16 c.p., and upwards of 80 per cent. of the consumers were on the meter system, which was a satisfactory change. The number of arc lamps in operation at the same date was 274. The supply of current for power purposes showed a steady increase. The number of passengers carried during the year amounted to 687,618, or an increase of 37 per cent. over the previous year. Since the close of the financial year 2½ miles of additional tramway—viz., the San Pedro extension—had been opened to public service, and there was an urgent demand for extension in all directions.

Mr. Frederick Davies seconded the motion, which, on being put to the meeting, was carried unanimously.

APPOINTMENTS VACANT.

Foreman, to take charge of switchboard shop. Full particulars in our advertisement columns.

Traffic Assistant, Huddersfield Corporation Tramways, £100 per annum, Jan. 13. Full particulars in our advertisement columns.

Electrical Engineer, to take charge of the driving and lighting plant at printing works. Full particulars in our advertisement columns.

Assistant Mains Engineer, Corporation Electricity Works, Manchester, £200 per annum, Jan. 10. Full particulars in our advertisement columns.

Engineer-in-Chief, South Lancashire Electric Traction and Power Company, Limited, £500 per annum, Jan. 15. Full particulars in our advertisement columns.

Switchboard Attendant, Electricity Works, Ayr, N.B., used to paralleling of alternators and had experience with continuous three-wire system, 30s. per week. Full particulars in our advertisement columns.

NEW COMPANIES REGISTERED.

South-West Wireless Telegraph Ship Company, Limited.—Capital, £25,000. Objects: to supply telephone, telegraph, electric light, heat, and power.

Leicestershire and Warwickshire Electric Power Syndicate, Limited.—Capital, £20,000. Object: to supply electric power in the two counties named.

Sussex Automobile Company, Limited. — Capital, £4,000. Objects: to acquire the business carried on at 163, Western-road and Castle-street, Brighton, as the Sussex Automobile Company, etc.

Hobbs and Sons, Limited.—Capital, £15,000. Objects: to adopt an agreement with H. E. Hobbs, W. A. Hobbs, and A. J. Hobbs, and to carry on the business of boatbuilders, boat fitters, steam and electric launch builders, motor manufacturers, suppliers of electricity, etc.

Electrical Investment Syndicate, Limited.—Capital, £1,000. Objects: to carry on the general business of electricians, mechanical engineers, suppliers of electricity for the purposes of light, heat, or motive power, manufacturers of apparatus, machines, wires, lines, cables, accumulators, lamps, buildings, plant, machinery, and works.

Speedwell Motor and Engineering Company, Limited.—Capital, £10,000. Objects: to acquire the business of the Speedwell Electrical Motorcar and Cycle Company, Limited, at 134, Broad-street, 1, Minster-street. 172, Oxford-road, and 106A, King's-road, Reading, and to carry on the business of electrical and other motor vehicles, etc.

Aluminium Rotary Press, Limited. — Capital, £200,000. Objects: to purchase or otherwise acquire any real or personal property in any part of the world, or any concessions, options, rights, or interests in respect of any such property on such terms and conditions as the directors may deem advisable; to acquire and turn to account any patents or patent rights, to construct, maintain, and work any rail and tram roads, canals, docks, wharves, hydraulic, gas, and electric works, etc.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ghent.—The Municipality require tenders for the electric lighting of the town. Tenders must be posted before March 1, 1902.

Elstree (Herts).—The Parish Council invite tenders for lighting the parish of Elstree with 20 lights from January to April, 1902. Tenders by Jan. 6.

Bournemouth. — The Town Council invite tenders for feeder cables, pilots, arc lighting cables, conduits, etc. Tenders by Jan. 6. Details in our advertisement columns.

Barrow-in-Furness.—The Corporation invite tenders for the wiring of the new town hall. Specifications, etc., may be seen at the Electricity Works. Tenders by Jan. 10.

West Bromwich.—The Council invite tenders for the reconstruction and electrical equipment of about 12 miles of tramway in the borough. Tenders by Jan. 17. Details in our advertisement columns.

Barking (Essex).—The Urban District Council invite tenders for supply and erection of additional generating plant. Full particulars may be had from the Engineer, Electricity Works, East-street, Barking. Tenders by Jan. 24.

Brussels.—The administration of the Belgian Government Telegraphs will receive tenders for 7,300 telegraph posts by Jan. 8, 1902. Specification No. 12 may be obtained at the office of the department, Brussels.

Paris.—The Under-Secretary of State for Posts and Telegraphs, Rue de Grenelle, 103, requires tenders for three lots of submarine cable of 25 km., 60 km., and 60 km., and for 30,000 kg. of 8mm. iron wire. Tenders by Jan. 7, 1902.

Kirkcaldy.—The Corporation invite tenders for the supply, delivery, and erection of steam, exhaust, feed, and drain pipes, feed pumps, feed heater, feed tank, tools, etc. Tenders by Jan. 8. Details in our advertisement columns.

Brussels.—The Belgian Government Railways invite tenders for the plant, etc., for an electric lighting station at Marchienne au Pont. The estimate is 4,027,282fr. A deposit of 3,600fr. is required. Tenders by noon on Jan. 20, 1902.

Poplar.—The Establishment Committee invite tenders for the installation of electric light in the Poplar Town Hall and the Bow and Bromley Vestry Halls respectively. Tenders by Jan. 11. Details in our advertisement columns.

Huddersfield.—The Corporation invite tenders for the supply and delivery of about 300 tons of chilled blocks. Specifications, etc., may be obtained on application at the offices of the Borough Engineer and Surveyor, 1, Peel-street. Tenders by Jan. 10.

Cairo.—The Public Works Department require tenders for the public and private electric lighting of the towns of Suez and Damanhur. For particulars, application may be made to the Electrical Engineer's Office at the Public Works Department, Cairo, by Jan. 15.

Hornsey.—The Urban District Council invite tenders for the supply and erection of steam, exhaust, water, and other pipes, valves, tanks, footplates, and accessories, and elevator and transporter, electric motor and switch gear. Tenders by Jan. 15. Details in our advertisement columns.

Huddersfield.—The Corporation invite tenders for the supply and delivery of about 6,600 copper bonds, in length varying from 3ft. to 12ft. Specifications, etc., may be obtained on application at the offices of the Borough Engineer and Surveyor, 1, Peel-street. Tenders by Jan. 10.

Stepney.—The Borough Council invite tenders for the installation of electric wires, lamps, and other fittings on the premises of private consumers in the borough, on the basis of a fixed annual charge per point wired. Tenders by 12 noon on Jan. 9. Full particulars in our advertisement columns.

Madrid.—The Department of Agriculture invite tenders for the construction of an electric tramway from Linares to the mines of San Roque and Torilla, in the Province of Jaen. Tenders by Feb. 24. This is the extension of the tender advertised for Nov. 17, but the conditions have been modified.

Paisley.—The Corporation invite tenders for the supply, delivery, and erection of steam-engines, dynamos, switchboards, and condensers. Specifications, etc., may be had on application from Mr. C. F. Parkinson, M.I.E.E., burgh electrical engineer, Electricity Works, Blackhall Paisley. Tenders by Jan. 13.

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West Ham.—The Council invite tenders for four sets of surface condensing plant, each to deal with 40,000lb. of steam per hour, complete with electrically-driven air and circulating pumps; and one travelling crane, to carry 30 tons, span 67ft. Tenders by Jan. 14. Details in our advertisement columns.

Leeds.—The Lighting Committee invite tenders for a complete 2,000-b.h.p. set of surface-condensing plant, comprising condenser, air-pumping engine, and circulating engine. Specifications, etc., may be obtained from Mr. Harold Dickinson, manager of the department, 1, Whitehall-road. Tenders by Jan. 16.

Louvain (Belgium).—The period within which proposals will be received for lighting the city of Louvain by gas or electricity, or by a combination of the two systems, has been extended from 31st inst. to Feb. 19, 1902. Proposals, marked "Lighting Contract," to be addressed the Burgomaster, Louvain, Belgium.

St. Pancras.—The Borough Council invite tenders for supplying (Section 1) engines, dynamos, condensers, exhaust pipes; (2) boilers, feed pumps, steam and feed-water pipes, etc. Specifications, etc., may be obtained upon application at the Electricity Department Offices, 57, Pratt-street, N.W. Tenders by Jan. 17.

Grimsby.—The Corporation invite tenders for the extension of the plant at the electricity works, as follows: steam dynamos, extension of switchboard, accumulators, condenser plant and pipework, and water-tube boiler. Specification, etc., can be obtained from the borough electrical engineer, Mr. W. A. Vignoles. Tenders by Jan. 20.

Horley (Surrey).—The London County Council invite tenders for wiring and fittings for the electric lighting of the new buildings now being erected at the Farmfield Reformatory for Female Inebriates, near Horley, Surrey. Specification, etc., can be obtained at the Chief Engineer's Department, County Hall, Spring-gardens. Tenders by Jan. 14.

Nantwich.—The Urban District Council invite tenders for the supply and erection of boiler-house plant: one water-tube tube and one Lancashire boiler, fittings, steam and exhaust pipes, etc.; engine-house plant: continuous-current steam dynamos, pumps, etc.; switchboard, etc., underground mains, lamp posts, etc., accumulators, meters, crane, etc., dust destructor. Tenders by Jan. 6, 1902.

Barnstaple.—The Town Council invite tenders for the supply and erection of three straight water-tube or Economic boilers, fittings, steam and exhaust piping, condensers, three high-speed engines (220 i.h.p. each), three 125-kw. c.c. dynamos, switchboard, underground mains, lamp-posts, etc., meters, accumulators, crane, etc. artesian well. Tenders by Jan 16. Details in our advertisement columns.

Madrid.—The Public Works Department invite tenders for an electric tramway from San Sebastion to Toloso, with power to work same for a maximum of 60 years, after which the undertaking becomes Government property without compensation. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m. Tenders by Jan. 27.

Huddersfield.—The Corporation invite tenders for the supply and delivery of about 2,339 tons of steel tramway rails; 108 tons 5cwt. steel fishplates; 76 tons 7cwt. steel soleplates; 37 tons 8cwt. of wrought-iron tie-rods; 25 tons 2cwt. of iron bolts, 1in. diameter; and 13 tons 13cwt. of iron bolts, ¾in. diameter. Specifications, etc., may be obtained on application at the offices of the Borough Engineer and Surveyor, 1, Peel-street. Tenders by Jan. 10.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Stuart-street generating station of (a) main high-tension three-phase switchboards at generating station, (b) exciter and auxiliary switchboards at generating station, (c) high-tension three-phase switchboards at 10 sub-stations, (d) low-tension switchboards at 10 sub-stations. Tenders by Jan. 21. Details in our advertisement columns.

Hartlepool.—The Corporation invite tenders for the erection of a generating station and the supply and erection of plant—viz., erection of buildings, boilers (two of marine type), engines and dynamos, steam, feed, and exhaust pipes, valves, and other apparatus, storage battery, switchboard, arc lamps, feeder mains, arc light leads, etc., arc lamp columns and brackets, and overhead travelling crane. Specification, etc., may be obtained from the borough accountant (Mr. C. Robson). Tenders by Jan. 25.

Middlesbrough.—The Electric Lighting Committee invite tenders for the supply and erection of—engine-house plant: one 300-kw. high-speed steam dynamo and accessories; switchboard panels: panels and instruments for dealing with the above plant, and three new feeders; condensing apparatus and pipework: ejector condenser for dealing with 8,100lb. of steam per hour, and steam, exhaust, and feed pipes; feed pump and economiser: one feed pump and extension to existing economiser. Tenders by Jan. 21. Details in our advertisement columns.

Leytonstone.—The West Ham Board of Guardians invite tenders for the supply, delivery, and fixing at their new infirmary, Forest House, Leytonstone, N.E., of three direct-coupled engines and dynamos and one motor-booster, one battery of accumulators; all engine and battery room accessories; the whole of the feeders, distribution mains, junction boxes, main and sub-distribution boards; and all wiring, fittings, lamps, &c., for about 1,756 lamps. Specification, etc., may be inspected on and after Jan. 6 at the Clerk's Office at the Workhouse between 10 and 4. Tenders by Jan. 22.

London.—The London County Council invite tenders for the supply of about (a) 3,250 tons of track rails; (b) 1,850 tons of slot rails; (c) 670 tons of conductor tee rails; together with (d) the fishplates, bolts, nuts, etc., required in connection with the reconstruction of the London County Council tramways for electrical traction. Alternative tenders must be submitted for the supply of smaller quantities as follows of the articles above specified: (a) 2,280 tons; (b) 1,300 tons; and (c) 475 tons, with the necessary accessories. Specifications and other particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by Jan. 28.

Rockhampton (Queensland).—The Municipality invite applications from companies desirous of undertaking the construction and working a system of electric tramways under the Queensland Tramways Act of 1882 and the Amendment Act of 1890, within the municipality of Rockhampton aforesaid. Rockhampton, with a population of 15,461, is a rising town, and is situated on the Fitzroy River, about 40 miles from the sea coast, and is the second largest town in Queensland. Particulars of construction, maintenance, and working of tramways are contained in the Queensland Tramways Act of 1882 and the Amendment Act of 1890, copies of which may be seen at the office of this paper. Applications to be forwarded to Mr. H. W. Johnson, mayor, Municipal Chambers, Rockhampton, Queensland, Australia, by March 31.

RESULTS OF TENDERS.

Stoke Newington.—The British Thomson-Houston Company, Limited, have secured the contract for the supply of ampere-hour meters, wattmeters, and house service cut-outs for the borough.

Mersey Railway.—In connection with the scheme for the electrification of the Mersey Railway the contract for the supply of about 60 cars, of the value of £40,000, has been placed with Messrs. G. F. Milnes and Co., of Birkenhead and Hadley, Salop.

London.—The Celvicol Company, Limited, S.E., have received the following tenders for the supply and delivery of one 1,000-ampere electrotyping dynamo, direct coupled to 400-volt enclosed motor:

Crompton and Co., Limited	£190
Collis and Sons	165
General Electric Company	150
Baxter and Caunter, Newton Electrical Works (accepted)	130

Sunderland.—The Corporation have received the following tenders for supply and erection of cast-iron condenser and water-pipes, and some copper steam-piping, valves, etc., for their Hylton-road electric lighting station: J. Abbot and Co., Park Ironworks, Gateshead (accepted); Sir J. Laing and Sons, Limited, Deptford Yard; Thornton and Crebbin, Bradford; Wearmouth Foundry Company, Monkwearmouth; Rectory Engineering Company, Sunderland.

Willesden.—The District Council have accepted the following tenders: (1) for erection of main electricity station, Taylor's-lane: Pattison and Son, £29,933 (there were 14 tenders, the highest which was £38,489); (2) the erection of sub-station electricity works, Salisbury-lane: Braid, Pater and Co., £11,300 (16 tenders were received, ranging up to £15,018); (3) the erection of chimney shaft, electricity works, Taylor's-lane: Johnson and Son, £5,364 (there were 18 tenders, ranging up to £8,324).

Manchester.—Subject to the approval of the Council, the contract for the boilers for the supplementary 12,000-h.p. installation at Stuart-street will be given to Babcock and Wilcox, of Glasgow; that for the coal economisers to Green, of Manchester; and the smaller one for feed pump will be placed with Blake and Knowles, of London. Normanton and Son have been recommended as the contractors for both ections of the subway for the conveyance of cables from the Stuart-street generating station to Ashton New-road.

Brighton.—The Council have received the following tenders for the supply of meters for a period of one year from Jan. 1, 1902:—General Electric Company, Limited, Queen Victoria-street, E.C., £4. 5s. per meter; British Schuckert Electric Company, Limited, Surrey-street, Strand, W.C., £3. 11s.; Electrical Company, Limited, Charing Cross-road, W.C., £3; Ferranti Limited, Hollinwood, Lancs., £3; British Thomson-Houston Company, Limited, Rugby, £2. 10s.; Reason Manufacturing Company, Limited, Brighton, £2. 10s. (accepted).

London.—The Celvicol Company, Limited, S.E., have received the following tenders for the supply and fixing of one 20cwt. electric goods lift:

Otis Elevator Company	£428	0	0
R. Waygood and Co. (accepted)	335	0	0
J. G. Childs and Co.	335	0	0
F. A. Glover and Co.	333	0	0
M. T. Medway	332	0	0
Moffatt and Eastmead	308	15	6

BUSINESS NOTES.

TRACTION.

Keighley.—The Highways Committee have been appointed to control the tramways *pro tem.*

Keymer.—The Parish Council have agreed to dissent from the proposals of the light railway company.

Rotherham.—Tenders will shortly be invited by the Tramways Committee for the paving of the tramway track.

Glasgow.—The Town Council have decided to have the stopping places of the tramcars marked on the street lamps.

Paris Metropolitan.—The Municipal Council have authorised a new loan of 150,000,000fr. for the completion of this railway.

Sheffield.—The receipts taken on the Corporation tramways during the quarter just closed totalled £46,324, giving a weekly average of £3,563.

Appointment.—Mr. H. David, superintendent of the Cardiff tramways, has been appointed to the position of chief traffic manager under the Corporation.

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Windsor and Maidenhead Light Railway.—We learn that the engineer's estimate for the whole of the works in connection with this scheme is £120,000.

Tramways in the Lake District.—The scheme for an electric tramway from Bowness, through Windermere, to Ambleside has for the present been abandoned.

Dunstable.—A committee of the Town Council has been appointed to confer with a committee of the Luton Town Council in regard to the proposals for a light railway in the district.

Southend.—Mr. J. Ward, chief inspector to the Potteries Electric Traction Company, has been appointed general manager and traffic superintendent of the Southend tramways.

York.—The City Council having decided to purchase the undertaking of the tramways, have agreed to promote a Bill in Parliament to authorise the construction of additional lines.

Nottingham.—A special meeting of the City Council will be held on Monday to consider the expediency of promoting a Bill in Parliament for powers to construct additional tramways in the city.

Buteshire.—The County Council have resolved to lodge objections against the proposed provisional order of the Rothesay Tramways Company for the extension of the electric tramway system to Ettrick Bay.

London-Brighton Electric Railway.—The proposal to construct an electric railway from London to Brighton is now ready for presentation to Parliament, and the necessary powers will be sought next session.

Wolverhampton.—A trial has been made on the Cleveland-road section of the Corporation tramways, when a car made a number of trips up and down the line. The test was regarded as very satisfactory.

West Bromwich.—The Town Council on Tuesday agreed to apply to the Board of Trade for sanction to borrow £121,000 to carry out the reconstruction and electrical equipment of the tramways within the borough.

Merthyr.—The directors of the Merthyr Electric Traction and Lighting Company have resolved to spend £10,000 on the provision of loop lines at Dowlais, on plant, and on extensions at the Merthyr depôt early this year.

Fifield.—A meeting of the inhabitants of Fifield and Water Oakley has approved of the scheme of the Metropolitan District Electric Traction Company for the construction of light railways from Windsor to Maidenhead.

Dingwall and Cromarty Light Railway.—A further grant of £10,000 from the Treasury for the Dingwall and Cromarty light railway has just been secured. The construction of the line will now be proceeded with.

West-end Electric Carriage Service.—A day-and-night electric carriage service at the ordinary rates charged for a hired horse carriage was inaugurated on New Year's Day for the use of visitors staying at the Carlton Hotel.

Middlesex.—Among the lines the Middlesex County Council have decided to promote this year are those from Wembley to Wealdstone, and from the Edgware-road, through Stanmore, to the boundary of Herts and Middlesex.

Batley.—The new directors of the Dewsbury, Batley, and Birstall Tramways Company have issued notices reducing the fare for the total length of line from 5d. to 3d., divided into three 1d. stages. A Sunday service of cars is also to be instituted.

Halifax.—A crowded meeting was held by the Corporation tramway employés last week to discuss alleged grievances in connection with the dismissal of four of the men. The authorities, however, have decided that the notices of dismissal must stand.

Repton.—Notice has been received by the Rural District Council from a company that they are about to make application to the Light Railway Commissioners for an order authorising light railways from Ashby-de-la-Zouch, through Swadlincote, to Burton.

Brighton.—The New England-road route of the new electric tramways was opened to the public on Saturday. Over a great part of this route the gradients are very steep, and the cars have had to be fitted with exceptionally powerful brakes in order to ensure safety.

Isle of Thanet Light Railways Co.—This Company have given notice of an intended application to the Board of Trade for a prolongation of the time limited by the extensions order for the completion of railways and works authorised by the order for a period of two years from Feb. 23 next.

Perth.—Presiding at the annual meeting of the Perth and District Tramways Company last week, the Chairman stated that with the unanimous sanction of his co-directors he wished to say that they were ready at any moment to treat with the city for the acquisition of the whole undertaking.

West London.—During Christmas week the passengers carried on the West London tramways averaged over 100,000 per day, and on Boxing Day the numbers totalled over 120,000. The increase for the week, as compared with the traffic on the old horse tramways last year, was nearly 400,000 passengers.

Levenshulme.—The District Council have resolved to apply for sanction to a loan of £13,000 for the conversion of the tramlines in the district to electric traction. The Council some time ago entered into an agreement with the Manchester Corporation under which the latter body will carry out the work.

Sunderland.—The tramway employés have resolved not to accept the new scale of wages offered. At present overtime is paid at the rate of time and a quarter after 10 hours' work each day. The new scale proposes that the men shall not be paid time and a quarter until full 60 hours are completed for the week.

Johnstone.—A local correspondent states that much disappointment is being shown at the delay in commencing the new electric tramways, the construction of which was sanctioned some months ago. It is felt that the tramways would be of great advantage to the town of Johnstone in giving communication with Elderslie and Paisley.

Tramway Movement at Beckenham.—The Croydon, Beckenham, and Penge Councils have determined to oppose the Croydon and District Tramways Bill, the promoters not having complied with the standing orders. The scheme is to construct electric tramways at Beckenham and Penge in connection with the municipal system at Croydon.

Greenock.—A letter was recently received by the Town Council from the tramway company, in which the directors declined to agree to the proposal that a new arbiter should be appointed in connection with the Sunday car controversy. The matter has now been remitted to the Tramway Committee for the purpose of obtaining the opinion of counsel.

Hamburg.—Messrs. Siemens and Halske, the Allgemeine Elektricitäts-Gesellschaft, of Berlin, and the Hamburg General Tramways Company have entered into an agreement to form a company with a capital of £750,000 for the purpose of constructing and working electric tramways in Hamburg and suburbs. This agreement has just been ratified by the Hamburg State authorities.

Baker-street Railway.—It is stated that Mr. Yerkes has purchased the Baker-street and Waterloo Railway in its unfinished state, and that he intends to complete and use this line as part of his new underground system, which includes the District, the Brompton and Piccadilly, the Charing Cross and Hampstead, and other railways. The price, it is stated, exceeds a quarter of a million.

Edinburgh.—Last Sunday the whole of the drivers and conductors of the trams struck work—the matter in dispute being the Sunday labour question. The men unanimously refused to accept the company's terms, and at a mass meeting on Sunday resolved to strike. In the afternoon three cars were brought out, manned by inspectors, and these constituted the entire tram service for the day.

Hales Owen.—On Wednesday the District Council came to a decision to apply to the Light Railway Commissioners for an order authorising the Council to construct extensions along Coombs-road-hill and Long-lane, Cakemore. It was explained that these were two additional lengths of railways that were not included in the Hales Owen light railway order obtained last year by the Council.

Wigan.—It has been decided to withdraw the negotiations with reference to the purchase of the tramway company's undertaking by the Corporation. It seems that the Corporation made an offer of £45,000, but that this has been refused by the company as insufficient. From a statement made at a special meeting of the Town Council this week it appears there is only a difference of some £3,000 between the parties.

Eastbourne.—It was mentioned at a town's meeting last week that a scheme for electric tramways had been prepared by the Electric Lighting Committee of the Town Council. The route proposed starts at Norway and proceeds *viâ* Seaside, Seaside-road, and South-street to the town hall, and then down Grove-road to the site of the proposed technical institute and free library, which is a few yards from the railway station.

Hampstead.—The Borough Council have received notices and plans in respect of intended applications to Parliament, session 1902, as to the following Bills—viz.: Charing Cross, Euston, and Hampstead Railway (No. 3), Edgware and Hampstead Railway, North-West London Railway, and London County Council (Tramways and Improvements). They have all been referred to the General Purposes Committee for consideration and report.

Ayr.—The Corporation electric tramway system between St. Leonards and Prestwick Cross has now been in operation for three months, and the financial results have so far exceeded expectations, the drawings having been maintained at a weekly average of about £140. This is believed to be slightly above the paying level. It is expected a start will be made with the work of laying the permanent way for the Alloway extension this week.

Stourbridge.—With reference to the proposals of the British Electric Traction Company in the district, it was stated at the last meeting of the Urban District Council that it was open to the Council to make advantageous arrangements with the company to supply current to them, or for the company to put down a large generating station in the township, and possibly later on make arrangements with the company as to the electric lighting of the district.

Mersey Railway.—The contract for 60 cars, as reported in another column, has been let to Messrs. Milnes and Co. for this railway. The cars will be of the very newest pattern. They will measure 60ft. long, and have a seating capacity for about 70. As a safeguard against danger of fire, the cars will be fitted with fireproof asbestos slates for a certain distance over the motors. The compartments for the motorman and the luggage will also be lined with the fireproof material.

Cardiff.—With the birth of the New Year at 12 o'clock on Tuesday night the Corporation came into possession of the lines, depôts, cars, horses, and equipment previously the property of the Cardiff Tramways Company. The purchase price is £50,000. In order to make provision for the cabstands in Queen-street and St. Mary-street it is proposed to place the poles for the overhead equipment of the electric tramways at the sides of the roads, and to leave space between the double lines for the cabs.

Birkdale.—Final arrangements have now been made by the District Council for the purchase of that portion of the Birkdale and Southport Tramway Company's lines which is situated in the township. The agreed price to be paid for the lines is £5,000. It is proposed to

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lease the lines to the British Electric Traction Company. It will be remembered that some time ago the portion of the tramway company's lines which were situate in Southport was bought by that Corporation for £12,500.

Sunbury.—Among the recommendations approved by the District Council with reference to the proposals of the London United Tramways Company in the district, is one that the company should not have power to alter the proposed double lines to single lines. It is also recommended that brackets fixed to houses should be used instead of standposts where necessary, and that a sufficient number of electric lamps should be erected by the company and lighted during the time the street lamps are lighted.

Bristol.—From a report presented by the Tramways Purchase Committee to the Town Council on Wednesday it seems that all idea of purchasing the undertaking of the Bristol Tramways Company at the present time has been abandoned. The committee informed the Council, with regret, that at the present moment there was no possibility of acquiring the tramways at a price which the committee would be able to recommend the Council to pay. The company's lease, it may be noted, expires in 1915.

Islington "Tube" Scheme.—The Great Northern Railway Company have prepared two Bills which will be promoted in the ensuing session of Parliament. The aggregate amount of capital which Parliament will be asked to sanction is £2,433,000. The largest item of expenditure appears to be the construction of an underground railway in Islington, which is proposed to be leased to the Great Northern and City Railway Company. For this work alone £433,000 of the aggregate amount of capital required will be set aside.

Southport and Lytham Tramroad.—The Southport and Lytham Tramroad Company are promoting a Bill in the next session of Parliament under which an extension of time will be sought for five years for the completion of the tramroads, tramway bridge, and other works authorised by their Acts of 1899 and 1900. The Bill also proposes to divide the shares of the company into "preferred half shares" and "deferred half shares," the dividend on the "preferred half shares" not to exceed 5 per cent. per annum.

Scarborough.—A petition signed by ratepayers opposed to the establishment of tramways in the town has been presented to the Mayor requesting him to call a town's meeting to discuss the matter. The petitioners claim that if tramways are at all necessary they should be in the absolute possession of the Council. Other petitions have also been presented asking that a single instead of a double line of rails be put down between Bar-street and Huntriss-row. The cabmen in the town are talking about coming out on strike as a protest against the licenses issued to motor omnibuses by the Corporation.

Sutton (Surrey).—The Urban District Council have agreed to the heads of the proposed agreement with the British Electric Traction Company with regard to the latter's Bill for providing tramways in Sutton. The company is to run a line from Belmont to Mitcham, and another from Sutton to Croydon, but agrees not to construct the portion from Sutton Station to Belmont without the consent of the Council in writing. The company also undertakes to make various widenings in the High-street and to pave the portion of the roads used for trams from Belmont to Benhill-street with wood blocks.

Leeds.—A proposal is before the City Council to obtain powers to construct a tramway from the existing line in Park-lane along Belle Vue-road, Moorland-road, and Hyde Park-road to Hyde Park-corner. The electric tramcars will probably run from Briggate to the New Inn, Wortley, and Whingate, within the next fortnight. The lowering of the road under the railway bridge in Wellington-road has been completed, and the electrical equipment of the route is nearly finished. The City Council on Wednesday rejected a resolution in favour of halfpenny fares on the several tramway routes in the city.

South Shields.—In reply to a letter from the South Shields Tramways Company with reference to the co-operation of the Town Council in a tramway scheme for the town, the Council point out that the Corporation and the British Electric Traction Company are both making application to Parliament for powers to lay down tramways within the borough. Until such Bills have been before Parliament, the Town Council are not prepared to proceed any further with the present negotiations with the South Shields Company. After Parliament has been applied to, however, the Council will be ready to consider any offer which that company or any other company are prepared to make for leasing the tramways.

Norwich.—A working-men's meeting has passed the following resolution: "That this meeting of Norwich citizens strongly protests against the action of the local tramway company in discharging three of their employés without assigning any reason for their discharge, and it hereby respectfully requests the immediate reinstatement of the men discharged, as it appears their only offence was in becoming members of the Amalgamated Association of Tramway Workers. This meeting further affirms the right of the men freely to combine in a trade organisation intended for their mutual protection, relief in sickness, and for a provision in the event of accident or death, without hindrance on the part of any of the officials of the tramway company."

Tramway Bills.—Among the Tramway Bills just deposited in the Private Bill Office of the House of Commons for promotion in the next session is one for constituting the Middlesex County Council a local authority for certain purposes of the Tramway Act, 1870, including the power to purchase certain undertakings, though this power of purchase is not to be exercised without the consent of the local authorities. Another measure deposited for the ensuing session proposes to confer further powers on the London United Tramways Company for constructing tramways and widening and altering roads in the counties of London, Middlesex, and Surrey. The North Metropolitan Tramways Company are applying for authority to use mechanical and electrical power upon their tramways in the county of Middlesex, and to erect generating stations.

South Lancashire Electric Traction and Power Co.—The warrants for the interest to Dec. 31, 1901, on the 4½ per cent. first mortgage debenture stock of this Company, payable 1st inst., were posted on Tuesday last. Rapid progress is now being made with the construction of the 133 miles of electrical tramways in South Lancashire, connecting Manchester, Liverpool, Wigan, Warrington, Leigh, St. Helens, Bolton, and surrounding districts. Contracts have been entered into for lines from Haydock, Brough, Ashton, and Hindley; from Hindley to Hindley Green, Atherton to Bolton, Atherton to Tyldesley, and Atherton to Leigh and the boundary of Lowton. The contracts for the whole of the permanent way of these tramways, necessary buildings, plant, rolling-stock, and complete equipment of generating station have been placed for £350,414.

St. Helens.—A proposed agreement will be brought forward at the next meeting of the Town Council, under which the tramways company will conduct goods traffic on their lines which are leased to them by the Corporation. A rent is to be paid for this privilege calculated at the rate of 2d. for every truck or car, whether laden or empty, passing through the borough in either direction, and 1d. for every car, whether laden or empty, entering or leaving, or passing from point to point, within the borough. The company are to provide proper depôts for loading and unloading, and vehicles are not to be allowed to stop to load or unload in the streets. According to the present lease, the company are entitled to electricity at 1d. per unit when the consumption reaches 800,000 units, but this figure has now been raised to 1,000,000, the price being at 1¼d. until that total is reached.

Block on the "Tube."—Much delay to business people travelling from West London to the City was caused on Monday by a stoppage on the Central London Railway between the "Museum" Station and the Bank. From details to hand we learn that the cause of the interruption of the service was the derailment of a light engine at the Bank "cross-over," which has to be used by all trains reversed at this terminus. The accident occurred at five in the morning, and passengers coming from Shepherd's Bush and other West-end stations found themselves unable to proceed further eastward on the "tube" than the British Museum. The traffic between the western terminus and the British Museum was maintained right up to about half-past four in the afternoon, at which hour the road to the Bank was reopened.

Bradford.—On Tuesday the town clerk gave notice to the Bradford Tramways and Omnibus Company, Limited, and the Bradford and Shelf Tramway Company, Limited, that the Corporation will terminate the companies' leases on Feb. 1 next, instead of on Feb. 1, 1903. This step has been taken in pursuance of the powers obtained by the Corporation under the Bill promoted in the last session of Parliament and of the agreement arrived at with the tramway companies. The companies have also been asked to tender for the letting of the rolling-stock to the Corporation until the equipment of the lines for electric traction has been completed. Owing to the bad weather that has been experienced lately the work has suffered considerable delay, and it will probably be necessary to continue the use of the old rolling-stock for some little time after the lines have been taken over by the Corporation.

Dundee.—The deputation which recently visited several English towns in order to make enquiries that might afford some guidance in the construction of the Constitution-road tramway have now submitted their report to the Tramways Committee. The report states that none of the lines visited presented greater difficulties than the proposed Constitution-road route. Although the gradients for short distances were in some cases slightly steeper, other features of a favourable character existed. At Sheffield the steepest gradients were of the nature of a switchback so that the car, getting beyond control going down one hill, came to a stop in going up the other. A financial statement just issued shows that for the six months from May to November the total working expenses of the tramway undertaking were £11,568, as against an estimate of £11,580, while the traffic receipts amounted to £18,220, as compared with an estimate of £17,700.

Whitechapel and Bow Railway.—A Bill has been deposited by the Whitechapel and Bow Railway Company for next session, in which powers are sought to complete the railway as a railway adapted to electric traction. As our readers are doubtless aware, this line will ultimately connect the railways of the Metropolitan District Company and of the London, Tilbury, and Southend Company. The Bill also proposes to vary the financial arrangements sanctioned in 1898 and 1900 so as to enable the London and Tilbury Railway Company to subscribe for and hold the whole of the debenture stock of the Whitechapel Compahy instead of one-half, and the right of the District Company to hold the other half is to be varied to the extent to which the Tilbury Company may exercise its new power. Powers are further asked for to raise as preference capital the whole or any part of the £300,000 ordinary capital authorised to be raised by the Act of 1900, and which may remain unissued at the time of the passing of a resolution creating the same.

Aberdeen.—A meeting of residents in the Queen's-road district has been held for the purpose of arranging definite and strong opposition to the equipping of Bayview section of the Corporation tramways for electric traction. It is understood that objection was taken principally to the poles proposed to be used in connection with the overhead system, also to the clanging of the bells on the cars, which, it was contended, would disturb the quiet of such a residential neighbourhood. It was agreed to interview the members of the Tramway Committee and Town Council generally with a view to having the scheme abandoned. The Tramways Committee have before them at the present time proposals for the electrical equipment of the Albyn-place and Bayview sections of the tramways and the extension of electric traction to the Bridge of Dee and Bridge of Don sections. The estimated cost of the work is between £30,000 and £32,000. When this

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is carried out the whole of the existing system of tramways will have been electrically equipped, except the Rosemount section.

Newcastle.—The tramway at Barrass Bridge is to be extended to Ponteland-road, a distance of some 700 yards. The total receipts from the various routes now in operation last week amounted to £1,052, or 1s. 4·9d. per car mile. This result is considered most satisfactory. At a meeting of the Tramways Committee on Tuesday it was agreed to proceed with the completion of the route to New Bridge-street with a view to inspection on the 14th inst. A report on the proposed line to Spital Tongues was submitted to the meeting. It was decided that the line should be a single one at present, and that it be so made that a double one could be constructed if this were necessary. A very satisfactory report was submitted with respect to the steam-generating power of the six boilers now erected at the power station. It stated that they had more than fulfilled expectations. It was intimated that up to the present time only from 35 to 40 cars had been delivered out of the 100 or more ordered, and that every effort was being made to get them finished as quickly as possible. The delay had resulted from circumstances which could not be controlled.

Manchester.—The returns of the working of the Corporation electric tramways for the first six months of their running are exceedingly satisfactory. On the Hightown route, which was opened on June 6, the number of passengers carried during the succeeding six months has reached 2,390,389. These passengers have paid £9,963 in 1d. fares. The cars to Cheetham Hill, which were started at the same time, have realised £12,869, although the total number of passengers is but slightly in excess of those to Hightown—namely, 2,444,465, against 2,390,389. The popularity of the ½d. fare is shown in the return of the large number of persons carried on the Bury New-road lines. The total was 4,422,973. The fares collected amounted to £9,268. On July 5 the Rochdale-road electric cars were started, and in 1d. and 2d. fares 5,476,646 passengers have on this line since paid £26,131 This is at once the most lucrative and the most largely used line, tapping, as it does, a populous district, and running to Boggart Hole Clough. Another line has been in use for some time, and this connects Rochdale-road with Cheetham Hill-road by way of Queen's-road. The fare is ½d., and since July 16, when it was opened, 328,018 passengers have travelled by it, and they have paid £684 in fares. Altogether, the city tramways undertaking has, since it was started, brought in no less a sum than £60,492, and carried 15,506,964 passengers.

LIGHTING AND GENERAL.

Pwllheli.—The new town hall is to be prepared for electric equipment.

Cheltenham.—The Corporation are considering the adoption of a municipal telephone exchange.

Ancient Lights and New.—The ancient temples of Luxor and Karnak are to be lighted by electricity.

Dover.—At a special meeting of the Town Council, the resolution to apply for a provisional electric lighting order was confirmed.

Mansfield.—With regard to the proposed municipal telephone service, we learn that about 150 subscribers have been obtained.

Alloa.—The electric light was switched on at the head station (the British Electric Plant Company's works) last week, and the municipal buildings were illuminated.

Durham.—We understand that everything is ready for the introduction of the electric light into the city, and that the opening is merely a matter of a few days.

Salford.—At a ratepayers' meeting held last week to consider the proposed Municipal Telephone Bill, the example of Manchester was followed, and a poll demanded.

Carlisle.—The question of introducing the electric light into the slaughter-houses, at a cost of £300 to £400, has been referred to the Slaughter-House Sub-Committee.

Louth.—The directors of the Louth Gas Company have decided to oppose the application of the Corporation for a provisional order to supply electricity within the borough.

Charing Cross and Strand Electricity Supply Co.—Warrants for the interest on the 4 per cent. debenture stock of this Corporation were posted to the stockholders on Jan. 1.

Dorking.—We understand that a draft agreement between Messrs. Edmundsons' Company and the Urban District Council has been forwarded to Mr. Trentham for his observations.

West Bromwich.—The Electric Lighting Committee have decided to recommend the Town Council to apply for sanction to borrow £8,500 for the extension of the electricity works.

Coventry.—With reference to a note in our last issue, on p. 924, we are informed by our correspondent that the coal costs for November last year should have been given at 1·15 and not 1·95.

Royal Warrant.—The Edison and Swan United Electric Light Company, Limited, has received the honour of appointment by Royal warrant as purveyors of electric lamps to his Majesty the King.

Derby.—An extension of the mains to supply the works of Handyside and Co., Limited, with current for power purposes, at a cost of about £66, has been ordered on certain conditions embodied in an agreement.

Southwold.—Christmastide has been marked by the introduction of the electric light by the Coast Development Company. Various hotels, churches, etc., in the town have been fitted, as well as their own hotel.

East Barnet.—At the last meeting of the Urban District Council a number of resolutions were proposed in reference to electric lighting. From a report to hand it does not appear that any conclusion was arrived at.

Electric and General Investment Co.—Warrants for the interim dividends on the 6 per cent. cumulative preference shares, and of 10 per cent. on the ordinary shares of this Company were posted on Jan. 1.

Bath.—A new switchboard has been fitted up at the electric lighting station by Messrs. Ferranti Limited, to replace that made by another firm, and which was in use at the time of the recent breakdown.

Islington.—The Council have approved estimates for complying with requisitions for a supply of electricity in various roads, amounting to about £900, and have authorised the committee to carry out the necessary works.

Broadstairs.—A committee is discussing a draft agreement submitted by the Thanet Light Railway Company containing the terms on which the company are prepared to supply electricity for lighting purposes to the Council.

Glasgow.—The Corporation have agreed to a scheme including several districts of the city to which the electric light is to be extended, and additional electric light extensions are to come before the Council within the next few weeks.

Institution Journal.—Messrs. Spon have just published Part No. 153 of the *Journal* of the Institution of Electrical Engineers, edited by Mr. W. G. McMillan. A full list of contents will be found in our advertisement columns.

Light Cure.—Leeds Infirmary will shortly be fitted up with the electric apparatus invented by Dr. Finsen, of Copenhagen, for the treatment of skin diseases by light, and patients suffering from lupus and rodent ulcer will be treated under it.

Llandilo.—The Urban District Council have received the County Council's provisional consent to cut the main road for the laying of electric light mains, on condition that they put the road in repair afterwards and pay the sum of 1s. a year.

Brighton.—The Guardians have asked Mr. P. Coote, electrical engineer, of North-street Quadrant, Brighton, to submit a report and approximate estimate of the cost of installing electric motors to work the machinery at present driven by steam.

Dundee.—Mr. E. B. Stiven, formerly in the employment of Messrs. Lowdon Bros., Dundee, and who was recently appointed electrical engineer of Rothesay, recently delivered a lecture to the members of the Rothesay Literary Society on electricity.

Crompton and Co.—The directors have declared an interim dividend for the half-year ended Sept. 30 last at the rate of 6 per cent. per annum, free of income tax, being the same rate as the interim dividend last year, and payable on and after Jan. 15 next.

Stirling.—A large extension of the public lighting of Stirling took place on Tuesday, 30 new arc lamps being switched on. Ten of the new lamps are in the Craigs district and 20 in the Cowane-street district. The whole town is now practically lighted by electricity.

Walker.—The Council are making enquiries from the Newcastle Electric Supply Company with the object of obtaining an increased candle-power for their street lamps. They have given the gas company three months' notice to terminate the gas supply for public lighting.

Norwich.—A town's meeting has endorsed the decision of the Town Council to purchase the business of the Norwich Electric Lighting Company. The price asked was £19 per £10 share, and the total amounts to about £214,000. There was only one dissentient to the proposal.

Cape Cable.—The steamship "Scotia" left the Thames on Wednesday with the last remaining section of the Cape-Australian cable to be laid between Perth and Adelaide. The vessel is due at Perth early in February, and the Eastern Extension, Australasia, and China Telegraph Company expect the line to be completed and opened for traffic by the end of that month.

London Gazette.—The last day for receiving proofs in the estate of H. Sewell, electrician, 63, Birklands-road, Shipley, Yorkshire, is Jan. 11. Mr. J. A. Binns, official receiver, 31, Manor-row, Bradford, is trustee. The partnership existing between A. H. Davies and James Pollard, electrical and general engineers, trading as Stanley, Davies, and Pollard, at Hyde, Chester, has been dissolved by mutual consent.

Sale of Plant.—The Electric Lighting Committee of the Hull Corporation are prepared to receive offers for two Willans-Holmes direct-coupled steam dynamos, three Davey-Paxman Economic boilers, one Amos and Smith boiler, together with two switchboard panels, condensing and water-softening plants, and sundry valves, fittings, spare gear, etc., appertaining thereto. Full particulars appear in our advertisement columns.

Accident.—The dailies came out this week with flaring headlines of a horse electrocuted. It was stated in the newspapers that a horse was killed at Hampstead through an electric shock caused by a leakage from the electric mains, but the facts of the case are as follows. There was a slight leakage from a private lead for supplying an outside lamp at the house in question. No doubt one of the horses felt this and became restive, but its death was caused by falling down and being trampled upon and kicked by the other.

Electric Trust.—It has been reported that Mr. Pierpont Morgan was endeavouring to amalgamate the interests of the Westinghouse Electric Company, of Pittsburgh, and the General Electric Company, of New York. The two companies practically control the manufacture of large electrical apparatus in the United States, and their combined capitalisation would amount to nearly £10,000,000. A later Central News telegram states that officials of the Westinghouse Company emphatically contradict the report of their amalgamation with the General Electric Company, and the president of the General Electric Company says he knows nothing of the alleged combination.

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Haslingden.—The borough surveyor has submitted plans of the site of the proposed refuse destructor and electric works, and a committee will visit Nelson for the purpose of examining the refuse destructor and electric works there before a further decision is arrived at.

Telephones between France and Italy.—The inauguration of the telephone connecting Milan, Turin, and Genoa with Lyons and Paris took place on Jan. 1. By the spring a telephone line will be established between Turin and Rome and the principal French and Italian towns.

Bournemouth.—The County Borough Council have approved the intention to make application for a provisional order, under the Electric Lighting Acts, 1882 and 1888, to authorise the Council to supply electricity for any public or private purposes within the districts recently added to the borough.

Bedwellty.—The consideration of applying for a provisional order to supply electric light for the district has been adjourned. It has been pointed out that as the Council did not oppose the South Wales Electrical Power Company's Bill in Parliament, they could not supply in bulk without such provisional order.

The Tidal Flow v. Coal.—It is proposed to introduce electric lighting into Dingwall, and the latest scheme contemplates utilising the tidal flow of the Dingwall Canal and the River Peffrey for the motive power. The total capital outlay is estimated at £4,000, and it will be interesting to watch future developments.

Rotherham.—The electric lighting department continues its success. Mr. Cross, the engineer, in his last report stated that the number of consumers connected up was 119, with an equivalent of 7,470 8-c.p. lamps. The total, including those not yet connected, was 128, with an equivalent of 7,808 8-c.p. lamps.

Brighouse.—At a recent meeting of local subscribers to the National Telephone Company strong complaints were made by many subscribers, and the result of a lengthy discussion was the appointment of a committee to take the matter up with the Telephone Company, and present a signed protest against alleged "wanton neglect."

The Recent Storms.—The Leeds Chamber of Commerce have decided to follow the example of the London and Liverpool Chambers by writing direct to the Government urgently asking for underground lines, so that the recent breakdown in telegraphic and telephonic communication might not be repeated, Leeds being an important centre of trunk lines.

Copper.—Several lots changed hands last week at £48. 15s. to £47 for near dates; £48, £48. 5s., and again £48 three months. Closing values, £47 cash, £47. 12s. 6d. three months, or 32s. 6d. and 30s. lower respectively for the two positions. Settlement price, £47. 10s. The shipments from America for the past week are advised by cable as 1,539 tons.

Poplar.—The City of London Guardians have made arrangements with the Borough Council to light the City infirmary at Bow with electric light. The Millwall Docks Company have also entered into an agreement with the Borough Council for the lighting of the docks by means of electricity. It is estimated that half a million units per annum will be required.

New Firm.—We are informed that Mr. Alfred H. Gibbings, who has recently been appointed resident electrical engineer to the Hyde, Stalybridge, Dukinfield, and Mossley Joint Board, has entirely abandoned his consulting practice. Mr. H. W. Appleby has joined Mr. Baker, and the firm of Gibbings and Baker having ceased, the busines will now be conducted under the name of Baker and Appleby, at Piccadilly-mansions, 17, Shaftesbury-avenue, W.

Consumption.—The Philadelphia City Council have appropriated £20,000 for the erection of a new hospital for consumptives, designed by Dr. Shoemaker, which will consist of eight large pavilions, with a framework of steel and the walls and roofs entirely of glass, so as to enable the consumptives to enjoy the sunshine on clear days. Static electric batteries will be installed in all the pavilions to invigorate the air and destroy all the germs of tuberculosis.

Port-Glasgow and Greenock.—Sheriff-Principal Sir John Cheyne has refused the appeal of Greenock Corporation that the tramways company should be called as a party to the action for interdict by Port-Glasgow against supplying electrical energy without consent for use within the burgh of Port-Glasgow, and has remitted the process to the sheriff-substitute, with the direction that it is not to be further proceeded with until the expiration of one month from date.

New Agency.—Messrs. Baxter and Caunter, 5, Macclesfield-street, Shaftesbury-avenue, W., who are the sole agents for the Newton Electrical Works, Limited, Taunton, have been appointed sole agents for London, south and east coast district for the Electrical and Ordnance Accessories Company, Limited, Stellite Works, Cheston-road, Aston, Birmingham, manufacturers of motor fans, traction switchboards, distribution switchboards, telephones, bells, and all electrical accessories.

Longton.—At present there are over 50 consumers, and the public lighting comprises the illumination of the town hall, court house, free library, and institute. The output of current is now about one-fifth of that which can be supplied with the existing plant, and exemplary foresight has provided that when the present maximum shows signs of being over-demanded the station can be extended. It is expected that manufacturers will become large consumers of the current for motive and illuminating purposes.

Aldershot.—With regard to a note in our last issue referring to a loan of £5,000 obtained by the Walthamstow Urban District Council, we have received an authoritative statement to the effect that the loan was obtained and used for wiring consumers' houses on the free-wiring system. We are not in possession of all the details surrounding the refusal of the Local Government Board to grant a loan for a similar purpose in Aldershot, and are therefore unable to perceive why the sauce which was good for the gander was not also served out to the goose.

Chelmsford.—It appears that the recent short interruption of the supply on the electric lighting company's new circuit was caused by the heavy rain, the water accumulating in a gutter and finding its way into a transformer pit. The company have asked the Council to see that the gullies were kept clear, as the stoppage of any of them was a great source of danger to the electrical machinery in the transformer pits. The Council have replied that they do not admit any responsibility, and that the company themselves should make their transformer pits watertight.

Crieff.—Mr. Purves, Edinburgh, representative of Messrs. Crompton and Co., London, has submitted to the Town Council a draft agreement for leasing to the Crompton Company a provisional order lately obtained by the Crieff Council for lighting the town by electricity. The company proposed to pay the cost of the provisional order, amounting to about £200, to light the street lamps at 3d. and supply the light privately at 6d. per Board of Trade unit. The company left the matter of lighting the town to the option of the Town Council, but promised to pay £25 annually for wayleave.

Hull.—At a meeting of the council of the Hull and District Chamber of Trades the National Telephone Company's Hull Bill was discussed. It was said that the Bill sought to place Hull in the position of London, preventing any lower rates being charged than those charged by the company. A resolution was passed calling upon the City Council to oppose the Bill, and to spare no effort to reserve to themselves the right to make such charges to subscribers of the municipal telephone exchange as may be sanctioned by the Postmaster-General and the Corporation, and to secure at the same time full control over their streets.

Accident.—We regret to learn that two deaths have resulted from the accident at Clifton, near Manchester. It seems that on Christmas Day four men were removing a gasholder in the yard of the Chloride Electrical Syndicate, a larger holder being required there. One man entered the holder by the manhole to cut a pipe, and was immediately suffocated. Another workman went through the hole to help, but was also overpowered. The foreman followed, and was seen to fall insensible. Others broke the lid of the holder, and a workman with a rope round him was lowered inside. The first man was found dead, and the foreman did not long survive. The other two men who barely escaped suffocation were sent to the hospital.

Annual Staff Dinner.—On Monday evening, the 23rd ult., the permanent staff of the Wigan electricity works held their first annual dinner, and as a mark of the respect in which he is held, Mr. H. Collings Bishop, the borough electrical and tramways engineer and manager, was specially invited to preside. The principal toast of the evening was "The Electricity Undertaking and its Engineer," proposed by Mr. P. T. White, to which Mr. Bishop suitably responded. An interesting feature was the presentation of a handsome walking-stick to Mr. William Hart, who is leaving to go to Leigh. A good musical programme was then entered upon, and a very enjoyable evening brought to a close with "God Save the King."

Wireless Telegraphy.—A series of experiments with a new system of wireless telegraphy has been carried out between Folkestown Pier extension and Dungeness Point. A mast 130ft. high was used, and it is stated that the contact between the two points was so perfect that conversation was carried on with the greatest ease. Signor Marconi is reported to have made the following statement: "I have definitely decided to erect my transmission station in Cape Breton, either at Sydney Mines or Louisburg, and work will be completed within a month. Within a very short time thereafter the wireless method will be put on a commercial basis, and the handling of messages between Europe and America will be done as safely and as expeditiously as is being done to-day by the cable system."

Romsey.—At the last Town Council meeting the Mayor referred to the question of lighting the town with electricity. He thought there was room for it in Romsey without interfering with the gas company. The manager and secretary of the Swansea Electrical Lighting and Wiring Company had been at Broadlands to settle about lighting the house. The company thought Romsey could be lighted for £6,000, and they would find £3,000 and guarantee 4 per cent. on the outlay. He told them he would call a town's meeting to discuss the matter for the evening of Jan. 6. He was going to spend a good sum at Broadlands to have electric light installed there, and he should like to know what Romsey was going to do, because if he could take electricity from the town supply then he might put his money into a scheme for supplying the town.

Shrewsbury. — The increasing demand for electric light has necessitated several extensions of machinery during the four years the undertaking has been in the possession of the Council. The latest of these extensions includes the erection of a new engine, and this was formally "opened" by the Mayor (Mr. S. M. Morris) at a recent meeting of the Lighting Committee held at the works. The new set of machinery is of 350 b.h.p., and the dynamos are of 242 kw. capacity, capable of supplying 4,000 16-c.p. lamps burning at one time. The engine was manufactured by Messrs. Belliss and Morcom, Birmingham, and the dynamos by Messrs. Thomas Parker and Co., Wolverhampton. The estimated cost was £2,650, and the work has been done to specifications supplied by the borough electrical engineer (Mr. C. M. Johnston), who has from the commencement of municipal electric lighting in Shrewsbury had much to do with the success which has attended the undertaking.

Cardiff.—Messrs. Turner and Sons, the contractors for the new town hall, have their own generating station for the electricity supply. One of the boilers is somewhat of an experiment. It is an 80-i.h.p. concern, and is fitted with a forced-draught system, by which it is claimed a saving of fuel will be effected. Another engine, of the same

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type but minus the forced draught, is laid in the same shed. These drive a dynamo whose specifications are: volts, 250; amperes, 220; and revolutions per minute, 550. The contracting firm have an agreement with Messrs. J. Booth Bros., Rodley, for the guarantee and repair of the machinery. Electricity is utilised both for power and lighting, the latter installation enabling the men to work when natural light is unfavourable in the morning and evening. There are 36 arc lamps of 2,000 c.p. on the contract, besides untold numbers of incandescents. Eight electrically-driven derricks, each capable of lifting five tons on its 80ft. jib or arm, are in use.

Edinburgh.—The reconstruction of the telephone system in this town will cost £100,000. The wires are being laid underground. They are on the metallic circuit system, and the scheme includes a central exchange in Rose-street, where the whole telephone business of the city will be conducted. This building is now in course of erection. It is four storeys in height. The basement will be used for stores for the district, the ground floor as offices, and the upper floors as test and switch rooms. The switchroom will be large enough to contain switchboards to carry the 18,000 subscribers' lines, for which provision is being made. On the opening of the exchange the switchboard will provide for 5,000 pairs of wires, so that it will likely be large enough for some years to come. This important undertaking is the result of an arrangement made about two years ago between the Corporation and the National Telephone Company, under which the Town Council gave the use of the streets, for a certain rent charge, for the laying of underground telephone wires on the metallic circuit system, the Corporation having the option in 1911, when the present license of the Telephone Company expires, of purchasing at valuation the whole of the underground plant.

Derbyshire and Nottinghamshire Electric Power Co.—A Bill has been deposited for next session on behalf of the Derbyshire and Nottinghamshire Electric Power Company, which was incorporated last session, for the purpose of amending that Act so far as fixed the site of the generating stations. The preamble explains that by Section 30 of the Act of 1901 the Company were prohibited from constructing stations for generating electricity at any other site than on the lands described in the schedule annexed to that Act. It is pointed out that the Act of 1901 incorporated with it the Electric Lighting (Clauses) Act, 1899, Section 81 of the schedule of which Act would apply to any generating station erected elsewhere than on the lands described in the company's schedule. The preamble, therefore, contends that, with a view to the more convenient supply of electricity within the authorised area, it is expedient that the restrictions imposed upon the Company should be removed. In accordance with this preamble, Clause 2 of the Bill proposes to enact that: "So much of Section 30 of the Act of 1901 as prohibits the construction of stations for generating electricity elsewhere than on the lands described in the schedule to that Act is hereby repealed."

Manchester.—At last week's meeting of the Electricity Committee of the Corporation, Dr. Bishop, who presided, referred to the progress made at the new generating station in Bloom-street. This station is in a central part of the city, not far removed from the chief station in Dickinson-street. It is designed to accommodate four engines, each of 3,000 h.p., and, in combination, of 12,000 h.p. The first engine was promised by the sub-committee to be ready for work on Nov. 1 last. It actually took up part of its load on Oct. 28—three days in advance of that date. The second engine, which was to have been ready by the beginning of February, 1902, has been the subject of strenuous exertions, night and day, for some time past, with the result that it was set running on Friday last, and is now in daily use. This addition to the generating power of the station will enable the department speedily to meet the wants of customers now waiting for current to the extent of over 50,000 8-c.p. lamps. The members of the committee were much pleased with the intelligence. The committee afterwards dealt with contracts for the erection of 12 boilers, coal economisers, and feed pumps for the supplementary installation of 12,000 h.p. designed by Mr. Metzger, the city electrical engineer, for construction at Stuart-street, reference to which appears in another column.

Brussels.—A new Act has been passed providing for the unification of the Brussels tramways. Some of the more important lines have already been transformed since 1898 on the conduit system. There are three central stations, with plant totalling 3,000 h.p. A new central station is to be erected outside the radius of the tramway system. From thence three-phase current will be distributed to the stations already existing, which will be transformed into sub-stations and fitted with transformers. This central station will contain four generating sets of 1,200 kw. each, and room will be provided for the erection of three more units of the same capacity. The engines, by Van den Kerchosen, of Ghent, work with superheated steam, and will be fitted with the new system of distribution shown by that firm at the late Paris Exhibition. These engines will be direct coupled to Thomson-Houston alternators of 94 revolutions per minute. At the same time great extensions of the municipal electric lighting undertaking are projected. The present station, which has a capacity of 5,500 h.p., is being reconstructed; a new unit of 1,500 is to be erected shortly. The station is, however, not large enough, and plans are being prepared for a new central station outside the town, which will contain plant totalling 20,000 h.p., and where high-tension three-phase current will be produced and distributed to the sub-stations in a manner similar as proposed in connection with the tramway undertaking.

Pemberton.—Last week the electric lighting of the main thoroughfares was formally initiated by a trial being made with the lamps in Billinge-road. On Tuesday night all the electric lamps erected in the township were brought into use for the first time. The cost of the works is about £20,000. They are situated a little behind the District Council Offices, on ground belonging to the Council. The contractors for the building are Messrs. T. and H. Houghton, of Pemberton. The buildings consist of an engine-room, a boiler-house, a battery-room, a storeroom, and offices. The dimensions of the buildings are as follows: engine-house, 50ft. by 30ft.; boiler-house, 50ft. by 40ft.; battery-room, about 30ft. by 30ft. The engines are about 150 h.p., and are by Messrs. Belliss and Morcom, Birmingham, and the dynamos are by Messrs. Mather and Platt, of Manchester. The condenser is by the same firm, with Klein's tower for water cooling. The switch-bar consists of three panels, each about 6ft. by 5ft., constructed by Messrs. Dorman and Smith, of Manchester. The battery consists of 254 cells, made by the Tudor Accumulator Company, of Dukinfield. The travelling crane is capable of lifting a weight of five tons, and was erected by Messrs. Carrick and Ritchie, of Edinburgh. The boiler-house contains two boilers working at a pressure of 160lb., by Tinkers, Limited, of Hyde, and provision has been made for two other boilers of 400 h.p. each. Tinkers, Limited, also supplied the economiser, which was made by Messrs. Green and Son, of Manchester and Wakefield. The cables were made and laid on the solid system by the British Insulated Wire Company, of Prescot. Mr. Theodore Partington is the electrical engineer. We understand that the formal opening of the works will take place in about a fortnight.

Hammersmith.—At the last meeting of the Borough Council the Electricity and Lighting Committee reported as follows: "We have at various times received applications from would-be consumers in the north part of the borough, around the Hythe-road district. The borough electrical engineer has carefully canvassed this district, and from information obtained we have come to the conclusion that as soon as the mains are laid the demand for current will justify us in expending the money necessary to take the mains up to that district. There will be no difficulty in supplying from the present station by means of trunk mains running directly to this district, although it may be necessary at a later date, if the demand increases to a very much larger extent than that now estimated for, to increase the pressure from the trunk mains so as to double the capacity and ensure a better pressure at the extreme end. The extra cost of such alteration will be very slight, and only means the cost of the transforming gear. We have carefully considered the estimates prepared by the borough electrical engineer for the work, and find it includes the laying of a low-tension distributing cable wherever ground is opened, and four 2in. cast-iron pipes, two of which will be immediately occupied by two trunk high-tension feeders, and the other two will be spare ones ready for use for any further extension for street-lighting or main feeders. The route of these mains will be along the west side of Latimer-road to the North Pole-road, along the south side of North Pole-road to Wood-lane, northwards along Wood-lane and Scrubbs-lane to Waldo-road and the northern boundary of the borough, a sub-station being built in Hythe-road. A branch feeder will also be taken down Wood-lane to Ducane-road, and a transformer box built opposite the proposed workhouse. The total estimated cost of this is £9,540. 5s. 4d., and we recommend that the work described in the report be carried out in accordance with the estimate submitted." The recommendation was adopted.

Rochdale.—Mr. A. R. Bennett having reported in favour of the establishment of a municipal exchange, the General Purposes Committee will recommend the Town Council to apply for a license. Mr. Bennett in his report states the average distance of the subscribers from their switchroom would not exceed five-eighths of a mile, which greatly conduces to economical construction, but this was balanced by the fact that higher poles would be required to carry the wires owing to the continuity of buildings. He proposed to lay down 4½ miles of underground pipes, which would enable all the main routes to be put out of sight, and the distribution would be chiefly by means of overhead spurs of light bronze wire. He estimated that £19 per line would be sufficient provision for a first-class metallic circuit telephone exchange system, construction in accordance with the specification annexed by the Post Office to licenses to local authorities. The provision of ducts, etc., for extending from 620 to 1,240 lines would cost about £2,200. This worked out: 600 subscribers' and 20 public telephone lines (including 21 junction lines), completed at £19, £11,780; ducts and pole accommodation for 620 additional lines at £4 each, £2,480—total, £14,260. An average receipt of £5. 7s. 6d. per line per annum was desirable at first, although he should expect a reduction to £5, or even £4, per annum would be found possible after a short experience. Under the Post Office license the Corporation would be bound to offer its subscribers the option of paying under the toll system—a small sum annually, with a further payment for each call originated—instead of an inclusive annual rental. As a rule, the gross annual payments made by the toll subscribers did not amount to so much as £5. 7s. 6d., and to maintain the desired average it would be necessary to charge more for the inclusive service than would otherwise be necessary. He suggests the following tariffs as being likely to result in an average receipt of £5. 7s. 6d. per annum: (1) £5. 17s. 6d. per annum to cover an unlimited number of calls; (2) £3. 10s. per annum with a toll of ½d. per call; (3) £2. 10s. per annum with a toll of 1d. per call. Except when the subscriber's place happens to be more than one mile from the nearest switchroom, in which case the annual charge would be increased at the rate of £4 per mile of extra distance, these tariffs should cover all charges; and in the Rochdale area, however, it would be possible so to lay out the switchrooms as to bring the great majority of the subscribers within the mile limit. Mr. Bennett estimates that an annual profit of £374. 8s. would be made, and adds that the estimate of working expenses he gives is an exceedingly liberal one, and provides not only for recovering the whole capital in 25 years, but for renewing the whole of the plant, so that at the termination of the license the Corporation would be in possession of an up-to-date system which had cost them nothing.

Portsmouth.—The National Telephone Company have had an exchange in Portsmouth for 16 years, and they have now 800 subscribers. Two years ago, when the company asked permission to lay wires under the pavements, it was suggested that the Corporation should maintain and control its own telephone system. A canvass

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was made, which gave sufficient guarantee that an independent telephone system would be gladly welcomed. The Corporation obtained a license from the Postmaster-General last September, and hope to complete their system within a period of six months. Upwards of 1,200 signed promises have been received from prominent tradesmen who are anxious to become subscribers. These promises were obtained before a single wire was laid, therefore the Corporation are in the happy position of being able to establish a new business with a complete set of customers. With a population in the town of nearly 200,000 it is hoped, and not unreasonably, that the number of subscribers will be more than doubled when the service is in full working order. The scheme provides for a central exchange at the town hall, where it is proposed to erect a switchboard for the accommodation of 4,000 wires. A radius of 10 miles will be covered, including such outlying districts as Emsworth, Havant, Fareham, Gosport, and Waterloo-ville. The wires will be laid underground in earthenware conduits, and provision is to be made for future extensions. The entire cost of the work will be £26,000, and the contract, with the exception of the subscribers' wall instruments, has been given to a British firm. The instruments are to be of the latest approved pattern, and subscribers will have the privilege of using the General Post Office trunk wires. The scale of charges has been reduced to a minimum, and they compare very favourably with the lowest rates in operation in any of the few towns that have provided a municipal telephone service. A subscriber may have the choice of three rates—viz.: (1) £5. 17s. 6d. per annum to cover an unlimited number of calls; (2) £3. 10s. per annum, and ½d. for each call originated by the subscriber; or (3) £2. 10s. per annum, and 1d. for each call. The present rate of the National Telephone Company for Portsmouth is £10 per annum. The Corporation claim that the new system will be identical with that of the company's, with the one important exception that the former will be up to date. In the event of the new service proving a success, the Town Council do not intend to apply the profits to the relief of the borough rates, but to effect a material reduction in the annual subscription for the use of the telephone. Quite recently the Corporation received a communication from Mr. Gane, the managing director of the National Telephone Company, requesting an interview with a deputation of the Town Council with a view to an amicable arrangement being arrived at. Nothing came of it, however, and now the Corporation are determined to enter into effective competition with their rival. Mr. A. R. Bennett, the telephone expert, has reported that the receipts, on the basis of the present scheme, would be £6,937, and the working expenses £6,660, leaving a net profit of £277. On the prospects of successful competition on the part of the Corporation, Mr. Bennett reports as follows: "These I hold to be good. The National Telephone Company, if permanently restricted to the underground wayleaves which they at present enjoy, could only compete at a disadvantage, since the Corporation's underground metallic circuit system would be more efficient and freer from interruption than the older overhead system of the company. The want of underground wayleaves would also deter the company from attempting to kill competition by reducing rates to an unremunerative figure, since room for the large number of additional wires which any notable reduction would bring them could scarcely be found overhead. There is a second reason which operates against cutting of rates. In numerous towns the company have accepted underground wayleave agreements, which contain a clause binding them to give the town granting the wayleave the benefit of any reductions in charges which may thereafter be made in any other town of corresponding size."

PROVISIONAL PATENTS, 1901.

DEC. 16.

25647. Improvements in apparatus for controlling electric circuits. Charles Ashmore Baker, 30, Lexham-gardens, Kensington, London.

25684. Improvements connected with renewal of electric incandescent lamps. Henry Edward Kershaw, 166, Fleet-street, London.

25710. Improvements in or relating to motor bicycles and electric ignition devices applicable thereto and to motors generally. Oscar Bailly, 111, Hatton-garden, London. (Complete specification.)

DEC. 17.

27522. Improvements in or relating to the rapid heating of water or other liquids by a current of electricity. Frank Herbert Briggs, 6, Park-crescent, Torquay.

25724. A spiral sheave or trolley for use in electric overhead tramcars and the like. John Hunt, 6, Finkle-street, Stockton-on-Tees.

25747. Improvements in electric fuse switch boxes. Joseph Sachs, 33, Chancery-lane, London. (Complete specification.)

25753. Improvements in systems of electrical distribution. John Sedgwick Peck, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 18, 1901, being date of application in United States.)

25768. Electric fan for use in theatres and other places. Hussein Agha, 53, Chancery-lane, London.

25778. Improvements relating to perforators for electric telegraphs. Donald Murray, 323, High Holborn, London.

25810. Improvements in the manufacture of incandescence bodies for electric glow lamps. Alexander Just, 46, Lincoln's-inn-fields, London (Complete specification.)

DEC. 18.

25831. Improvements in anchors or stays for overhead electric wires. Ernest Albert Browning, Donington House, Norfolk-street, Strand, London.

25833. Improvements in the method of supporting and joining the power wire for electric tramways or railways. Frank Hewer, 45, Barrowgate-road, Chiswick, London.

25878. Improvements in and relating to conduits for electric and other traction cables. Henry Fisher Spenser and Howard Brunlees, 45, Southampton-buildings, Chancery-lane, London.

25885. Improvements in or relating to switches for electrical current circuits. Ernest Francis Moy, Percy Henry Bastie, and Ernest F. Moy, Limited, 37, Essex-street, Strand, London.

25886. Improvements in trolleys used in electric traction. Jim Horsman, 99, Cannon-street, London.

DEC. 19.

25901. Improvements in section insulators for the overhead construction for electric tramways or railways. William Heron Loggey and Frank Hewer, 45, Barrowgate-road, Chiswick, London.

25908. Improvements in telephones and telegraphs. William Foxton, 87, Victoria-road, Scarborough.

25909. A method of and apparatus for localising the electric current operating tramcars and the like. John Booth, Sunbridge-chambers, Bradford.

25941. Improvements in tripping electric switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (John D. Hilliard, jun., United States.) (Complete specification.)

25942. Improvements in surface-contact electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William B. Potter, United States.) (Complete specification.)

25943. Improvements in electric railway systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William B. Potter, United States.) (Complete specification.)

25944. Improvements in electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Samuel B. Stewart, jun., United States.) (Complete specification.)

25945. Improvements in electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Asa F. Batchelder, United States.) (Complete specification.)

25946. Improvements in brush-holders for dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William E. Baker, United States.) (Complete specification.)

DEC. 20.

26002. Improvements in insulators for overhead equipment for electrical traction and other purposes. Edward Yates Walsh and John Leigh, 6, Bank-street, Manchester.

26005. Improvements in certain casings for electric wires and cables. Charles John Wightman and Arthur Hudson, 2, Market-street, Bradford.

26033. Improvements in electrical indicators. Alfred William Marshall and Maurice Walter Woods, 2, Gray's-inn-road, Holborn, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Jan. 11.

1900.

20808. Electrical burglar alarms. Pennington and Yates.

23014. High-voltage, quick-break, single-pole, double-poles, or multi-poles switch. Short.

23389. Regulation of dynamo-electric machines. British Thomson-Houston Company, Limited. (Lunt.)

23396. Rotary transforming apparatus. British Thomson-Houston Company, Limited. (Rice.)

23749. Electric distribution. Arnold, Bragstad, and La Cour.

28860. Electric distribution systems. Hewlett. (Date applied for under International Convention, July 28, 1900.)

1901.

1401. Controlling arrangements for electric lifts. Stevens, Major, Stevens, and Stevens.

1504. Apparatus for governing electric currents. Gattie.

2618. Electrical heating apparatus. Loacker and Riedl.

3112. Systems of electrical distribution. Lamme. (Date applied for under International Convention, July 14, 1900.)

3992. Electrical accumulators. Cobb.

4760. Electric measuring instruments. Campbell.

16398. Portable electric light apparatus for the treatment of lupus. Smith.

17556. Electromagnetic apparatus for oporating valves and for other purposes. Waterman.

22544. Circuit breakers for electric currents. British Thomson-Houston Company, Limited. (Read.)

22545. Incandescent electric lamps. British Thomson-Houston Company, Limited. (Howell.)

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22710. Telegraph and telephone system. Cerebotani.

22921. Selective systems for electrical communication. Reed.

23047. Means for adjusting the conductor in conduits of electric tramways on the slot-conduit system. Heindle.

23376. Electric fuse boxes. British Thomson-Houston Company, Limited. (Van Aller.)

23377. Electric fuse boxes. British Thomson-Houston Company, Limited. (Read.)

23379. Electric current transformers. British Thomson-Houston Company, Limited. (Moody.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1901.	1900.	Increase or decrease.	Total receipts for half-year. 1901.	1900.
		£	£	£	£	£
Aberdeen Corporation	Dec. 28	667	668	– 1	23,083	21,190
Birmingham Tramways	—	—	—	—	—	— *b*
Birkenhead Corporation	—	—	—	—	—	—
Blackburn Corporation	,, 27	532	547	– 15	26,064	23,279*b*
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 28	160	221	– 61	29,949	20,385*b*
Bolton Corporation	,, 29	1,447	1,396	+ 51	74,946	62,464*b*
Bradford Corporation	,, 29	1,185	1,067	+ 118	47,832	25,969
Bristol Tramways Company	,, 27	4,580	4,970	– 390	—	—
Carlisle Tramways Company	,, 28	160	175	– 15	4,518*b*	4,532
Central London Railway	,, 28	5,928	4,911	+ 1,017	161,327	—
City and South London Railway	,, 29	3,103	1,704	+ 1,399	58,674	43,273
Cork E. T. and L. Company	,, 26	437	450	– 13	23,634	21,198*b*
Darwen Corporation	,, 27	205	208	– 3	9,788	8,167
Dover Corporation	,, 28	170	185	– 15	11,131	10,618*b*
Dublin & Lucan Electric Railway	,, 29	104	92	+ 12	2,937	2,548
Dublin U. T., electric cars	,, 27	3,746	3,738	+ 8	—	—
Dublin S. District, Electric	,, 27	746	816	– 70	—	—
Dundee Tramways Company	,, 25	701	506	+ 195	—	—
Glasgow Corporation	,, 28	10,454	9,530	+ 924	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 28	1,858	1,883	– 25	44,851	37,813
Liverpool Corporation	,, 21	9,042	8,961	+ 81	457,519	407,117*b*
Liverpool Overhead Railway	,, 29	1,240	1,397	– 157	40,404	42,571
Newcastle-on-Tyne Corporation	,, 21	664	—	—	—	—
Portsmouth Corporation	,, 21	870	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 29	4,177	—	—	—	—
Southampton Corporation	,, 26	728	730	– 2	—	—

* Fortnightly. *b* From Jan. 1.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £579 decrease.
Barcelona Ensanche y Gracia, £253 increase. Barcelona, £247 increase.
Brisbane, £308 increase (month of Nov., £1,286 increase).
Buenos Ayres and Belgrano Electric, £30 increase.
Calcutta, £20 decrease.
Cape Town (month of Oct.), receipts, £14,063; expenditure, £6,817.
La Capital Traction and Electric, Buenos Ayres (month of Nov.), £1,973 increase.
Mexico Electric (month of Nov.), receipts, £17,300; expenditure, £10,500.
Perth Electric, £100 increase.
Port Elizabeth (month of Oct.), receipts, £3,240; expenditure, £1,960.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Tramways.—	£	£
Anglo-Argentine, 1-260,007	5 ..	3¼-3⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	123-126 xd
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2¼-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	101-103 xd
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6½-6⅝
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9-9½
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13¼-14¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12-12½
—— 5 per cent. Perpetual Debenture Stock	100 ..	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅞-2
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106 xd
—— Prov. Cert., all paid	100 ..	97-100 xd
Cape Electric Tramways, Nos. 1-400,000	1 ..	1⅛-2⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11-12
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	102-104 xd
New General Traction, Ordinary	5 ..	2½-3½
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	98-102
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10⅝
—— 5 per cent. Cum. Pref.	10 ..	11¼-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £251,132 6 per cent. Preference	8s. ..	7/16
—— £250,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	40 p.c. ..	40 p.c.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅞-1
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅛-⅜
—— Ordinary, 1-125,000	1 ..	⅛-⅜ xd
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-6
—— 5 per cent. Mortgage Debentures	100 ..	100-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5¼-5½
Brush Electrical Engineering, Ordinary	2 ..	1⅛-1⅛
—— Nos. 90,001-105,731	2 ..	1⅛-1⅛
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	97-100 xd
Callender's Cable, Debentures	100 ..	110-114 xd
—— Ordinary	5 ..	16½-17½
—— 5 per cent. Pref.	5 ..	5⅞-6¼ xd
Crompton and Co.	3 ..	3-3½
—— 5 per cent. Debentures	— ..	100-105
Edison and Swan United, Ordinary	3 ..	⅛-⅜
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	78-83
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	84-89
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1⅞-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2⅜-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9⅜-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16½-17½
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	112-116
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21½-22½
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15½-16¼
Telegraph Construction and Maintenance	12 ..	37-41
—— 5 per cent. Bonds	100 ..	104-106
Telegraph Manufacturing, Ordinary	5 ..	10¼-11½
—— 5 per cent. Cum. Pref.	5 ..	5½-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	9½-10½
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6-6¼
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	103-105
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅛-⅜
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	97-102
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9½-10¼
—— Debenture Stock, Red.	100 ..	100-103 xd
Brompton and Kensington, Ordinary	5 ..	8¾-9¼
—— 7 per cent. Preference	5 ..	8½-9
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7½-8¼
—— Nos. 20,001-30,000	5 ..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10¾ xd
Charing Cross and Strand	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5-5¼
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	103-105
Chelsea Electricity Supply	5 ..	5⅜-6¼
—— 40,501-50,936	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	108-111 xd
City of London, Ordinary	10 ..	9-10
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	121-126 xd
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	104-107 xd
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5¼-6
—— 6 per cent. Cum. Pref.	5 ..	5¼-6
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-4⅜
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5⅜
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	103-105
Kensington and Knightsbridge and Notting Hill	100 ..	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	3¾-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	94-98
Metropolitan, Ordinary	10 ..	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-115 xd
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	96-99 xd
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9½
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7⅛-8
—— £2½ Shares, New	4½ ..	6¾-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2⅜
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-2½
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15¼-16½
—— 7 per cent. Pref.	5 ..	8¼-9½
—— 3½ per cent. Deb.	100 ..	97-100 xd
Westminster, Ordinary	5 ..	11½-12½
Electric Railways.—		
Central London, Ordinary	100 ..	105-108
—— 4 per cent. Pref.	100 ..	105-108
—— ,, ,, deferred	100 ..	106-109
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-119
City and South London, Consolidated Ordinary	100 ..	62-64
—— Ordinary	10 ..	6-6½
—— Nos. 60,001-70,000	10 ..	6-6½
—— 4 per cent. Debenture Stock	100 ..	113-117
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Telephones.—		
National Telephone, Ordinary	5 ..	3¼-3⅜
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4⅜-4⅝
—— 4 per cent. Deb. Stock, Red.	100 ..	93-96 xd
—— 3½ per cent. Deb. Stock, Red.	100 ..	93-103 xd
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

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NOTES.

Lectures.—A course of ten lectures will be given in the Fulham Town Hall by Mr. E. Halford Strange, M.Sc., upon the subject of "Electric Power and Lighting," commencing Tuesday, Jan. 21, 1902.

Reduction of Alumina by Calcium Carbide.—In the electric furnace aluminium oxide is not reduced by carbon, but if lime be added, calcium carbide is formed, and Messrs. A. Tucker and Herbert R. Moody have discovered by experiment that this reduces alumina; also that the yield of aluminium is increased by the presence of free carbon. The heat should not be applied longer than 15 minutes, for by that time aluminium carbide is formed.

Copper-Aluminium Alloys.—Mr. Leon Guillet, working in France, has prepared various copper-aluminium alloys by heating pure cupric oxide with granular aluminium in proportions varying from those which should yield pure copper to those which should yield the alloy $CuAl_4$. By treating the products with acids, he has isolated three distinctly crystaline definite alloys—Cu_3Al, $CuAl_2$, and CuAl, the last being mixed with a small quantity of copper-aluminium silicide.

Royal Institution.—Lecture arrangements at the Royal Institution for the next fortnight include the first of a course of six on Tuesday, the 14th inst., by Dr. A. Macfayden, his subject being "The Cell, its Means of Offence and Defence, Immunity." The Friday evening discourse on Jan. 17 will be delivered by Lord Rayleigh on "Interference of Sound"; on Jan. 24 Mr. H. G. Wells will give a discourse on "The Discovery of the Future"; and on Jan. 31 Prof. A. Crum Brown will lecture on the "Ions of Electrolysis."

Wireless Telegraphy for Scotch Lighthouses.—It has been decided to adopt the Marconi system of wireless telegraphy in connection with the lighthouses round the north and west coasts of Scotland. The Commissioners of the Northern Lighthouses of Scotland have the matter in hand. They propose to carry out the first installation at the Flannan Islands, which are about 16 miles off the west coast of Lewis. This is practically the first land sighted by vessels coming from America, and a wireless telegraphy station at such a point will doubtless prove of great value.

Submarine Cable Faults.—A fault which was removed a short while ago in the Eastern Extension Telegraph Company's cable between Sydney and Nelson has brought to light an interesting fact in connection with the interruptions occurring in submarine telegraph cables. In the case in question the fault was discovered in a part of the cable at a depth of 330 fathoms, where was found a tooth firmly fixed in the core of the cable, although the core was protected by the usual sheathing of thick iron wires and outer coverings. On examination it was proved that the tooth belonged to a species of shark, the exact variety of which could not be identified.

Post Office Telephones.—It is stated on the authority of Mr. J. Gavey, the assistant engineer-in-chief to the Telegraph Department of the General Post Office, that the central exchange for the London system of Post Office telephones will be opened within a fortnight or three weeks. It is added that although the Post Office canvassers have been at work for only a few days, more than 1,100 subscribers to the London service have been obtained. We note that the latest municipality to take up a scheme for the establishment of municipal telephones is the Corporation of Folkestone, and the Dover town authorities have been approached by that body with a view to their co-operation in the movement.

Rapid Transit in New York.—With the completion of the rapid transit tunnels in New York the remarkable state of things will exist of four passenger railroads in three tiers, one above the other, at a point located in the centre of the city. Counting from the bottom, there will, in the first place, be the rapid transit tunnel itself, running east and west, and next above this comes the Sixth Avenue surface underground trolley line, running north and south. On the same level there is another system of street lines, running east and west, and above this, making the third tier, runs the elevated railway, going north and south. This latter system is also soon to be equipped with electricity. It is said that in no other city in the world does a similar arrangement of electric railways and tramways exist.

Prospects for Emigrants.—The Emigrants' Information Office has issued a circular, dated Jan. 1, on the prospects of emigration at the present time. These are, unfortunately, not very encouraging, as the Colonies do not appear to be "hard up" for either skilled or unskilled labour just now. In New South Wales, however, and especially in Sydney, all trades continue to be fairly well employed, and there is still some opening for general mechanics, plumbers, joiners, carpenters, and good labourers. There is no general demand for more labour in Victoria, although a competent mechanic has not much difficulty in finding work. South Australia, Queensland, and Western Australia seem to be in pretty much the same condition, and in South Africa no one is now allowed to land without a permit.

Magnetic Observatory Influence.—On Dec. 9 Mr. Mascart presented to the Académie des Sciences de Paris a note by Mr. T. Moureaux on the influence of street currents on the earth's magnetic field at the observatory of Parc Sant-Maur. The author's conclusions from the comparisons made at the observatory above mentioned, and at the station at Valjoyeux, are that even if the actual magnetic curves can be restored by the use of amortisseurs on the machines at generating stations, this does not prevent the earth's field being disturbed by the street currents from the tramway returns. These currents, which have seriously interfered with the observations at Parc Sant-Maur, leaked from the trolley system of the East Parisian line. The author shows that the troubles not only affect the diurnal variations, but also the absolute value of the magnetic elements.

System of Charges.—The Electric Lighting Committee of the metropolitan borough of Fulham are recommending a new system of charging in order to encourage large and profitable consumers. The scale will be as follows: 5d. per unit for an average consumption of 12 units per 8-c.p. lamp fixed per annum; 4d. per unit for an average consumption of between 12 and 24 units per 8-c.p. lamp per annum; and 2d. per unit for all energy consumed over and above 24 units. Under the new scale the discount will be given on the last quarter of the year. This system is a simple one, in so far as no maximum-demand indicator is required, and it is also easy to understand, which is a great advantage to the majority of consumers. We think, however, that it is not quite so equitable as a system which makes a slightly higher charge for the first hour or so per day of the average consumption, and then a lower charge for all in excess.

Disease by Telephone.—It is generally admitted by users of the telephone that the equipment of the same in the public call offices leaves much to be desired from the point of view of health. A source of danger, which was

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recently called attention to in the *Lancet*, arises from the fact that the use of the instrument is open to everyone who can pay his "call" money, and whose state of health is not, nor can it be, enquired into. As a protection against the spread of disease due to this cause, the article in our contemporary referred to described an "odourless, retentive disinfecting cloth," which had been patented, and was said to be especially adapted for use in telephone call offices. Mr. J. F. N. Roberts now writes to the daily Press a letter, in which he testifies to the great value of such a cloth for the purposes mentioned. It appears that he has used it in connection with a telephone, and, in his own words, he "has found it an excellent safeguard, its retentiveness of disinfecting action for two or three months giving it a particularly valuable qualification for such uses."

Telephones on Trains.—We note that the officials of the Chicago and North-Western Railway Company are considering a plan for telephoning from trains to different parts of Chicago, while the same are at rest at the stations at which they are timed to make a few minutes' stop. The proposition is to equip all the overland trains of this line with telephones and connect them with the wires of the Chicago Telephone Company which run in same direction. They would be expressly for the convenience of travellers who might desire to telephone back to the city when on long journeys. Of course it would only be possible to carry on such communication after a train arrived at a station and before it started again. The scheme also embraces a proposal to equip the cars with telephones to be used between the different parts of the train while the latter is running. There would be a small telephone in each department and in one end of the open sleepers. The wants of a passenger who desired, for instance, a meal served in his own compartment or sleeper would thus be quickly attended to.

Rotary Converters.—An article in which the operation of the rotary converter is contrasted with that of the direct-current generator, appears in the December number of the *American Electrician* from the pen of Mr. McAllister. The author's view is that the operation of a rotary converter is in general much more satisfactory than that of a corresponding direct-current generator for several reasons. In the first place, the operation of a rotary converter is preferable from the point of view of the absence of field distortion. The rotary is both a generator and a motor, and as a generator the armature current tends to distort the field in a direction opposite to the distortion as a motor. The effects of the armature reactions, therefore, neutralise each other, and since there is no shifting of the field, the point of commutation does not vary with the load. Sparkless commutation results. In the second place, there is less friction loss in the rotary, and, thirdly, there is greater output from the same armature. Since the load current at portions of each revolution feeds directly from the alternating-current side without traversing the whole winding, as must be the case with a generator, the effective armature resistance is less than it is for the same armature used in a generator.

Gigantic Water-Power Plant.—Operations commenced a few months ago in the development of an immense electrical power plant, gained by impounding and utilising the entire body of water at some falls on the Susquehanna River, near York Haven, Pa. When the work is completed, which event is expected in the fall of 1902, the installation will rank second in importance to the great Niagara power plant, and as the largest plant of the kind in Pennsylvania. We understand from our American contemporary the *Electrical World*, that in the power-house, now in course of construction at York Haven, will be installed 40 turbine water-wheels of 600 h.p. each, operating 20 750-kw. generators. There will also be two turbines of 250 h.p. each to drive the machines required for excitation purposes. Running from the power-house there is being built a granite wall 3,500ft. long and from 26ft. to 38ft. high, which will enclose a race 375ft. in width and 16ft. in depth, connecting with the dam at the head of the falls. The construction of the wall will require, it is estimated, over 100,000 cubic yards of masonry. A large cofferdam has already been erected inside, while the foundation for the power-house has been excavated in solid rock. It is expected that a large part of the current generated at this station will be used in the immediate neighbourhood to drive large industries, which are already negotiating for the power.

Dielectric Constants of Pure Solvents.—The dielectric constants of a large number of organic and inorganic compounds have recently been determined by Mr. Herman Schlundt, among them many amines and nitro-compounds. The following are the values of the dielectric constant for some of the more important compounds as given in the January number of the *Journal* of the Chemical Society: Ethylene cyanide, 61·2 at 60deg.; ethylamine, 6·17 at 21deg.; nitromethane, 40·4 at 19deg.; nitroethane, 29·5 at 18deg.; methyl nitrate, 23·5 at 18deg.; ethyl nitrate, 18·3 at 18deg.; phosphorus trichloride, 3.36 at 22deg.; arsenic trichloride, 12·35 at 21deg.; antimony trichloride, 33·2 at 75deg. (liquid), 5·4 at 18deg. (solid); stannic chloride, 3·2 at 22deg.; phosphorus oxychloride, 13·9 at 22deg.; sulphuryl chloride, 9·15 at 22deg.; liquid sulphur dioxide, 12·35 at 22deg.; bromine, 3·18 at 23deg.; liquid cyanogen, 2·52 at 23deg. In homologous series, the dielectric constant diminishes as the molecular weight increases. The introduction of the cyanogen group in a compound causes a large increase in the value of the dielectric constant. There is no anomalous absorption in compounds containing a cyanogen, an amino, or a nitro group. Whilst a number of cases have been discovered where the Nernst-Thomson rule is applicable, striking exceptions to that rule have also been found, showing that the nature of the solvent is of prime importance in determining whether a solution will conduct electricity. Obach's law is found to hold only approximately for the nitriles.

Niagara Falls Power.—Mr. P. P. Barton, the superintendent of the operating department of the Niagara Falls Power Company, contributes an article on the organisation of the works in the current number of *Cassier's Magazine*. The illustrations given in this article are excellent, and are in our opinion of a much higher order than the text. For instance, in connection with the maintenance of the overhead line illustrations are given of the replacing of a defective insulator on the 2,500-volt line, but we fail to find in the text any description of how this is done. We are told, however, that the company have a record of 13 consecutive months without any interruption of the service through line troubles, in spite of the fact that the region is invested with mischievous boys and also with hunters who find an insulator a good mark for practice. The author adds that among the tasks which the line force has been called upon to perform are the replacing of a broken insulator on a live line and the removal and replacing of a pole on the line while in service. Both of these feats were performed with the conductors charged to a potential of 11,000 volts, and each of them has recently been accomplished without accident or interruption of service with lines in operation at 22,000 volts. We should much like to know some details as to how this was done, as the position of a man

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on a pole when securing a 22,000-volt line on to its insulator does not seem to be particularly safe. In the other parts of the article most useful information is given as to the working of the plant and the organisation of the staff.

Electricity on Warships.—Details which have come to hand of the electrical equipment of four new men-of-war for the United States navy give a very fair idea of the progress which is being made in the use of electricity as a lighting and power agent on modern warships. On each of the two battleships it is proposed to construct in America this year, the electric generating plant will consist of a suitable number of units, not less than eight nor more than twelve, having a combined total output of 800 kw. Each unit is to consist of an engine and dynamo on a common bedplate. The means of interior communication include all the usual appliances—such as engine-room telegraphs, telephones, electric bells, gongs, etc. Each vessel will be lighted throughout by electricity, will have the usual electric signalling apparatus, and will carry six searchlights. All turret guns will be supplied with electrically-driven ammunition hoists. The United States naval programme for this year also includes the construction of two armoured cruisers, and these are also to be fitted with a full electrical equipment. In each vessel the electric generating plant will consist of eight units, each composed of an engine and dynamo mounted on a common bedplate. Four units will have a capacity of 100 kw. each and four of 50 kw., making the total output 600 kw. The following auxiliaries will be operated by electric power—viz., turret-turning gear, all ammunition hoists, rammers and elevating gear for 10in. guns, all blowers for hull ventilation, boat cranes, deck winches, laundry machinery, and tools in workshop. The miscellaneous electric fittings on the cruisers will be practically the same as those on the battleships.

The American Cable to the Philippines.—In view of our "note" in last week's issue with reference to the manufacture of submarine cables in the United States, it is significant to see what are the views on the subject of one of the heads of the Commercial Cable Company, which has been organised to lay a submarine cable from the western coast of the States to the Hawaiian and Philippine Islands. Mr. George G. Ward, the gentleman in question, has, according to our American contemporaries, made a statement in relation to the letting of the contract for laying this cable to an English firm. He was questioned as to why the contract has not been awarded to an American company, and his reply was that there is no company in the United States that could perform the work. They in America have not the machinery, and his company could not afford to have the work of laying the cable take the form of an experiment. The Silvertown Company have been established for over 40 years, and have laid most of the deep-sea ocean cables throughout the world, so that they understand perfectly just how the work should be accomplished. Mr. Ward's remarks are distinctly complimentary to British manufacturers of submarine cables as a whole. He further stated that the Silvertown Company have promised to have the cable complete and ready for laying in about seven months. When this section is complete, another that will connect the Hawaiian Islands with the Philippines will be commenced. It is probable that the station at that end of the line will be on the island of Luzon, and near or in Manila. The whole work is expected to be completed in two or three years. The estimated cost of the undertaking is about £3,000,000. Nothing has yet been decided as to the schedule of rates to be adopted, but it is promised that it will be reasonable. It is to be noted that the Commercial Cable Company have not yet obtained the consent of the United States Government to the landing of the cable in California, Hawaii, and the Philippines, and that the contract for the first section has been placed on the assurance of the American Attorney-General that such landings are perfectly legal.

Prevention of the Smoke Nuisance.—We learn that the authorities of the city of Chicago, U.S.A., are considering a proposal which aims at the abatement of the smoke nuisance by thorough inspection of boilers and steam plants. The scheme provides for the formation of a Board of Inspectors who would deal with all cases of violation of the smoke laws. One of the most potent causes of smoke abuses is the installation of cheap and unsatisfactory boiler systems in manufacturing and other plants, and the proposed new ordinance aims at the abolition of such plant. One of the members of the Board of Inspectors would be an expert in the examination of boilers, and if steam plants were found to be constructed in violation of well-known and accepted principles, by reason of which perfect fuel combustion was not obtained, this Board would have power to order the necessary changes to be made and to enforce its demands. A more stringent proposal still is that the new department should be empowered to examine the specification for the rection of new buildings, and to demand of the owner the exact quality of the coal he intends to use for his fires. Among other provisions directed more particularly to the prevention of boiler explosions, is one which includes the inspection of boilers before they are installed. We think that the Board will do wrong if they go into more than the question of whether chimneys smoke or do not smoke, as there is no reason why they should force manufacturers to alter their arrangements, introduced to get more economical results, if their chimneys are not smoking. We would suggest, as a first step, that the committee of the Anti-Smoke League in London should be exported as a body to Chicago.

Alternators with Amortisseurs.—Mr. J. Fischer-Hinnen contributes an article to the *Electrical World* of New York for Dec. 28, in which he publishes a mathematical determination of the influence of damping coils on the operation of alternators, based on actual experiments with machines of this type. In the course of the article the author shows that when an alternator fitted with damping coils is being operated by a driving force which rhythmically varies, its steadiness of speed must be largely due to the electrical inertia of the damping coils, and is by no means solely to be ascribed to the mechanical inertia of the flywheel. The increased stability of the machine in parallel running is, in fact, attributable to this electrical inertia. The fact that alternators provided with damping coils are thereby reduced in armature reaction, or apparent reactance under load, is not generally known, and is important. The author in the latter part of the article gives statistics to indicate that the weight of copper in the damping coils on the field is generally in excess of the weight of copper in the armatures, and more than half the weight of the copper on the field magnetising coils. The conclusion at which he arrives is that it is not worth while incurring so great an expense, since correspondingly good results can be obtained without damping coils by employing in the armature winding a part of the copper that damping coils would require. While it is possible that this substitution of increased armature copper for the damping coils might secure equally good automatic regulation of pressure under load, it does not seem likely that the same substitution would secure equally good stability in running. In other words, it appears that in order to secure the best stability in parallel operation under sudden variations of speed or load, the effect of the copper in damping coils must be greater

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than the effect of the same amount of copper added to the armature winding.

Submarine Signalling.—A novel system of submarine signalling, which is based upon the principle that water transmits sound under conditions that practically are unvarying, is soon to be put into practical operation at the entrance to Boston Harbour, U.S.A. The invention, which is the joint work of the late Prof. Elisha Gray and Mr. Arthur J. Mundy, of Boston, is simple, in that it consists of a system of submerged bells controlled by electric cable connections from the shore. At Boston it is intended to have two such bells, one on either side of the harbour entrance. The bells sound different numbers, and can, therefore, easily be identified; and they are so located that a line drawn upon the chart along a course leading directly to the beginning of the harbour channel also traces the course where the two bells will be heard simultaneously. Thus, if the navigator of a vessel hears either bell first, it is evident that he is off his proper course, and since sound travels under water at the rate of 4,712ft. a second, the interval between the sounding of the two bells will show the distance from the course in one direction or the other at any given moment. Such constant promptings, therefore, will enable a vessel to feel her way unerringly to points where the chart gives the exact course by compass to the harbour entrance. Various ingenious methods for transmitting, recording, and receiving the soundings of the bells have been devised. Thus, a receiver invented by Prof. Gray tells just the direction from which the signal proceeds, while another device by the same inventor makes it unnecessary to listen at the receiver for the sounding of the bells, for whenever such a signal is given a gong in the pilot-house is rung automatically by sympathetic vibration. The system, in connection with a signal code, also offers a means of communication with lightships to and from the land and between other vessels and the shore. It is further thought that the system would be adapted to the conditions of river navigation by placing a series of electrically-controlled bells at stated intervals along the river. We understand from the *Canadian Engineer* that as early as practical the arrangement is to be tried in connection with the safe navigation of the St. Lawrence River.

Utilisation of Exhaust Steam.—A paper by Mr. John Buley on this subject was read before the Institution of Junior Engineers on the 3rd inst. In introducing the subject, the author criticised the several methods adopted with a view to disposing of the lime scale deposit on the tubes of evaporative condensers, and suggested that in many cases it would be feasible to overcome the difficulty by periodically circulating a dilute solution of hydrochloric acid over the fouled surfaces. Special attention was directed to the employment of exhaust steam for heating circulations and for hot-water supplies for hospitals and asylums, and also its utilisation by equivalent methods for raising the temperature of the water delivered to the ponds in public baths and wash-houses. An interesting illustration was given in which the exhaust steam from a 7½in. by 6in. duplex pump was utilised for heating the day rooms of an asylum where the cubical content was 54,864ft. With an external temperature of 37deg. F. and with ample provision for ventilation, an internal mean temperature of 63deg. F. was maintained. Reference was made to the relative merits of direct heating, and inducing the flow of exhaust steam throughout a main circuit by means of an air-pump, as against the adoption of a central heater through which low-pressure water would have an accelerated circulation derived from an ordinary plunger pump. Where a complex system over a widespread area was a necessity, the latter system was advisable on the score of efficiency, first cost, and the general upkeep. Where exhaust steam was utilised for the concentration of liquors, the writer advocated the "Lille" system as the one from which, perhaps, the most favourable results had been obtained; with it an efficiency so high had been reached as to evaporate 40lb. of liquid per 1lb. of coal. The direct return of condensation water to steam-boilers was not commended, on account of the liability of intermittent shocks occurring. The writer considered that in practice trapping was the most satisfactory arrangement, and in spite of the disadvantages that sometimes attended the working of steam-traps, it was best to adopt this method of drainage, and to depend upon the condensation being returned to the boilers from a central hot-well, into which all the discharges should be led. The trap that relied for its action upon the concentration of the vapours of surplus heat was the one commended, rather than that on the expansion principle, by reason of the extreme fluctuations of pressure and consequent temperature where steam was employed in such a way as to bring about heavy spasmodic demands.

Gigantic Tunnel Scheme in New York.—News has reached this country of a scheme prepared by the Pennsylvania Railroad Company to construct in New York an underground terminal system, which may well prove to be the greatest step that has ever been taken in the electrical equipment of main-line railways in America. Briefly stated, the system contemplates a subway constructed in tubular tunnels, beginning at a point near the North River, in New Jersey, continuing under that river to a large terminal station centrally situated in the borough of Manhattan, continuing thence across Manhattan Island and under the East River to a great open-air terminal station in Brooklyn, and there connecting with the entire system of railways of Long Island. Throughout the whole system it is proposed to operate the trains by electricity to the exclusion of all other forms of motive power. At the present time the terminus of the Pennsylvania Railroad is in Jersey City, and connection with the metropolis is maintained by three lines of passenger ferry boats and several routes over which freight-cars are ferried on floats. The plans of the scheme, which have just been completed, indicate the gigantic scale on which the work is to be undertaken. The tunnels will be 18ft. 6in. in diameter inside, and will be supported at appropriate intervals upon piers of concrete and structural steel. The exact length of these tunnels is not yet known, but it is stated that the first section to be proceeded with will be considerably over two miles long. As already stated, the intention is to have the central station in the borough of Manhattan, where it is calculated some two miles of platforms will be provided. The station will probably be of a three-deck type, and as it will be a through station, open at both ends, it is expected that the handling of the trains in it will be greatly facilitated. The actual terminus of the trains will be at the Long Island end of the subway, which will practically consist of a dead-end station for the electric service. Under the North River the top of the tunnels will be 45ft. below the river bed, and at the point where the grade turns upward toward Manhattan the tunnel will be 80ft. below high-water mark. The lines in the great central station will be 45ft. below the ground surface, and at other places between 55ft. and 60ft. The section of the proposed subway which is to cross Manhattan Island will be of the inverted horseshoe form, the cuttings being for the most part in solid hard rock. With regard to the electrical equipment, although it is decided that the whole of the trains in these tunnels shall be worked by electricity, no information has yet been

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given out as to the system of electric traction to be employed. A rough estimate puts the cost of this gigantic scheme at about 10 millions sterling.

Distribution in Moderate-Sized Cities.—The question of the distribution of electricity is one for which it is impossible to lay down any hard-and-fast rules, and only general principles will apply to many actual cases. The subject may, however, be considered with some degree of certainty from the point of view of the size of the city or town to be served, and it is from this aspect that Mr. Wm. L. Robb discusses the question in a paper presented to the American Institute of Electrical Engineers at a recent meeting. Dealing first with towns of less than 50,000 inhabitants, he points out that the commercial lighting and power in a town of this class would not be concentrated, but scattered over several square miles. He therefore advises that under such conditions only three-phase alternating current, having a frequency of 60 cycles and under a pressure of 2,300 volts, should be generated. The distribution for lighting, should, in general, be single-phase, and if motors of 3 h.p. or under only were used, it would be best to operate the motors from the single-phase lighting system. When the motors required are large, three-phase motors should be used and three-phase rotary converters installed on the customer's premises should be employed for electrolytic purposes. The city should be divided into sections. In sections where there is any concentration of lighting and power, a 220-volt three-wire system of secondary wiring should be used and be supplied, if the system be small, from a single transformer, or, if the system be large, from transformers suitably located at several points. The author considers that it is not desirable in practice to cut out any of these transformers during the hours of light load. In the larger of the cities of moderate size, ranging in population from 50,000 to 200,000, a different set of conditions exists, and the problem of electrical distribution is very materially modified. It cities of this class there are generally two sections where the demand for electricity is concentrated—viz., the business section, where are located stores and office buildings, and the manufacturing district. The author considers that the characteristics of the business section make it desirable to supply at the present time with direct current, which should be distributed on the three-wire 220-volt system. This voltage is preferable to a 440-volt system, as the saving in copper in distribution if the higher voltage be used is much more than counterbalanced by the inferiority of the 220-volt arc and incandescent lamps as compared with the corresponding 110-volt lamps. The needs of a city of moderate size would not justify the operation of two power-houses, and the electricity for the business district should, therefore, in general be supplied from a rotary-converter sub-station, situated as near as possible to the centre of distribution. The main power-house should generate only alternating current. This should have a frequency of 60 cycles, be a three-phase, four-wire system, and have a pressure of approximately 2,300 volts between each phase wire and the common wire. The four-wire three-phase system is preferred owing to the saving of copper over other systems that would prevent the using of standard 2,300-volt transformers and other standard line materials. Outside the business section, the author favours the supply of electricity for all purposes on the alternating-current system. The current should be taken to the power-house from various distributing centres on the four-wire three-phase system. From these centres of distribution single-phase circuits should be run for the operation of commercial arc and incandescent lighting and small motors. Additional phase wires would have to be taken from the centres of distribution to manufacturing plants where large motors were used. When the lighting is at all concentrated, the lighting and motors should be supplied from three-wire 220-volt secondary mains, fed by large transformers, and it will be found desirable to ground the neutral wire thoroughly. From his concluding remarks we gather that Mr. Robb is distinctly in favour of the generating and distribution of alternating current rather than direct current where practicable. The author's remarks as regards 220-volt lamps are distinctly behind the times, and we doubt if, in many cases, the mixed systems he advises can compare favourably with what he calls the 440-volt three-wire direct-current system of generation and distribution.

Submarines for the United States Navy.—A good description of the new type of "Holland" submarine boats which are under construction for the United States navy appears in the *Scientific American* for the 28th ult. Compared with the six boats of this type which are at present attached to the American navy, the new submarines will be larger and more powerful boats. In place of the 45-h.p. Otto gasoline engine for driving the boat when on the surface and the 50-h.p. electric motor for use when she is submerged, the new type of "Holland" boat will be equipped with a 160-h.p. single-screw four-cylinder Otto gasoline engine and a 70-h.p. electric motor. The gasoline engine will be capable of giving the boat a speed of eight knots an hour on the surface, and the electric motor capable of a speed of seven knots when submerged. The length of the new boats will be 63ft. 4in. over all; the diameter, 11ft. 9in.; and the displacement when submerged will be 120 tons. As regards the construction of the submarines we gather that the muzzle of the torpedo tube will be closed by a watertight door, which may be lifted from within for the discharge of torpedoes. In the same forward compartment a series of air-flasks, a gasoline tank of 850 gallons capacity, a compensation tank which will be filled with a sufficient amount of water to compensate for the loss of weight due to the discharge of the torpedo, and one of the trimming tanks are to be located. Above the double bottom and below the axis of the vessel will be placed the storage batteries. These will be charged by the gasoline engine, running the electric motor as a dynamo when the vessel is at the surface. The four-cylinder gasoline engine will find a place in the rear compartment. This engine is rated at from 160 to 190 actual horse-power at from 320 to 390 revolutions per minute. Its net weight is 1,300lb. The arrangement of the cylinders is such that while one is on the expansion stroke the other three are on the suction, compression, and exhaust strokes respectively, and thus the engine is perfectly balanced and vibration reduced to a minimum. The fuel consumption is said to be 0·88 of gasoline of 0·74 specific gravity (Baumé scale) per horse-power hour. The boats are to have a radius of action at the surface of about 400 knots, and the storage batteries will have sufficient capacity for a run of 28 knots on a four hours' submersion. It is claimed that for keeping the boat under water at desired depths the use of the trimming and ballast tanks is most satisfactory, and this means of control is being adopted in the new submarines. The air supply and ventilation will be secured by the use of compressed air stored in tanks, and suitable devices are to be used for excluding noxious gases. Provision is also made for automatic control of the rudders, and, further, for preventing the vessel from taking excessive angles when diving or coming to the surface. There are at present six of this new type of "Holland" boat on the stocks for the United States navy.

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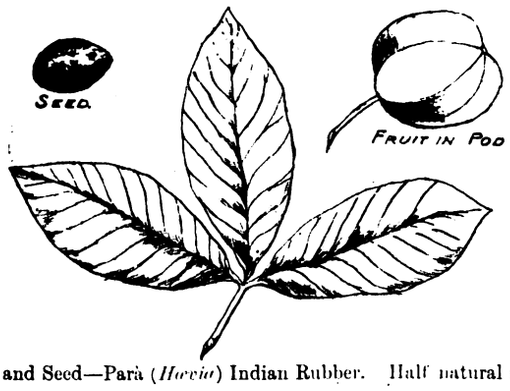
THE HŒVIA, "PARA," INDIAN RUBBER: ORIGIN OF THE INTRODUCTION AND CULTIVATION OF THE TREE.

BY H. A. WICKHAM.*

Although advertisements for sale of the seed of Parà rubber (*Hœvia*) at so much a thousand have now been commonly seen for some time past in all the planting journals in Ceylon and the East, it is not generally known that to the initiation of the Government of India is due the fact that they are within the reach of the planting community at all. Any planter who has had practical experience with the seed of this tree will understand the difficulty which had to be encountered in getting the original stock plants established in the Eastern tropics at such distance from their primitive home in the highland forests of the valley of the Amazon.

In the first instance, so far back as the seventies, the initiation of the Government of India in backing liberally the recommendation of Sir Joseph Hooker enabled me to seize an opportunity, singularly occurring, for specially chartering a steamship which happened to be up the Amazon River at the exact time of the fall of the ripe seed in the rubber forest. Had this not been so, I should never have been able to accomplish the feat of securing the large original stock from an oily seed so prone to quickly lose vitality.

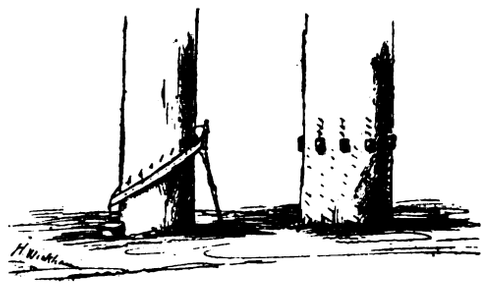


Leaf and Seed—Parà (*Hœvia*) Indian Rubber. Half natural size.

Just now there seems to be a disposition in some quarters to deprecate the efforts made by the Indian Government as bearing on the method best for the cultivation of the *Hœvia*. This seems to be exceedingly short-sighted and ill-advised. As a matter of fact, in the hands of the Government of India, through their forestry officers, all such experimental planting or cultivation cannot be calculated to be other than object lessons of the greatest value to practical planters in all the equatorial colonies, in that it will furnish them with authoritative data (especially the *Hœvia*) of a nature to be depended upon.

The true "Parà" Indian rubber (*Hœvia*) is to be found growing naturally within the immense forest-covered area of the valley of the Amazon and in the tributary rivers, including the head streams of the Orinoco. I found it abundant high up on the Orinoco, above the junction of the Guaviare (the latter stream by right, indeed, should be styled the head stream of the Orinoco). It is plentiful on the banks of the Cassiquiare—that curious bifurcation by which the Orinoco gives off a stream to the Rio Negro, and so converts Guayana into an immense island. I also found it growing in the interior betwixt the Tapajos and the Xingu. The rivers from which the largest supply is drawn now by traders are the Purüs and the Madeira. In its native forests it grows dispersed among the other forest trees, two or three trees rarely being found in juxtaposition. In appearance the *Hœvia* is a handsome tree, with straight cylindrical trunk—differing wholly from the Ulé—the Indian rubber tree (Castilloa) seen in Moskito and Nicaragua to South Mexico. The wood is soft and perishable. The bark, as in the great majority of tropical trees, is not very thick, and is of a grey colour on the surface, but when scraped, approaches the appearance and colour of a light bay horse's coat. This cleaning has to be done, as in moister regions the bark is thickly coated with growths of moss, ferns, and orchids. The seeds grow, three together, in a sort of hard pod. This pod, becoming heated by the sun, bursts when it is ripe with a sharp popping sound, and scatters the seed for a considerable distance around the tree. The seed is exceedingly oily, and the oil extracted therefrom, closely resembling linseed oil, is a valuable product. The range of temperature in the *Hœvia* forest is between 70deg. and 90deg. throughout the year. Rainfall varies considerably in different districts where *Hœvia* are found, some districts being nicely divided into wet and dry seasons, each of about six months' duration, while in others it rains more or less the year round. In such districts it is more difficult to collect the *caoutchouc* profitably, as if the stem of the tree is very wet when it is worked, the *latex*, or rubber-milk, spreads over the surface of the bark, and is in large part lost. From what has been said it may be seen that the main part of the Indian rubber must be collected during the dry season, although "siringaros," who live near their "siringals," or rubber walks, improve their opportunity by tapping their trees whenever fine days occur during the rainy season. But the trees are doubtless better for a half-yearly rest.

When the native hunter has discovered for himself a district of the forest in which "siringa" trees are sufficiently numerous and near together, he first connects them together by cutting a "picado," or path, with his



bush knife. Having thus discovered their relative bearing, he next straightens and clears out his paths, endeavouring at the same time to take in as many trees as possible in each path, and to make all the paths converge to a certain spot, where he puts up his "barrica," or curing station. This done, and having collected a supply of the old nuts of the *inaja* (Maximiliana regia) or similar oily palm nuts, he is ready to commence operations on the first fine day. There is some diversity in the manner of taking the rubber *latex* in the Amazon Valley. In some districts they prepare long strips from the inner pith of the foot-stalk of the leaf of the *inaja* or of the *bacaba* palm. These are tacked obliquely round the stem of the trees, with sharpened pieces split out of hard covering of the same leaf stalks. These strips, being smeared on the inside with wet clay, form a channel for collecting and conducting the *latex* milk into the cup placed to receive it. In the other method, which I consider the better, the cups are put on in a ring round the trunk, usually a span apart. Three cuts about 1½in. long are made in the bark with a small axe. In this way the number of cups is proportioned to the size of the tree. Tin cups are used. They are made slightly concave on one side in order to fit the convexity of the tree trunk. They are attached to the tree by the use of a piece of the ball of kneaded clay, which each collector carries in his bag. The tapping always begins as soon as there is light enough in the forest path to see by. One man is usually apportioned to each path, containing, say, 100 trees. When he has cupped his trees he sits down at the end of the path for half an hour or so, but as soon as he sees that the tree last tapped has ceased to drip the milk, he starts at a trot on the back track, detaching and emptying the cups into his calabash as quickly as possible. Speed throughout is a great object, as the milk *latex* speedily coagulates, and then can only be sold on the market for an inferior price, as *sernamby*, as compared to that obtained for that which has been smoke-cured. When the men arrive at the central hut from their different

* Planter, and some time Commissioner for the introduction of the *Hœvia* (Parà) Indian rubber for the Government of India, and inspector of forests, B.H.

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converging paths they each empty their quantum of the *latex* taken for the morning's work into one of the large Indian native earthenware pans, usually used as a receptacle. Care is taken to squeeze out with the hands all of the already coagulated curd-like masses. These are thrown on one side to be made up into balls. Earthen pots in form of miniature kilns are placed over small fires, and the "siringero" sits down to the really tedious part of his business. He drops a handful or so of the oily palm nuts down the narrow neck of the kiln, and forthwith arises a dense smoke. Taking a wooden mould—like an ace of spades in form—and holding it over the pan, he pours some of the *latex* over it in a thin film, keeping it turned, so that it shall not run off before he succeeds in setting it to an even surface, which it soon does as it is passed backward and forward through the column of smoke. This is continued, one coating after another, until he has finished the day's supply of rubber-milk. He then sticks his mould up in the thatch of the roof of the shed for the repetition of the process next day, and until he finds the thickness of the *biscuit* makes the mould unwieldly to handle, when it is cut down one side, slipped off, and stored. This is the native method, which can without doubt be improved upon under conditions of systematic cultivation.

But as all the stock of plants or seed available for the planting and cultivation of this tree in the Eastern tropics are and will be derived from direct lineal descendants of some or other of those 7,000 odd originally introduced by me at the instance of the Government of India in 1876-77, it may be well if it be recollected that their exact place of origin was in 3deg. of south latitude, and to remember their natural conditions there. This the more so since a very general error seems to have obtained that swampy or wet lands are the fitting locality for the *Hœvia*. This would seem to have arisen in that the "explorer" of a few years' experience would have some of these trees pointed out to him (naturally in answer to enquiries) growing scattered along the wet margins in going up the lower Amazon or tributaries, whereas the true forests of the "Parà" Indian rubber tree lie back on the highlands, and those commonly seen by the enquiring traveller are but ill-grown trees which have sprung up from seeds brought down by freshets from the interior.

As a matter of fact, the whole of the *Hœvia* which I procured for the Government of India were the produce of large-grown trees in the forest covering the broad plateaux dividing the Tapajos from the Madeira rivers. The soil of these well-drained, wide-extending, forest-covered tablelands is a stiff soil, not remarkably rich, but deep and uniform in character. The *Hœvia* found growing in these unbroken forests rival all but the largest of the trees therein, attaining to a circumference of 10ft. to 12ft. in the bole. These forest plains, having all the character of widespread tablelands, occupy the space betwixt the great arterial river systems of the Amazon, and present an escarped face, which follows, at greater or less distance, and abuts steeply on, the *igapo* or *vagas—i.e.*, the marginal river plains—subject to inundation by the annual rise of the great river. So thorough is the drainage of this high land that the people who annually penetrate into these forests for the season's working of the rubber have to utilise certain *lianas* (water-bearing vines) for their water supply, since none is to be obtained by surface-well sinking, in spite of the heavy rainfall during great part of the year.

The *Hœvia* is much more amenable, better adapted for systematic cultivation, planting, and working than any other of the rubber-yielding trees with which I am acquainted—for instance, the *Ficus elastica* of the Eastern tropics or the *Ficus regia* of New Guinea, and probably of Malaya; the various species of jungle rubber *vines* of the East and of New Guinea and tropical Africa; and, to a less degree, the *Castilloa* and *Ceara* of tropical America. The remarkably shapely cylindrical form of the lower trunk (the workable part of the tree) from the ground upward renders it singularly adapted to regular extraction of the rubber *latex*, and although the *latex* of the *Hœvia* does not appear to lend itself to the process of separation by centrifugal separating machines, as do the *Castilloas* of Guatemala and Southern Mexico, the "Parà" rubber, produced by a simple smoke process which has been devised, always commands the best market price.

In New Guinea I was first to discover a vine growing in the forest there which produces a very fine quality of Indian rubber. There is also a large forest tree, native of these forests, (a species of *ficus*) which yields a good class of rubber in quantity. None of these, however, being so suited (so amenable) to cultivation in plantation as the "Parà," it is much to be recommended that cultivation of the *Hœvia* be encouraged in that late and undeveloped possession of the British Empire. Now that it has been established in the East, there should be no great difficulty in bringing it down from Singapore; and I have myself seen large tracts of forest and jungle land in New Guinea which are admirably adapted for the planting of this, the premier rubber-producing tree.

The conditions required for the successful and profitable cultivation of Parà (*Hœvia*) Indian rubber are, in my opinion, that it be regarded as a plantation—a *cultivated* product—rather than as one to be planted with view of being widely disseminated under canopy of an area covered by primitive standing forest. This opinion, formed at the time of the original introduction of the *Hœvia* to cultivation at the instance of the Government of India in 1876, has been strengthened by subsequent years of planting experience; and I am convinced that any advice for the setting out of the *Hœvia* rubber tree as a self-disseminating forest product—*i.e.*, planting it out under canopy through wide areas of existing forests or jungle—will be found to be founded on fallacy. The *Hœvia* has no light-winged seed, as mahogany and others. On the contrary, although the seed is scattered to some extent around the parent tree by the bursting of the ripe triform pod, it should be remembered that the seed is in form an exceedingly heavy and oily nut, and falls thickly in a circumscribed area. Even there it is exceedingly attractive to every four-footed creature of the jungle, who devour it greedily. In its own forests it owes its preservation only, as I think, to the fact that very venomous and large snakes, the *saracucu*, are in the habit of lying in wait about the base of these trees in seeding time, and so ward off to a great degree the *agonti*, Indian rabbits, and other rodents. Forest deer, also, in my experience, are very destructive to the young plants. In any case I have found that *Hœvia* take at least three times as long to come to productive size grown under forest shade as under plantation cultivation free from top shade. Lateral shade to the extent required, at first, for formation of a straight trunk form is readily got by allowing intermediate "second growth" to come up between the young *Hœvia*. For myself, I have known these trees, when grown in the open, seed abundantly in three years, whereas they would have taken 10 to 12 to do so in the shade of the woods. It is, therefore, recommended that *Hœvia* should be systematically grown in cultivated plantation. For spacing distance I advise the half chain (33ft. by 33ft.) diagonal, as giving more root scope. This gives 40 trees to the acre. Besides being a good distance, the half chain is of practical advantage in marking off forest land, as by opening lines with the prismatic compass or theodolite, the man following can plant the seed to stake as the chain is drawn over the lines. As soon as the young trees attain proper trunk form the more light and air they are given, and the cleaner they are kept, the stouter and quicker will be their growth, and in the fourth to fifth year they would be in condition to yield to a first tapping for rubber *latex*—say, by using two cups taking on an average a pound (1lb.) of rubber during the drier season of that period. The empty tins used for "preserved milk" answer admirably for this purpose, as they are of about the right size, and being made of thin tin readily bend to the shape of the tree trunk. The operation if carefully done will not arrest the growth of the tree. It is rather shown from experience that accumulation of the *latex* in the bark of the trunk of the trees is augmented thereby. For purpose of extraction there has yet, as I think, been no better instrument devised than the ordinary carpenter's chisel, carefully used with a light mallet. The cuts (three oblique cuts one above another) should be clean cut, and should not penetrate into the wood of the tree.

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Caution should be exercised in this respect, as if the wood is injured certain species of boring beetles attack the tree. The spacing should be about a span apart, one circle round the trunk of the tree (beginning at the ground surface) for each day's tapping, and so giving an increased number of cups in use as the tree grows in circumference, with proportionate increase in yield of the *latex*.

One advantage of the close system of cultivation recommended, besides greater economy in working, is that centrally-placed curing stations can be secured. This is necessary in order that the *latex* may be quickly treated, so soon as it is taken from the trees, or much of it will become coagulated before it could be subjected to the smoke curing process, and so lose the higher market value.

The *Hevea* is naturally a large tree, under favourable conditions attaining a girth of 12ft. in the bole. To stint it in matter of root space or scope will be found to be false economy. I would, therefore, strongly deprecate closer planting than that recommended—half-chain (33ft. by 33ft.), 40 to the acre. Planted and cultivated at this distance, and giving, say, 5lb. of rubber per tree at 3s. (only) per pound, it would yield at the rate of some £30 per acre for sale of rubber alone, apart from value of the seed crop, to be converted into oil worth £25 to £30 per ton.

SOME PRINCIPLES UNDERLYING THE PROFITABLE SALE OF ELECTRICITY.*

BY ARTHUR WRIGHT, ASSOCIATE MEMBER.

(*Concluded from page 14.*)

The writer will have entirely failed in his endeavour to put the case clearly unless he has shown that the undertaking does incur a *real loss* by selling electricity under the assumed conditions of the supply to the majority at less than the equivalent of the combined two charges of standing-by and production, which, turned into the cost per unit sold, work out for the Brighton station as shown on the accompanying table and Curve IV. of the cost per unit for electricity used under varying load factors. This table and curve has been obtained by dividing the above-mentioned £9. 13s. 4d. per kilowatt demanded by the number of hours of use in the year and adding to it the production cost. The curve shows graphically the rapid reduction in total costs due to a lengthened use of the plant, and the sloping line on the same sheet shows how slowly the total cost of supplying a consumer with a given demand increases with the number of hours in the year he uses the same. It is interesting to note that the cost of producing and supplying double the quantity of electricity to that actually sold in 1900 from the same plant would only have increased the charges to the revenue account by 17½ per cent.

STATEMENT SHOWING THE SOURCES OF PROFIT AND LOSS AT BRIGHTON IN THE YEAR 1900.

To *Loss* on supply to 524 consumers who did not consume the equivalent of the use of their demanded number of lamps for 365 hours during the year :

Preparation costs—375 kw. at £9. 13s. 4d....	£3,616	
Production costs—65,860 units at $\frac{6}{10}$d.	160	
	£3,775	
Less revenue from above consumers	1,921	
		£1,855
To *Loss* on service account :		
Service costs	3,476	
Less meter rentals, etc.	1,640	
		1,836
Bad debts—amount provided.....	186	
Less balance brought forward.....	14	
		172
		3,863
To balance—net profit		507
		£4,370

By *Profit* on first hours' supply to 2,331 consumers who consumed more than the equivalent of the use of their demanded number of lamps 365 hours during the year :

Revenue from sales—1,159,878 units at 7d.....	33,800	
Less { Preparation costs—3,175 kw. at £9. 13s. 4d.	30,700	
Less { Production costs—1,159,878 units at $\frac{6}{10}$d.....	2,900	
	33,600	
		200
By *Profit* on sales after the first hour to above consumers :		
Revenue from sales—2,501,985 units at 1d.....	10,425	
Less production costs—2,501,985 units at $\frac{6}{10}$d.	6,255	
		4,170
		£4,370

* Paper read before the Institution of Electrical Engineers, Dec. 12, 1901.

In order to determine how cheaply electricity can be supplied in other towns, the writer has analysed on the foregoing principles the results of one of the most economically run municipal electrical undertakings—viz., that of Nottingham for the year ending March, 1900—and assuming, for want of proper data, the diversity factor and price of coal shown, he has calculated the load factor curve of costs. The Curve V. exhibited shows how the actual tariff favours the early-closing community to the disadvantage of the profitable later-closing classes. From the curves can be seen what might have been the correct form of tariff, also the number of hours' use of each consumer's demand, which must be paid for at 8d. per unit in order to recoup the supply authorities' out-of-pocket expenditure. It will be seen that electricity cannot be supplied without actual loss at less than 5½d. per unit to the class who only use their demand 365 hours, or, say, have a 4 per cent. load factor, and that under the tariff adopted of 4d. for 400 hours and 2d. afterwards, the three-hour consumer actually was made to pay 12 per cent. more than his fair share of the charges, and the one-hour consumer obtained his electricity at less than 70 per cent. of its cost. The losses made on the supply to the small load factor consumers are owing to our having to contend with the persistent but erroneous impression that the cost of supplying electricity is in some very near proportion to the amount consumed, as is the case with candles, petroleum, and gas, and such are the influences at work that it now seems hopeless, in some districts, to entirely resist the demand for electricity charges being based on the units consumed instead of on the commercially sound principle of a charge compounded of kilowatts demanded and units consumed.

Having now detailed the method of determining the cost of supplying nearly every class of electricity consumer met with in practice, no matter how varied their load or diversity factors, it remains to be seen whether one tariff can be devised which will fairly meet all varieties of electricity consumers, and at the same time be in a form best calculated to increase the profitable sale of electricity in the shortest

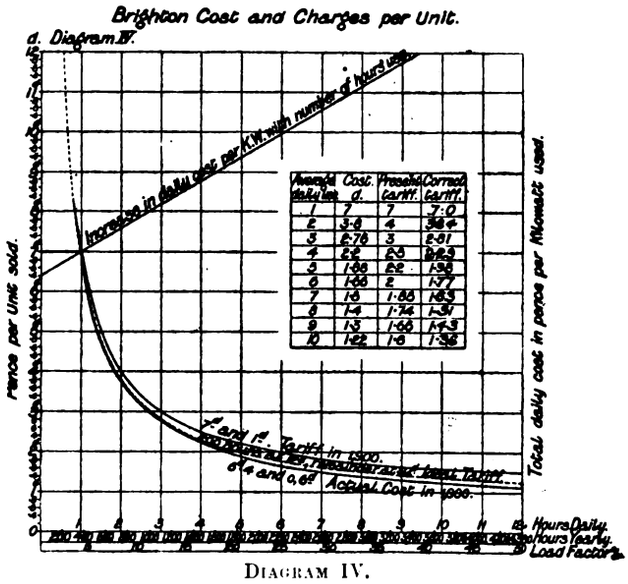

DIAGRAM IV.

possible time. The latter is, or ought to be, the common object of companies as well as of municipalities, although their respective ideas as to the amount of profit to be made, and the methods of effecting this object, may differ considerably in each case.

It is now becoming generally recognised that the chief aim of municipality supply managers should be to ensure the general use of electricity among all classes of ratepayers, consistent with making a sufficient margin to cover contingencies, whereas the only aim of a company is the annual return to the shareholders of as large a percentage on their investment as possible, consistent with the proper discharge of their obligations. However divergent these two aims may at first sight appear, on further study it will be found that owing to the special conditions governing the cost of supplying electricity above described, the real aim of both classes of supply authorities should be to make a customer of the middle-class small householder and shopkeeper. The poorer householders in a town are so much more regularly at home and make their purchases so much later in the evening that the lighting of their districts offers a much better load factor for the supply authorities' capital than that of the richer classes, who are frequently away from home, and do most of their shopping before dusk. Again, the number of artificial light users is so much greater per square mile in the poorer districts of a town as to far more than counterbalance the extra cost per lamp of connecting their smaller premises to the distributing main.

It must be noted that whilst there is generally no difficulty in finding customers among the richer classes for the electric light, owing to its greater convenience, the obtaining of the custom of the bulk of the community must always depend largely upon the fixing of a low average price, which may be seriously hindered by the adoption of a wrong tariff. The supply to the many small householders and poorer shopkeepers in any town must therefore be the first consideration in determining upon a system of charge; no steps should be taken which will raise the cost to this class above what is necessary to provide for a fair share of the ultimate net profit and of the reserve fund. A study of the curves of costs will demonstrate that electricity can be profitably supplied to the class of consumers who use their lamps on the average three or four hours per day throughout the year at a sufficiently

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low price as to make it in many cases cheaper than that of gas, as generally used by them. It is fortunate, therefore, for the future of our industry that the great majority of artificial light users belong to such a class, although the majority of present consumers of electricity do not belong to it. This is due to (1) the natural effect of the various imperfect systems of tariff until recently in vogue in many towns; (2) the practice of only running distributing mains in the parts of a town where the wealthier inhabitants reside or do their shopping; (3) the initial cost of wiring, and the present legal inability of municipalities, and the unwillingness of supply companies, to assist in this matter.

There can be no doubt that if supply authorities were to provide the interior wiring (on the principle of the hire-purchase system) and simple, enables the average user to obtain a service at a lessened annual charge, as in the case of the modern telephone charges. In other words, will the majority be more attracted by simplicity of charge, or by low annual cost, since it is easy to show that these desiderata cannot both be obtained by the same tariff. We must bear in mind that the popularity of the form of tariff does not necessarily imply the popularity of the service given. A uniform price to all classes involves the long-hour consumer paying for the loss made on the short-hour consumer, thus making the price to the long-hour class higher than it otherwise need be. It follows that a uniform charge per unit means a higher price to those who use the electric light for three or four hours, than does an equitable differential tariff. Thi taxing of the good load factor consumer for the benefit of the bad one

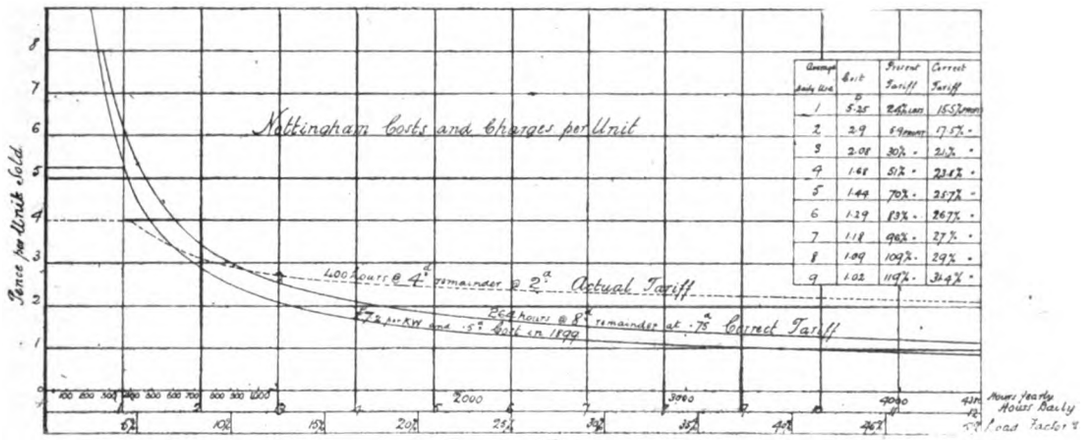

DIAGRAM V.

adopt a form of tariff which charged the small load factor consumer with at least the bare cost of supplying him, and which represented a modest scale of profits, even although it should be negative or negligible during the first two or three years, the inclusive charge for supplying the electric light to the average artificial light user could be made low enough to defy the competition of gas. The four curves, Nos. VI., VII., VIII., and IX., derived from the results obtained at Brighton, where distributing mains have been very freely run, will prove the correctness of the above assertion as to the relation of low cost and rapid extension of business among consumers who form the bulk of the middle-class community. The first two curves show how the standing-by, the production, and the average costs per unit were reduced as the total demand for the supply increased, and the effect of the persistent encouragement of good load factor consumers in improving the power station's load factor. The third curve shows the

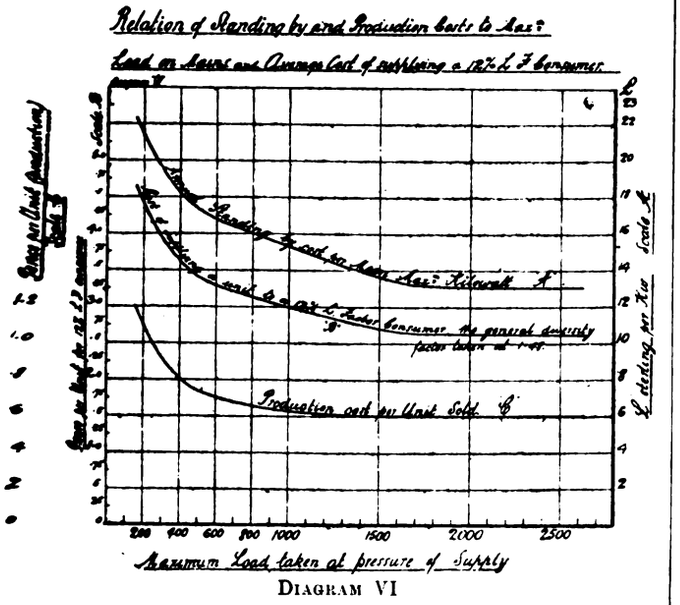

DIAGRAM VI

must encourage the latter and seriously discourage the former, which obviously implies an unnecessarily poor load factor for the whole undertaking, which in turn raises the average cost. A uniform charge, therefore, keeps the cost and charges to the majority of possible consumers unnecessarily high, and it keeps the business and load factor of the supply authority unnecessarily low.

The bad effects of the flat-rate system are further accentuated by the custom of working it in conjunction with a system of discounts to large annual consumers, without any reference to their profitability, based on the fallacious assumption that larger consumption necessarily involves greater profit. This indiscriminate discount to large consumers is another mischievous inheritance from the erroneous analogy of the gas business. How inexpedient is this discount system may be seen from an example of two consumers, one large and the other small, both paying the same rate per unit, where the former may easily be a source of loss, while the latter is a source of profit. For instance, a consumer using 1,000 lamps 365 hours per year and paying a uniform charge of 4d. per unit, will have an account of nearly £400 to pay, and most supply authorities would make a loss on his account, whilst another consumer using only 10 lamps three hours per day, charged for at the same rate, will only have an account of about £12 to pay, and will certainly be a source of profit. This large account discount system, while it encourages the custom of the few theatres, hotels, and restaurants, at the same time encourages the custom of a far greater number of large early-closing businesses and blocks of offices.

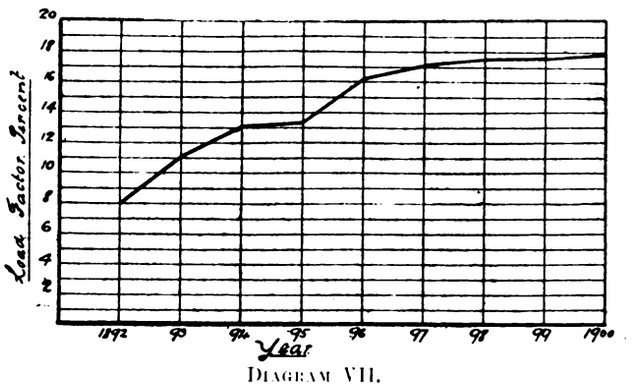

DIAGRAM VII.

marked effect of a reduction in price on the increase of business, and the other curve shows at what rate per 16-c.p. lamp per annum electricity can be supplied to even a small five-light installation, to include the use of wiring and all house service charges. From the last curve it will be seen that small premises which, on the average, require the use of artificial light for three hours per day, or, say, until 9 p.m. throughout the year, can be wired and profitably supplied with electricity at a lower price per candle-power than can be done with gas as generally used on such premises.

It remains, then, to consider whether this large class of possible consumers can be most quickly secured by adhering to the plain flat rate of charge, or by adopting a tariff in which the charges to all classes of consumers follow approximately the cost of supplying them individually—that is to say, whether the custom of the middle and poorer classes can be more rapidly obtained by means of a rate dependent entirely on the quantity consumed, as in the case of gas, or by means of a system of charge which, though less

Diagram X. shows how the present consumption of electricity at Brighton is divided among the different classes of consumers, the number of units sold to the various classes, the total amount of net loss or profit made on their custom on the existing tariff, and the net return on the capital allocated to the supply of each class. Owing to the operation of the three causes previously mentioned, it must not be taken for granted that this division of consumption among the various classes represents the natural market for electricity supply in Brighton. The dotted line indicates the writer's idea of what may be the probable form of the artificial lighting business curve when the wiring problem is dealt with, and all the poorer districts of the town are provided with distributing mains. That a differential tariff has no real retarding effect on the general growth of an electrical supply business must be apparent when it is recognised that not only *the use of electricity per inhabitant*, but also the *annual increase of use per inhabitant*, has been as great, if not greater, in Brighton than in any other town in Great Britain, and differential tariffs have been in use there ever since

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April, 1883, when the original really sound form of Hopkinson tariff—viz., an annual rent per lamp actually used in conjunction with a charge proportional to the number of hours per annum of such use—was first inaugurated. It is, moreover, very likely that the differential tariff in use will make the annual consumption per inhabitant to be more than 50 units in less than five years from now.

It will be found that whether municipalities or companies are the supply authorities, equity of tariff, with its consequent necessary concomitant of a lower average price, is much more essential to the rapid general adoption of electric lighting than mere uniformity of charge per unit. It is often urged in favour of the uniform tariff system that in an electricity supply business, as in most others, it is necessary to take the bad with the good, but the writer knows of no business consisting in the supply of one commodity which willingly carries out this happy-go-lucky policy when it can easily be avoided by a little thought and trouble.

There is another form of tariff which, although not definitely following the Hopkinson law of cost, has at times been viewed with favour by power-station managers, and is of great interest. The Kapp two-rate meter tariff is the one referred to, which charges a low rate for electricity consumed during the daytime, when the plant is lightly

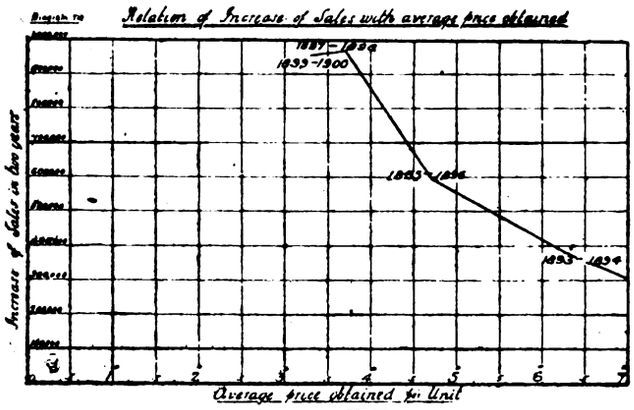

DIAGRAM VIII.

loaded, and a high rate during the evening. The inevitable effect of this form of tariff must be to discourage the use of electricity when the majority of men want it, in order to encourage the use of it when the majority of men have no use for it. It seems to have been overlooked that by charging a high rate per unit during most of the hours when artificial light is usually required, the business of every day supply to the average householder is rendered prohibitory. Surely, if a consumer once makes it necessary for the supply authority to instal

In most controversies, however, there is generally a substratum of truth underlying many of the strongly held opposing views. Thus the old tariff of a fixed price per lamp per annum was nearly as unsound as that of a uniform charge per unit has been shown to be, but the combination of the two constitutes the more correct Hopkinson tariff. For instance, the system of giving discounts on large consumptions is commercially sound provided that a correct Hopkinson tariff is blended with it. A very large consumer charged on this basis is entitled to a special discount for either or both of the two following reasons. If his account be large because of his demand being large, his large custom may materially reduce, at all events in the early years of the undertaking, when there is an ample margin of buildings and mains, the average preparation costs per kilowatt, or if his consumption be large by reason of his prolonged use of the plant, the percentage

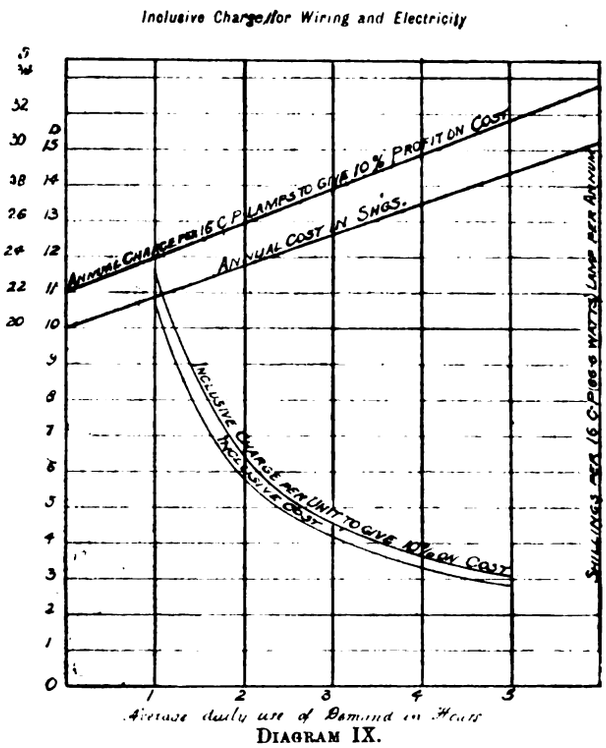

DIAGRAM IX.

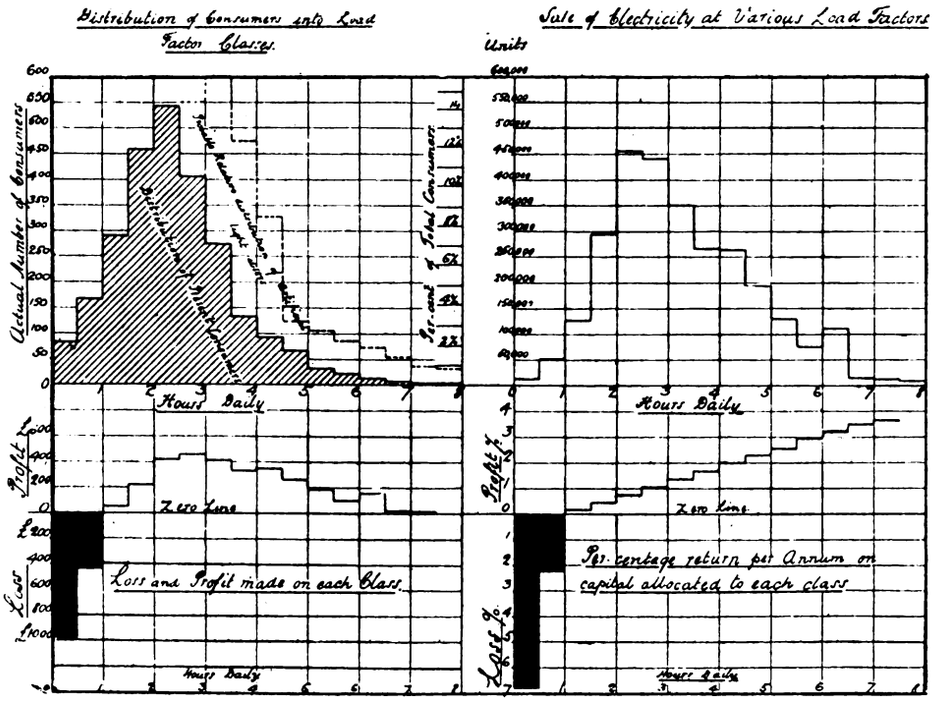

DIAGRAM X.

plant and mains for his service, he should be encouraged in every way to use such plant and mains as often and for as long as possible. The two-rate meter system aims at encouraging the use of electricity when very few can make use of it, but it also actually discourages the use when the majority want it. Moreover, it makes the profitable three-hour consumer pay three times as much for lighting his premises as it does the unprofitable one-hour consumer, instead of the latter having to pay very nearly as much as the former. In the writer's opinion, the two-rate meter system entirely underrates the value of the artificial lighting business, and is based on an exaggerated idea of the amount of business obtainable in the daytime.

of profit made on the *investment* allocated to meet his supply is greater than the average. Discount based on largeness of account should, however, be so regulated as to permit of other consumers, and the shareholders, in the case of a company, benefiting by it. As the relative reducing effect of a large consumer on the standing-by costs becomes less as the total business grows larger, the rate of discount given off such large accounts should gradually diminish as the total undertaking grows in size. Again, the Kapp system of cheap day supply can be made commercially correct provided it be associated with the encouragement afforded by a Hopkinson tariff to use the plant during lighting hours. The practice commonly adopted of

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noting a lower rate for power purposes than for light has some justification from theory, in that the diversity factor among the particular motors is generally much greater than that among artificial light users, but unless there be a check on the maximum demand made by some form of Hopkinson tariff there is a danger of the supply authority having periodically to meet a very high load of short duration when works and factories start up after meal-times or at 5 p.m. in the winter months, when the lighting and motor loads overlap. Under a system of a low flat rate for power any early-closing consumer can obtain electricity for artificial lighting through the medium of a motor-generator at a much lower price than he could obtain it direct from the mains, which is, of course, an absurd anomaly. Lastly, the system of charging entirely on the basis of units consumed can be made sufficiently correct for all practical purposes provided only that a high enough initial charge per unit consumed be made, and this high rate be maintained for a sufficient number of hours per annum to cover the standing-by and production costs charges. The losses then made on small load factor consumers will be negligible. To complete the basis on which to form our single tariff, it is necessary to consider in what manner the total requisite profit should be distributed over the charges to the various classes of consumers. For instance, will it best further the object municipalities and companies respectively have in view if they seek to make: (1) a fixed percentage of profit on the inclusive cost of each unit sold; or (2) a fixed amount of profit per unit sold; or (3) a fixed return on the capital involved in supplying any consumer, irrespective of the amount of electricity supplied from such capital; or (4) a profit derived partly from a percentage on the amount of the particular investment and partly from a fixed amount from each unit sold; or (5) a percentage of profit, whether made per unit sold or on the capital involved, varied so that the larger class of artificial light users may be specially encouraged to take a supply by a lower rate of profit being expected from them than from the smaller class.

Municipalities cannot be justified in selling electricity to one class of their ratepayers at a lower percentage of profit than to another class, unless compelled to do so by the terms of their provisional orders. There is no doubt, therefore, that in their case the first method is the correct one—viz., a fixed percentage profit on the inclusive cost per unit, including sufficient to provide for a reserve fund and contingencies. Thus, if 1 per cent. on the total capital be required for these purposes, and this is equal to, say, 4 per cent. on the total charges to revenue account, then the tariff has to be such that every unit sold has to produce a net profit equal to 4 per cent. of its inclusive cost.

A company is obliged in the nature of the case to take a different standpoint in regard to the tariff problem. In its case equity of tariff has to be subordinated to the making of adequate commercial profits and very often to expediency, but as there is generally some difficulty in raising the capital in the early stage of the enterprise, it must always be inexpedient to lock up money in supplying consumers whose custom will not ultimately produce a total return of at least 5 per cent. on it. In fact, it might be quite justified in refusing from the first to take on business which could not be shown would ultimately produce a total 10 per cent. return on the capital allocated to this said business. A company, therefore, should be careful to frame its tariff in such a way as not to spoil its future chances of expanding by quoting too low a price at first to the easily acquired early-closing consumers. Moreover, a company would be unwise in framing its tariff in such a manner that the large load factor consumer was charged at a less rate than necessary to obtain his custom, irrespective of equality of profits. Its chief endeavours should be to encourage the custom of that class which is the most numerous and the most profitable to supply at prices which can compete with gas—viz., late-shopping and middle-class residential districts.

In Great Britain, unfortunately, it has hitherto been the practice of Parliament to fix a maximum to the price paid per unit irrespective of the size of the town supplied. It would have obviously been much better for the small consumers if a limit had simply been put to the general average price of electricity in the town. Again, any consumer in this country can demand to be charged entirely on the basis of units consumed, and, moreover, need not guarantee to take more than 20 units per quarter irrespective of his demand. These three conditions necessarily raise the cost of electricity to the middle classes, as these, if they use electricity at all, have to make up the losses incurred in supplying the large consumers with low load factors and the irregular users. It is to be hoped that future provisional orders will provide some more effective means than at present exist of protecting the interests alike of the small consumer and of the supply authorities.

Dealing with present conditions, however, the maximum price per unit generally allowed in this country is 8d. From what has already been stated, it will be seen that no supply authority is wise in lowering this price to any consumer until the consumption charged at this rate covers all the standing-by charges incidental to his supply, in addition to the production costs of this part of his consumption and the proper share of the required profits. To find how much electricity any consumer has to pay for, at this maximum rate, the following calculation is necessary:

If D = the consumer's demand in kilowatts as defined in the preceding pages;
K = the annual cost of standing-by in pence of each kilowatt so demanded;
M = the maximum price allowed to be charged per unit;
p = the production of cost per unit;
u = the total number of units expected to be sold in the year in question;
$\frac{1}{r}$ = the ratio of the net profit to the total charges against revenue account;
L = the total loss in pence expected to be made on the supply to the small load factor consumers;
D × H = the amount of electricity that has to be paid for at M pence per unit before the second price P is charged;

then
$$D \times H = \frac{D\,K\,(r+1)}{M r - p(r+1)},$$

$$P \text{ in pence} = p\left(\frac{r+1}{r}\right) + \frac{L}{u - \Sigma D \times H}.$$

As an example take the Brighton figures of 1900.

Here M = 7, K = 2,320, p = 6 pence, let $\frac{1}{r} = \frac{1}{10}$, L = 880,000 pence, u = 3,726,000, and D = 1 kw.

The D × H = 403 units, or
H = 403 hours, and
if Σ D = 2,950, P = 1d.,

or after a consumption equivalent to the use of the maximum demand for 403 hours, the price can be reduced from 7d. to 1d. to produce the required margin of profit. The margin of net profit made beyond the 3 to 4½ per cent. already charged to the revenue account must be such as to allow of an additional discount being given at the end of the year to all large consumers whose accounts exceed a certain figure, and whose annual consumption of electricity has been in excess of the quantity represented by their demand used for H hours. The meter rentals should be sufficient to cover service costs, notwithstanding the frequent tendency of gas companies to abolish them.

The proposed tariff can be stated in two forms. The first is a charge of 8d. per unit, or higher where possible, for that part of the consumption which is equivalent to the use of the consumer's demand for . . . hours a year, or quarter, or month, whichever period is considered most suitable for the district, and . . . pence for any further consumption in the said period. The second form (which is equivalent to the first in the case of all but the smallest load factor consumers) is stated in terms of a yearly or monthly charge per lamp demanded and a charge of . . . pence per unit for the electricity consumed.

If L = the yearly rent in shillings of each demanded standard lamp;
M = the highest price allowable; and
P = the price per unit after a consumption equivalent to H hours use of the demand;
W = watts of standard lamp;

$$L = (M - P)\frac{W\,H}{12{,}000}.$$

Thus if M = 8d., P = 1d., and H = 365 hours, and W = 33½, then a tariff of 8d. for the equivalent of the use of a consumer's demand for one hour per day and 1d. afterwards is the equivalent to an annual rent of 7s. per lamp demanded and 1d. for every 30 hours' use of such standard lamps.

As the business grows the number of hours during which the highest price chargeable is maintained can be reduced, but the initial price should on no account be altered. This reduction of hours, in conjunction with a reduction in the lower price, P, gives all the elasticity required by the lower costs due to increased output and greater economy of production. The second way of declaring the tariff, coupled with the explanation that the demanded number of lamps is taken to be the number of standard 8-c.p. lamps, or their equivalent, which have been used simultaneously for about an hour in the six winter months, will enable any intending consumer to estimate fairly correctly his probable annual account, which he certainly cannot do when using gas. The mean of the latest three winter months' demands should form in all cases the demand on which to charge the summer consumption, and every consumer should be given the privilege of making one or two unmeasured demands per month, and of having an excess demand alarum fixed on his premises on his agreeing to pay an extra rental for same. In the case of power users and other consumers who are likely or willing to make their demands during the daytime or after 10 in the evening, greater than during the early hours of evening, a demand indicator time cut-out should be supplied and an additional rental charged. In the case of motors, the demand actually recorded is the equivalent of one which must be maintained for an hour. In practice the registered demand may be taken to be roughly the measure of the mean power taken by a motor during the hours it has been most heavily loaded. It is difficult to imagine any class of consumers who will be unfairly treated by the above tariff, or any desirable classes that cannot be sufficiently encouraged by it. It must not be forgotten that there is considerable administrative economy in having one rigid tariff, which does away with all bargaining and disputes, as in such case the whole of the onus of deciding the proper amount of a consumer's bill is borne by a simple instrument whose record can be checked, and whose upkeep is much less than that of the staff of clerks necessitated by an elastic schedule of rates. It may be here pointed out that the demand indicator involves a greater saving of time in the office than expenditure of time among the meter readers; it enables a distribution superintendent to have a very accurate knowledge of the maximum load on his mains, and enables a very perfect balance to be kept on three-wire systems. It is often objected that the charging of the high initial rate suggested will provoke great opposition, but it must be remembered that such opposition will only come either from those who now claim to be supplied at a loss, or from those who have not had the effect of the tariff in reducing their accounts properly explained to them. The former objectors are generally those early-closing business establishments which can very well afford to pay the supply authorities at least the bare cost of giving them a supply.

While permission cannot yet be obtained to raise the initial charge from the present maximum of 8d., no sufficient reason can be adduced for charging a lower figure, or for not maintaining it for the requisite number of hours per annum. All the arguments which have been

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given against a uniform rate system of charging apply nearly to the same degree to the very common tendency of municipal authorities to either lower the initial price charged on a Hopkinson tariff below the maximum price allowed in their order, or to the equally unsound practice of giving consumers the option of paying on a flat rate, should the differential one make their accounts too heavy. Both practices must, as previously explained, unnecessarily raise the price to the average artificial light user and render it more difficult for the supply authority to obtain his custom.

It has been suggested that the extra cost and loss of energy in having demand indicators installed on all consumers' premises is sufficiently great to counteract all their theoretical advantages, but as there are now many forms of combined instruments in the market which are neither more expensive nor extravagant in electrical losses than many of the electricity meters at present used, this objection falls to the ground. Moreover, it can be shown that the *general load factor has only to be increased by unity* for the extra profit thereby made to more than cover the increased annual expenditure the use of demand indicators may involve. The wiring problem will undoubtedly have to be energetically attacked if electric lighting is to develop rapidly and among the masses, and in the case of municipalities it must be recognised that the same principles govern the profitable use of a supply authority's capital inside the houses as outside them. Nothing could be more injurious to the interests of a supply authority than to make an additional uniform charge per unit for the use of the wiring. The charge should obviously be independent of its use, or only the wiring of long-used lamps should be undertaken. To charge so much per unit for the use of the wiring is to directly encourage the installation of poor load factor lamps and discourage good load factor ones. As the number of lamps wired is generally in excess of the actual number demanded, it is obvious that a charge based on the number demanded is also wrong. In the judgment of the writer, the sound method is to offer either to wire only long-used lamps or to make an inclusive rental of so much per lamp per annum coupled with a low charge per unit consumed, the difference between the lamps wired and the lamps demanded to be credited at the rate of, say, 15s. per lamp per annum, or whatever the tariff may determine, the lamp rental to be diminished after the first four years when the wiring has been paid for. Supply companies have not hitherto seriously undertaken this branch of distribution, but it is just as important and justifiable as the running of distributing mains in promising districts and the laying of house service connections. Supply authorities do not object to speculate in the way of the laying of irremovable house services, but hesitate in extending their mains up to the lamps on the ground that it is putting money on private property. But with a tariff which can compete with gas, surely the risk of idle wiring is no more than that of idle services, which in practice amount to merely 5 per cent. of those laid. Moreover, the Electric Lighting Acts protect already the supply authorities' wiring against seizure or damage. The Curve IX., showing the proper inclusive charge per lamp per annum at Brighton, demonstrates the possible aid which this way of tackling the problem may bring to the supply authorities. Wiring firms cannot be expected to give much assistance in this matter of loan wiring, as they are not so much interested in getting an increased consumption for the supply authorities as in selling expensive fittings; but if they were given a substantial interest in the first year's consumption, their valuable aid would doubtless be forthcoming. In discussing this tariff question, it is often argued that as the supply authority has had to put down a great deal of capital long before it can be used, it is commercially sound to fill the plant up with business as quickly as possible, without reference to the load factor of the business so obtained, but this implies either an extravagant initial capital expenditure, or a want of faith in the future expansion of the business, or both. If the scheme be properly laid out from the first, proper provision for repeated extensions made, and an encouraging tariff adopted, no fear need be entertained on account of the capital invested remaining unproductive for one or two years, because such loss of interest is much less than the loss which ensues from taking unprofitable business during the early years of the undertaking, which cannot easily be got rid of later on.

Before concluding this very long paper, I desire to acknowledge my sincere thanks to many engineers and commercial experts for their valuable criticisms of my often crude ideas on the subject of electricity tariffs. Particularly am I indebted to Messrs. Henry R. Beeton, W. A. Chamen, J. R. Dick, W. L. Madgen, W. C. P. Tapper, P. Tuckett, and, above all, to my late friend, Mr. Henry Reason, who did more than any other worker on the subject to drive home the fundamental truths of the Hopkinson theory, both by reason of his forcible and charming eloquence and by his great manufacturing skill in developing a simple means of carrying the theory into practice.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

445. The diagram (Fig. 1) shows the present connections of electrical bells in a mine. All the three wires are bare. The two wires B and C are suspended on porcelain insulators, but the return wire, A, is allowed earth connection. By bringing the two wires

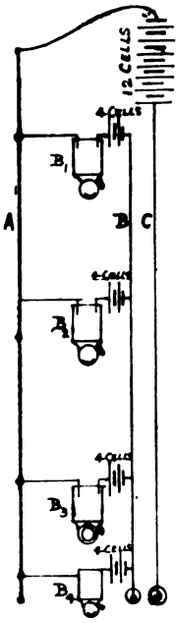

FIG. 1.

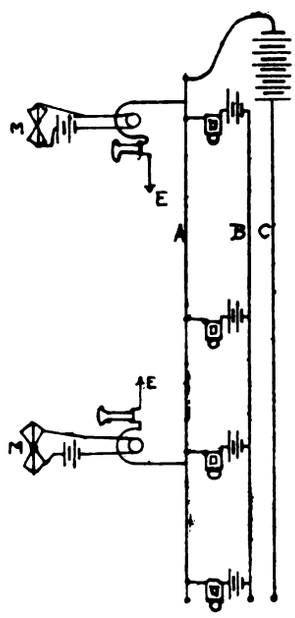

FIG. 2.

B and C together at any point, all the bells ring. The bells are about 500 yards apart. It is now intended to add telephone connection between B_1 and B_3. Would it do to insulate the wire A and to connect the telephones as in Fig. 2?—K. B.

446. Are there any reasons, and what are they, why japanned iron clips should not be used for lead-covered wires?—E. J. F.

ANSWERS

Question No. 439.—The switchboard of a large warehouse installation which has its different circuits controlled by two-way switches, is fed by the company's own dynamo and the corporation supply. The corporation supply is the three-wire continuous current, and all the three cables come to the board. The 'bus bars, which run horizontally at the back of the board, are four in number. The top one, No. 1, and No. 3 are fed by the dynamo, No. 2 by the corporation middle wire, and the bottom one, No. 4, is cut into two, and takes the two outer wires of the corporation supply. A smaller dynamo is about to be put down to take the day load, the corporation supply to be still kept connected to the board. What will be the simplest way of connecting the new dynamo to the existing board, so that all possible combinations of the two dynamos and corporation supply can be avoided?

Best Answer to No. 439 (*awarded* 10s.).—Fig. 1 will generally represent the original arrangement of the switchboard, although the number of branch switches may, and probably will, be largely increased. In the sketch the 'bus bars are shown dotted, as we are told that at the back of the board the two single-pole branch switches for each circuit are placed tandem wise, and will be joined together to act as a double-pole fuse. The advantage of this arrangement is that any one circuit may at will be supplied from the dynamo or the corporation mains. In the sketch D M stands for dynamo main, C M corporation main, S switch, F fuse. It will be noted that on the top of the board is a double-pole main fuse and switch controlling the dynamo supply, also the necessary ammeter and voltmeter.

If, now, for day load purposes only a smaller dynamo is put down, the two machines will never be run at the same time, and the simplest arrangement would be that shown in Fig. 2. Two double-pole main switches and fuses are now inserted, one for each dynamo, and below this is arranged a double-pole two-way switch. Thus either dynamo can supply 'bus bars 1 and 3, and there is no possible chance of ever getting the two machines in parallel, while at the same time only one voltmeter and ammeter will be required. This arrangement will be satisfactory if the dynamos are either compound or shunt wound.

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f, however, while the additional dynamo is primarily down for day load purposes, it is required to assist the ge dynamo at times, the former arrangement will no ger be suitable, and it will be necessary to adopt the thod shown in Fig. 3. This is the ordinary arrangement parallel running: the main fuses and switches are placed by circuit breakers; and two ampere-meters and

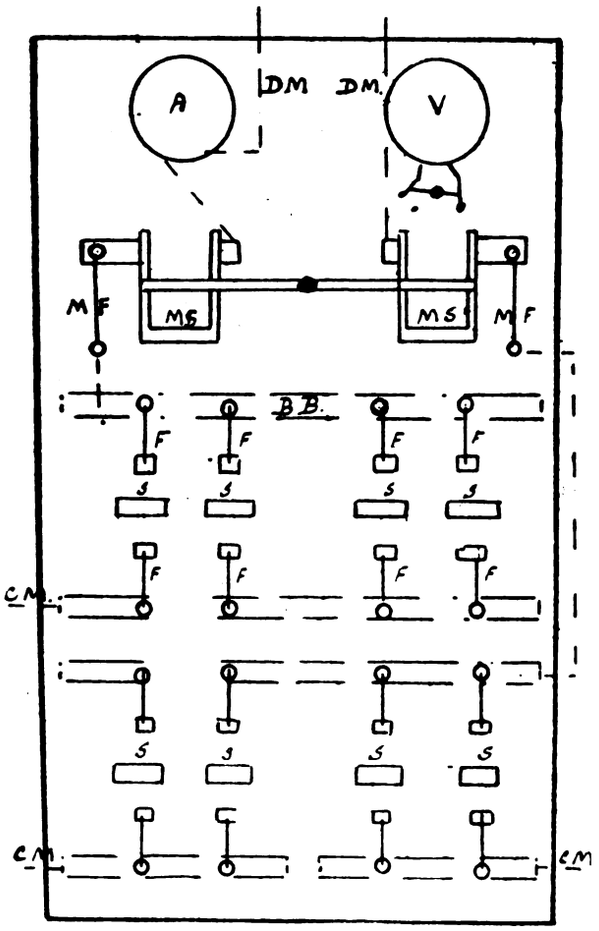

Fig. 1.

voltmeters are required, in order that the attendant may regulate the load of each machine. If the dynamos are compound-wound, an equalising switch, marked E S on the sketch, will be required.

In both of the above arrangements, the lower parts of the board will remain as shown in Fig. 1, and it will still be

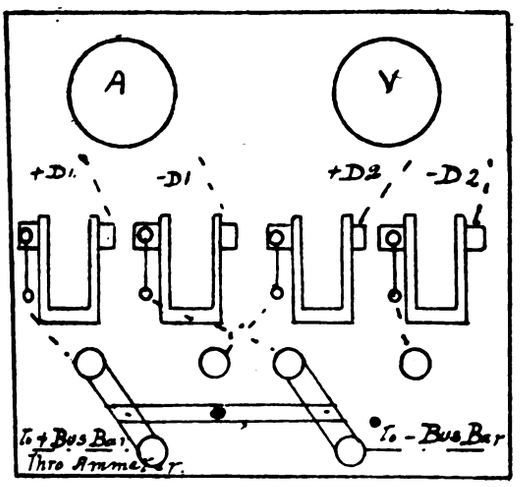

Fig. 2.

possible to supply any circuit at will from either the private plant or the corporation mains without any chance of making a disastrous connection.

There remains one other suitable arrangement: two additional 'bus bars must be added to the switchboard, and there must be an equal pitch between the bars. Numbering the bars from the top downwards—Nos. 1 and 4 must be connected to one dynamo; Nos. 2 and 5 to the second dynamo; and Nos. 3 and 6 to the Corporation mains. Vertically down the switchboard will run metal bars, one for each branch circuit. These bars must be made in two, and joined in the middle by a suitable insulating coupling. On these bars must be mounted double-pole switches, the two component single-pole switches being held apart at a

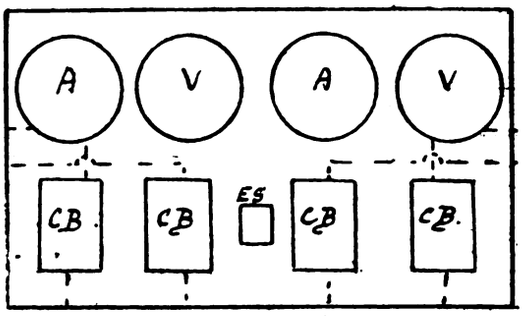

Fig. 3.

distance equal to the pitch between the switch studs of No. 1 and No. 4 'bus bars. It will then be possible to slide the switches up and down the rods, so that they can be connected to any pair of 'bus bars required, but never to two 'bus bars which do not form a pair. Of course, the bars must be so arranged that the switch can only be held in position in such places as will enable them to make true contact with the switch contacts. Two ammeters, voltmeters, and double-pole main switches and fuses will be required with this arrangement. This system is due to Mr. Storey, of Lancaster, who some years ago patented a similar device, and it readily enables the operator to connect any branch circuit with any source of supply. It is, moreover, very simple, and, if properly arranged, perfectly safe; yet for general work the advantage is not very patent, and the writer would prefer the arrangement shown either in Fig. 2 or Fig. 3.—M.

Answer to No. 439 (*awarded* 5*s.*).—It is somewhat difficult to answer this question from the data given, as the type of generator is not mentioned. Neither is it made clear in stating that the small machine is to take the day load, whether or not this load is at present taken solely by the existing large machine, by the corporation mains, or whether it can be transferred to either system at will by means of the two-way switches mentioned. It is, therefore, assumed that two shunt machines are intended, and that the two-way switches mentioned are for the purpose of throwing over a circuit or circuits from the corporation mains to those of the dynamo, or *vice versâ*. If this is so, it appears all that is necessary to do is to so connect the small dynamo that it will run in parallel with the larger

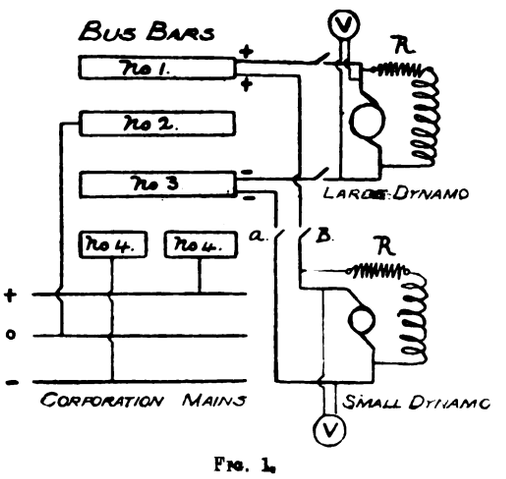

Fig. 4.

one on the existing 'bus bars. To do this, mains should be run from dynamo to 'bus bars and two single-pole switches inserted at A and B, as in diagram (1). A shunt regulating resistance, R, and running-up voltmeter, V, should also be placed in circuit as shown. Either of the two machines can then be run on the load at will, or the two can be run together in parallel.

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To change over from large to small dynamo, proceed as follows: Close switch, A, and run machine up to speed, regulate volts of incoming generator by means of the shunt resistance until they are equal to voltage on mains, then close switch, B. The load can now be taken over by gradually increasing the field of the incoming generator and decreasing that of the outgoing one until all load is on small machine, when the large one can be switched out. If care is taken to switch the incoming generator in at the right voltage, and also to increase its field gradually as the field of the other machine is gradually decreased, the operation of changing over machines will not cause any fluctuation or jumping of the lights. The change over from small to large dynamo is, of course, effected in the same manner. In case no provision is made on the existing switchboard for changing over the circuits from one system to the other, it would probably pay best in the long run and make the most satisfactory job to redesign the board so that this could be done. All or part of the lights could then be supplied with current from either system, the sections on one system being quite independent of those on the other. Diagram 2 shows a method of doing this. A, B, C, D is a two-pole change-over switch of the knife pattern, the dynamo leads are connected to the terminals A B, the lighting circuits to the centre terminals, *x y*, and the terminals C D are connected, one to the outer, the other to the middle wire of the corporation supply. When the blades are in the position A B (shown by black lines) current is supplied to the lamps by the dynamo; when the switch is thrown over to

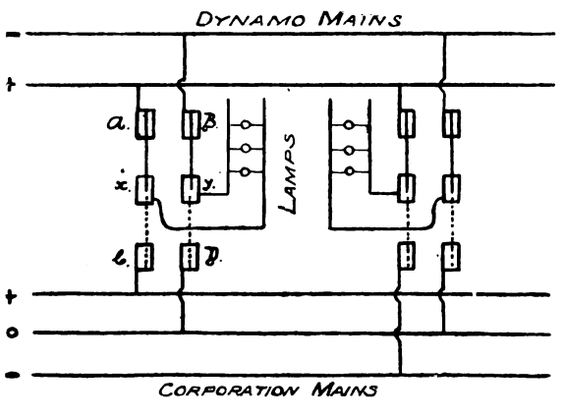

FIG. 2.

the position C D (shown by dotted lines) current is supplied by the corporation mains. A number of subdivided and separately fused circuits may be connected on one switch and main fuse, and unless the installation in question is a very large one, four such main switches would probably suffice; this number, however, would depend largely on the circumstances of the case and the requirements of the corporation engineer as to balancing, etc. The switches should be arranged as in diagram, where one switch is shown connected to positive and neutral, the other to negative and neutral; in the case of two switches the lamp circuits should be divided up, so that each switch takes as nearly as possible half the total load; if more switches are used, the load on each side of the three-wire system must be balanced in the same way. If this method is adopted it is impossible (if the connections in the first place are correctly made) to get any combination of the two systems, as the connections on one system are completely broken before those on the other are made. The writer has used this method in a large private installation of 3,000 lamps with perfect success.

If arc lamps or motors are in circuit, due regard must be paid to polarity when connecting up to the corporation mains in the first place, otherwise, when the circuits are switched over, a reversal of polarity may take place; with incandescent lamps only, this precaution is unnecessary.—A. D. F.

Answer to No. 439 (*awarded* 5*s.*).—The combinations that are required on the switchboard are apparently as follows: One must be able to switch the corporation current on to any circuit at any time without the least risk of disastrous consequences as to the dynamos. The small dynamo which is to be installed will run during the day, and must be able to supply any of the circuits. The large dynamo will take the night load, and must supply all or any of the circuits. The only alteration that is required on the existing board is that a change-over switch or a two-way switch should be fixed capable of carrying the total current. The switch, G, shown on the sketch is really no longer required. The fuse connected to it—*i.e.*, the positive main fuse—has to be of sufficient size to safeguard the larger dynamo, and does not, therefore, protect the smaller dynamo from an accidental short-circuit properly. For this reason it will be better to fix a single-pole fuse, L, in circuit with the small machine. When the main change-over switch is made to M then the smaller dynamo, No. II., supplies current to the positive 'bus bar, A. From thence the current passes to the circuits *a*, *b*, *e*, *f*, in sketch, returning at *a*, *b*, *e*, *f* to the negative bar, C, and from thence to the main switch and fuse, F, to which is attached the negative pole of No. II. dynamo. When, however, the switch is made to N, dynamo No. I. supplies current to the circuits in exactly the same manner as the No. II. machine does.

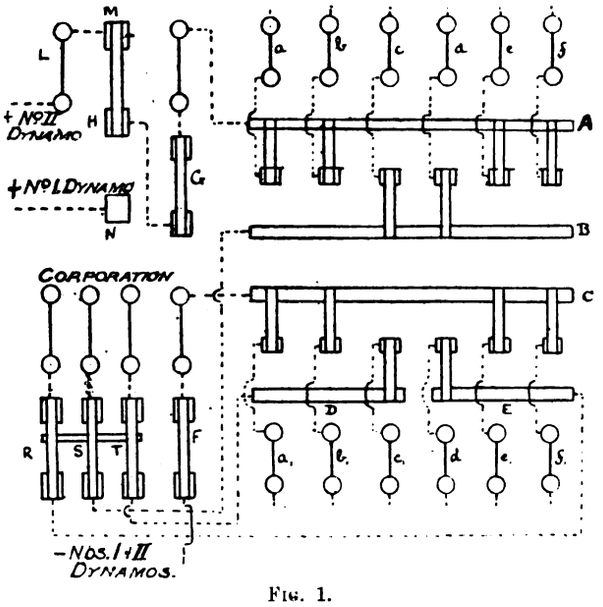

FIG. 1.

The corporation switches and fuses are just the same as before. A change-over switch is preferable to an ordinary two-way switch, as a quick break can be obtained. Where possible it is best to take the main cables first to the switches—and not to the fuses, as is often done—for then the fuses can be quickly and easily replaced without risk of shock or burnt fingers. The above arrangement will be the simplest and the best possible, and there is no possibility of any complications occurring through carelessness. "H. H." may prefer to fix a double-pole change-over switch instead of a single-pole one, but that is merely a matter of taste.—W. A. T.

Answer to No. 439 (*awarded* 5*s.*).—Although the above question takes considerable space in explaining itself, it is lacking in not giving further detail—viz., the capacities of the corporation mains, the company's present dynamo, and also the proposed additional dynamo. Had these been given, they would have considerably helped to a more satisfactory solution of the question. However, the question states that the different circuits in the warehouse are controlled by two-way switches. The writer takes this as indicating that the capacity of the company's dynamo is equal to the capacity of the corporation mains, and that the centre studs of the two-way double-pole switches—*i.e.*, presuming these are double-pole two-way—go off to the lamps (see sketch, Fig. 1), and that the top and bottom contacts of the switches are connected to their respective 'bus bars, as stated in the question.

The question further states that the new dynamo is to be put down to take the day load. This leads one to infer that the present plant is in the daytime engaged in charging a battery, or perhaps engaged in power work.

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nsequently, if the new dynamo were connected, for tance, to 'bus bars Nos. 1 and 3 (present dynamo 'bus s), if these 'bus bars were required to do other work at same time, and assuming these are of a sectional area ficient only for present arrangements, it is therefore possible to connect the new dynamo to these and get e full capacity of the new dynamo and also the present e, without increasing the sectional area of these bars; however, these are of sufficient sectional area to take e capacity of both dynamos, the present arrangement board may do, with the addition of main switch r new dynamo, by assuming that only one dynamo required at the same time—that is, the main switch the present dynamo must be closed when the main vitch of the new dynamo is open, or *vice versâ*, so as prevent any possible combination of the two when

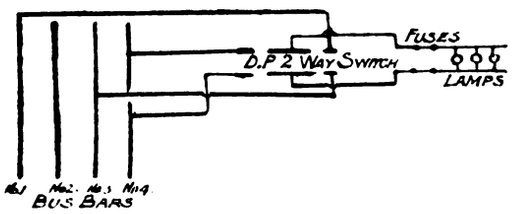


Fig. 1.

eeding their respective circuits. Regarding the 'bus bars o which the corporation mains are connected, if the main witch controlling the supply could be switched on or off it will, the new dynamo may be connected to these bars, nd thence to a main switch and off to the day circuit. This is assuming that when the day load is required the corporation mains are switched off, or that we are restricted by present arrangements in not being able to have both these on at once, without again having a combination of the two. This still restricts us to the conditions as stated previously.

The writer, however, thinks that with the data given in the question the more simpler plan will be to connect up as shown in the sketch (Fig. 2); thus the present board would require only one main switch equal to the capacity of the

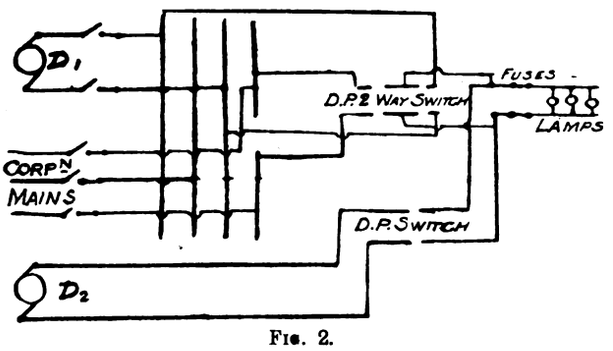


Fig. 2.

new dynamo, the mains of the same coming directly to the lower contacts, while the mains from the top contacts would be tapped on the circuit which it is desired to control, or *vice versâ*. A glance at the diagram of connections will make this more clear.—J. W. M.

Question No. 440.—In connection with my installation is an overhead tank, water being drawn from the canal by a steam pump. I intend putting down a motor-driven pump, and should like to know if it is possible to keep the tank full by the automatic starting and stopping of the electric pump.

Answer to No. 440 (*awarded* 7*s.* 6*d.*).—Although it is possible to automatically start and stop a motor-driven pump supplying water to a tank as the level of the water rises and falls, the successful working of any device capable of fulfilling the requirements of the question, depends much upon the amount of attention it is likely to receive, which can also be said of most automatic arrangements.

The following is a method of automatically starting and stopping a motor-driven pump by means of an electro-magnetic device. The motor in this case is series wound, as is generally the case with motors used for driving pumps. In Fig. 1, T is the tank in which a float is suspended by a small wire rope running over pulleys, P^1 and P^2, as shown in sketch, the other end of the rope being connected to the handle of a quick-break single-pole switch, O, which is pivoted at U. To this handle is also attached a weight, W, which must be lighter than the float. This tends to keep the switch in its off position. The positive main is connected to the switch blade, the jaw, C, of the switch being connected through the coil, H, to the negative main. As the coil, H, is across the mains, it must have a high resistance. The arm, R, of the motor-starting switch is pivoted at *p*. To this arm is fixed a plunger, *l*, which is suspended

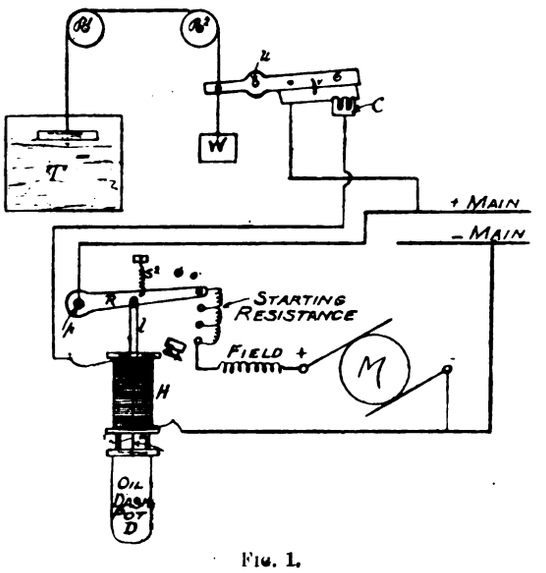
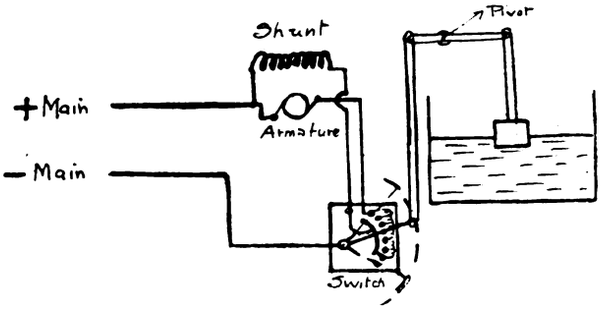


Fig. 1.

over the shunt coil, H. The plunger is also connected to the dash-pot, D, by a brass rod running through the coil, H. The spring, S^2, controls the force by which the arm, R, is drawn over the contacts by the plunger. When the level of the water in the tank drops, the float descends drawing up the switch arm, O, causing it to make contact with jaw, C. When this happens, a current flows through the shunt coil, magnetising it. The plunger, *l*, is then drawn down into the coil, moving the arm, R, over the switch contacts, against the force of spring, S^2, thus starting the motor. The dash-pot, D, offers a resistance to the descent of the plunger; by so doing it prevents the motor circuit being made too quickly, but it does not offer any resistance to the plunger being pulled up by the spring, S^2, when the current in coil, H, is stopped. As the tank fills up the float rises, and the weight, W, descends, pulling the arm, O, down till it breaks circuit, which it does quickly by the action of its own spring, V. —J. W. R., SWANSEA.

Answer to No. 440 (*awarded* 7*s.* 6*d.*).—The above shows an arrangement which would suit the requirements. The motor is shown shunt-wound, and has a resistance in circuit with it capable of carrying continuously the full current of the motor. The resistance is connected to a multiple-way switch, whose centre is connected to the main, the other main being connected to the common terminal of shunt and armature. The contact arm of the switch has its end attached to a vertical lever, which has



an up and down vertical travel imparted to it by means of a horizontal lever to which its upper end is attached, and whose movement is obtained by attaching it to a float in the water of the tank as shown. The ratio of the two parts of the horizontal lever must be such that the travel of the float between full and empty (or between full and the point to which the water is to be permitted to sink

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when the tank is as empty as is intended it ever should be) produces exactly the travel of the contact arm of the resistance switch at the end of the horizontal lever connected to that arm. The float must be sufficiently heavy to pull up the arm as the water sinks, and the water must buoy it up sufficiently when rising to cause it to push down the switch contact arm.

The switch is shown with a separate contact arc for the shunt, on which the arm always makes contact, and which is connected to the first stop of the resistance switch so that when the circuit is broken the shunt current dies down gradually, because the shunt and armature still form a closed circuit through the regulating resistance. This contact arc might be left out if desired, and the shunt connected direct to the first resistance contact. As resistance was cut out of the armature circuit it would be inserted in the shunt circuit, but it would only be a small percentage of the shunt winding resistance, and would make little difference in the speed or efficiency.

After this explanation the action should be clear. When the float is lowest the switch is right up, and the armature is "full on" the mains, and is therefore doing its greatest power. As the float rises the contact arm goes down, and the motor will go slower and slower, until when the float is at the top the arm is on the "off" stop of the switch. There will be practically no spark on breaking circuit, as the shunt and armature are still connected, as shown, and the shunt current is, therefore, not broken suddenly, as the armature continues to work as a generator. Suppose the water empties out too fast, then the float will be at its lowest, and there should be a stop to keep it in this position, else the circuit would break at the top side of the switch, and the pump would cease work just when it is most wanted. This, of course, should occur only exceptionally, as ordinarily the motor will be designed large enough to keep the tank full This arrangement should work very well.—T. C.

Answer to No. 440 (*awarded* 5*s.*).—A simple method of obtaining the results required by the questioner would be tc have a float arranged in the tank, so that when the level of the water falls it will complete the circuit to the motor through resistance, which will gradually be cut out should the water-level continue to fall; but with this device, as the pump would naturally be capable of delivering a greater quantity of water than the amount used from the tank, the motor would nearly always have resistance in series with it, except when a quantity of water was drawn from the tank in a very short time.

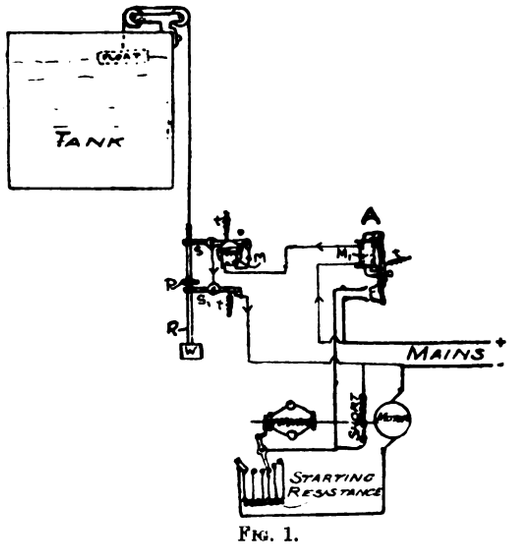

FIG. 1.

A much better arrangement is shown in Fig. 1. It consists of a float, to which is attached a light chain that is passed over two grooved wheels and connected to a metal rod, R, and weight, W. The metal rod passes through loops in the two switch arms, S and S_1, and is fitted with a stop, P, which will not pass through the loops. When the water-level falls to a certain point, the float pulls the stop on the metal rod against the switch S and closes it; this switch is drawn and held full on its contact stud by the electromagnet, M. As soon as any contact is made, it completes the circuit to the coil, M_1, of the magnetic switch, A, causing it to close and make the circuit to the motor through resistance. The motor then starts up, and on gaining enough speed some resistance is cut out by an automatic device — shown in Fig. 2 — this makes the motor run faster, which in turn causes more resistance to be cut out, and so on till the motor is running at full speed, when all resistance is cut out. The water-level will then rise until the stop comes down against the switch S_1 and opens it, thus breaking the circuit of the coils, M and M_1, which are connected in series. This allows the switches, S and A, to be pulled open by their springs, *t*, and thereby stops the motor. The switch S_1 differs from S: it has no coil and is held closed instead of open by its spring, *t*. The automatic device (Fig. 2) referred to for cutting out resistance as the

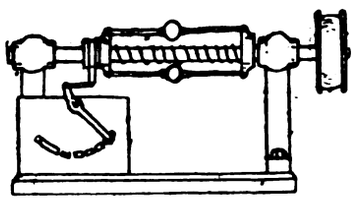

FIG. 2.

motor gains speed consists of two weights, each connected by links to a fixed and a movable sleeve on a shaft. These two sleeves are held apart by a spiral spring, but as soon as the shaft and weights revolve the latter fly out by centrifugal force and draw the movable sleeve along the shaft more and more as the speed increases. This movable sleeve is grooved and fitted with an iron or brass strap, which does not revolve, but is connected by a link to the switch arm, and pulls it over the contact studs as the speed gets up. The apparatus is driven off the motor shaft by a small belt. If it is necessary to keep the tank very full, the two switches, S and S_1, must be placed close together. With this arrangement the pump can be any distance from the tank, to which it must be connected two small wires sufficient to carry the current taken by the two coils, M and M_1.—A. J., SWANSEA.

Answer to No. 440 (*awarded* 5*s.*).—In the absence of data concerning the sizes of the tank and pump, I can put forth only the bare principle of a contrivance which will answer the above requirements. Figs. 1 and 2 show the front and side elevations respectively. For the sake of clearness the tank is not shown in the former. From these sketches it will be seen that I recommend a liquid resistance, my recommendation being based upon its reliability and durability. The secret of the successful working of this kind of resistance lies in the adoption of a low current density. This should not exceed ·6 or ·7 ampere per square inch of plate. Probably the best, and certainly the cheapest, electrolyte is made up of 95 per cent. water and 5 per cent. common washing soda. It must be borne in mind that with the percentage of soda and the temperature of the liquid the resistance varies enormously. Experience shows that the best material to employ for the plates is iron.

Referring to the sketches: A is a casting fastened to the top of the tank by the set-screw, B, and, as is shown, forms a double bearing for the shaft, S. The floating ball, D, is made of copper, and has a nipple soldered to it for receiving the rod, R. The latter is made of wrought iron, and has a boss forged on the end of it which is drilled to fit the shaft, S, to which it is fastened in the position shown by a taper pin. W is a sprocket wheel, secured to the shaft, S, by a key or set-screw. The resistance box consists of two cells, each of which contains a funnel-shaped casting resting upon two thin strips of wood. The box is made of well-*seasoned* wood lined with lead. Two strips of wood project upwards from it, each with a perpendicular slot cut in it for the cross-piece, E, to move up and down in. The two cones, F F, are made of cast iron. Each is tapped to receive a rod, which is secured at its other end to the wooden strip, E, by means of two nuts. Electrical connection is made between the two rods by a

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strip of copper, each end of which is clamped under the lower nut of either rod. The chain, H, is made up of links of cast iron. One end of it is fastened to the weight, G, the other to the cross-piece, E. The variable weight, G, is of sufficient value to permit the ball, D, to actuate the apparatus either by its weight or its buoyancy. The terminals, T T, are tapped into the lower plates, and then

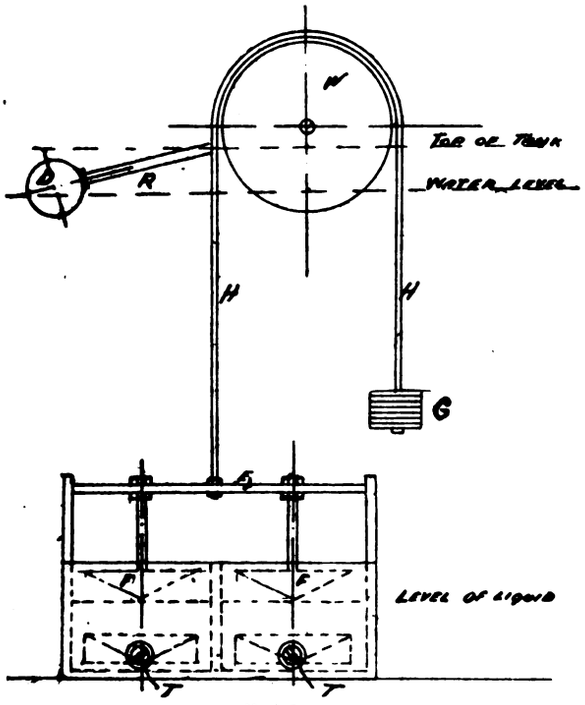

FIG. 1.

carried through bushed and watertight holes in the side of the box. It will be seen that when the tank is full the ball is lifted to the position shown in the sketches, and the cones being held out of the liquid no current can flow through the controller, and, of course, the motor is stopped. If, however, water is drawn from the tank, the ball, by virtue of its weight, falls, and being secured to the shaft, S, it

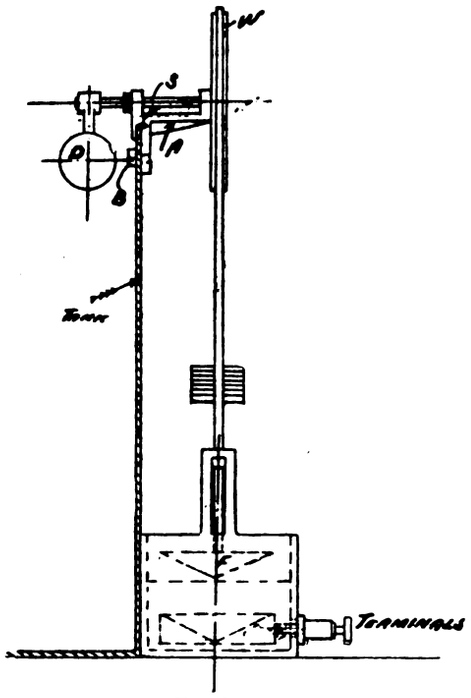

FIG. 2

rotates the sprocket wheel, W, which lowers the cones into the liquid, and thus, through the two cells in series, the current enters at one terminal and leaves at the other. The lower the ball descends the more resistance is cut out of circuit, until, when it has moved through about 45deg., the two plates are in actual contact, and the motor attains its highest speed. If the current is considerable, extra contacts should supplement the contact between the iron plates, but for the current required by motors of 2 h.p. or 3 h.p. these are superfluous.—S. F. B.

THE SOLID SYSTEM—A REVERIE.

In their long and narrow bed
They were laid at early morn,
They were buried with the dead
That will lie till Gabriel's horn.
Not a note of "Saul's" Solemnal,
Nought of crape was worn.

Not a bearer stopped to sorrow
As the earth was shovelled o'er,
For we knew that on the morrow
They would be alive once more,
And their lights should shine before men
Lighting up the golden shore.

Monuments may glow the rogue,
Headstones lie with morbid zeal;
Stones are not with us the vogue,
What we *cut* we know and *feel*.
Just suffice a pinewood coffin,
Clothed with pitch from head to heel.

Let the moral truly show
We should pass each factory test;
Then, when we are put below
To our never-ending rest,
All the epitaph we need is:
"Seldom cursed and often blest,
——— cables are the best."

—J. H. C. B.

FORTHCOMING EVENTS.

SATURDAY, JAN. 11.

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "A Coal-Burning Internal-Combustion Engine," by Mr. P. F. MacCallum.

Manchester Association of Engineers.—At 7 p.m., ordinary meeting. The president will deliver his inaugural address.

MONDAY, JAN. 13.

Faraday House.—Prof. C. A. Carus-Wilson on "Dynamo, Motor, and Transformer Construction" (Lecture I.).

Society of Arts.—At 8 p.m., Cantor Lecture. Dr. Samuel Rideal on "The Purification and Sterilisation of Water" (Lecture I.).

Telephone Conference.—At 3 p.m., at the Guildhall, City Conference on London Telephone Charges.

TUESDAY, JAN. 14.

Institution of Electrical Engineers.—(Manchester Section): At 7.30 p.m., ordinary meeting. Paper: "Feed Water for Boilers," by Mr. G. J. Wells. (Glasgow Section): At 8 p.m., ordinary meeting. Paper: "Practical Notes on Continuous-Current Distributing Mains," by Mr. John C. A. Ward. (Students' Section): At 7.30 p.m., ordinary meeting. Paper: "Single-Phase Induction Motors," by Mr. H. F. Northcote.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper: "American Workshop Methods in Steel Construction," by Mr. H. B. Molesworth.

Royal Institution.—At 3 p.m., Dr. Allan Macfayden on "The Cell" (Lecture I.).

WEDNESDAY, JAN. 15.

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "Elliptographs," by Mr. Frank J. Gray.

Royal Meteorological Society.—At 7.45 p.m., at the Institution of Civil Engineers, annual general meeting. Address by the President on "The Element of Chance in Relation to Various Meteorological Problems."

FRIDAY, JANUARY 17.

Institution of Civil Engineers (Students' Section).—At 8 p.m.: Lecture on "The Theory of Heat-Engines," by Capt. H. Sankey, R.E.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. Paper: "Modern Machine Methods," by Mr. H. F. L. Orcutt.

Royal Institution.—At 9 p.m., the Right Hon. Lord Rayleigh on "Interference of Sound."

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "Manchester and Liverpool High-Speed Electrical Railway," by Mr. F. B. Behr.

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TO CORRESPONDENTS.

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THE BRITISH INDUSTRIAL CRISIS.

It has become the fashion amongst certain sections of the English Press to collect series of articles on the decay of British trade. These articles are, of course, all written by experts, but the internal evidence of the same is apt to raise the question as to the degree of expert knowledge which their writers possess. We do not dispute that in a great number of instances the increase of foreign competition can be clearly shown, and that in consequence certain departments of our commerce are not increasing. The reasons for this are numerous, and it is of the highest importance that these reasons should be understood by all concerned, in order that steps may be taken to improve our manufacturing facilities and to extend our commercial interests in all quarters of the globe. Intimately connected with this question as our policy of free trade is, it is interesting to note how few of these experts recommend a protection policy as a means of increasing our trade. For instance, while we are now importing in large quantities automatic machine tools from the United States as a means of increasing our manufacturing facilities, the converse can hardly take place. Only a fortnight ago we noticed a complaint in an American journal that the cablemakers in that country could not compete with our own because, amongst other things, of the high import duty which they would have to pay on English-made cable plant. It comes as a great refreshment, after the many articles referred to above, to read the remarks made by Mr. Joseph Chamberlain in Birmingham on Monday last. This gentleman's reputation as a manufacturer before he entered the political arena was exceedingly high, and the successes of his relations in the same field are remarkable. The history, for instance, of the manufacture of screws is closely bound up with the name of Chamberlain. A perusal of this history will show that while the wood screw as at present known was perfected in America, its manufacture was so keenly taken up in this country that screws were largely exported to the States. Reverting to the speech above mentioned, Mr. Chamberlain pointed out that for the last five years we have enjoyed an unparalleled condition of trade, and that although there are some signs that trade is not quite as brisk as it was, the prospects were still extremely good. In order, however, that we may keep the trade we have, and increase it as our population increases, both the employers and employés must do their best. Higher education of employers is, as Mr. Chamberlain pointed out, most important, and the University of Birmingham is an example of what that city is doing towards higher scientific education. The concluding remarks on this subject of Mr. Chamberlain dealt with the question of the employés. With his accustomed straightforwardness, Mr. Chamberlain, while commending the principle of trade unionism, and the practice of the majority of these unions, stated that "the theories of some of the leaders of trade unions would, if they were given practical application, be simply disastrous to the interests of the working-man. Any attempt to limit production is fatal to trade. The men want to get the highest wages, but they must do the best work." It is the bringing down of all workmen in any particular trade to a dead level as regards wages which has such a bad influence on certain classes of workmen. With this supposed equality of value there comes the tendency for a man to look upon his membership in a trades union as being all that is required to secure for him the regulation wage, independent of his individual efforts. The next tendency is to restrict the output of the members of that union to be in accordance with the capabilities of the least efficient men. This whole

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question is treated very differently in the States, as there in manufacturing works it is frequently the practice to increase the remuneration for making any particular article in the factory with the number of articles which the workman is able to complete in a given time. The result is that the inefficient man is quickly eliminated. We notice that the British Westinghouse Company has adopted a somewhat similar course in connection with the building of their new works at Manchester. A vast amount of bricklaying had to be done, and the company determined to be independent of the trades union officials. Their first step to this end was to give all the workmen employed elevenpence per hour instead of the tenpence per hour prescribed by the union. This naturally gave them the option of employing all the bricklayers in the Manchester district, and they proceeded by means of daily reports from the foremen to ascertain which men were really the best. According to an article which appeared in the *Daily Mail*, the result was that whereas the men commenced to lay on an average nine hundred bricks per day each, after the process of elimination the average was got up to one thousand eight hundred bricks per day per man. This, without doubt, involved a vast amount of detailed work on the manager, but the result would seem to be that for 10 per cent. increase in wages the company received 100 per cent. increase in the value of the work turned out. The result must be looked upon as an education to the bricklayers of Manchester, as we are quite sure that the men so trained would be quite prepared to work for other employers in the same way for the same wages. It seems to us that the London County Council would do well to retain the services of the Westinghouse Company's building manager for their Works Department. We would conclude by echoing the words of Mr. Chamberlain, that if manufacturers and the working classes will take advantage of their opportunities for improvement, "there is no fear for the future, no fear that we will take an inferior position to that of our ancestors who have gone before, no fear that we will not meet competition from whatever quarter it comes, and that we will not meet the rivalries of the world."

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE ARMSTRONG-ORLING SYSTEM OF WIRELESS TELEGRAPHY.

SIR,—I have read your reply to my letter and the leading article upon the above subject in last week's *Electrical Engineer*, and can only marvel at your evasion of the point at issue. It must be perfectly clear to all who may have read my first letter (that appeared in your issue of Dec. 13 last) that my object in writing was to protest against the ridicule you sought to bring upon "one of the gentlemen you saw at the company's office" (who was myself), and I also availed myself of the opportunity of indicating that I could not see anything absurd in comparing the Armstrong-Orling receiver with a telephone.

To the first part of my letter you were good enough to reply by adding insult to injury, and proceeded to deal with the rest by making a series of rambling statements, which you cannot substantiate, about what someone else has done.

I am not a member of any syndicate, nor am I financially interested in the Armstrong-Orling inventions, as you suggest, neither have I been instructed to take up the cudgels on behalf of those against whom your tirade is directed; but as one who was present on the occasion of the demonstrations referred to I do know what took place, and, in the interest of fair play and justice, I am bound to say that no such improper suggestion as you state was made to anyone, neither were you nor any of your technical contemporaries asked to express any opinion at all upon "a new system of wireless telegraphy." You were shown a receiving instrument and were expected to make whatever comment upon it that you—as a technical journal—might think fit. So far as the apparatus that was not exhibited is concerned, you were informed that you would be invited to inspect it at a later date.

With reference to the quotation you make from my letter, your comment upon it and your *non sequitur* conclusion, perhaps you would be good enough to show how difference of potential can be established at the terminals of the Armstrong-Orling receiver, or any other electro-capillary apparatus of the same class, without the passage of a current as a result. That a current does flow you now admit in your delightful illustration of what you mean, which as a specimen of contradiction (to say nothing else) is a masterpiece.

Your original contention was that current does not flow through this class of apparatus, "whose chief use has been to measure extremely small differences of electrostatic pressures, in which cases a passing current would be objectionable," and in comparing the Armstrong-Orling receiver with a telephone (which, by the way, you have previously characterised as absurd) you find that a current, of almost inappreciable percentage "to thatpassing through the telephone," does flow.

Besides this, you arrive at the conclusion that if equal E.M.F. act against equal resistance in the two instruments a stronger current will pass through the telephone, notwithstanding the impedance due to self-induction in this class of receiver as against none in electro-capillary apparatus. Surely this is not in accordance with Ohm's law, which shows that $\frac{\text{E.M.F.}}{\text{resistance}}$ = current. And, to adapt one of Euclid's axioms, if equals be divided by equals the quotients are equal, the conclusion that must force itself upon one is, surely, that, other things being equal, the current in both cases must also be equal.

But other things are not equal, for there is impedance in the telephone which retards the rise in current flow to its maximum, and, added to all this, the comparison, as qualified by you, is not a fair one, because the resistance of a telephone does not equal, but is very many times greater than, that of the apparatus under consideration, and consequently the current flowing through the latter is very much greater than through the telephone when equal E.M.F. is applied to the terminals of each instrument.

As regards my reference to your contemporary, it must also be clear to your readers that my object was to call your attention to the use made of the comparison which you have characterised as absurd.

That you are able to correct my rendering of Pope's dictum, which was intentionally paraphrased, and to quote Goethe, is not evidence, any more than is your calculation in connection with current that you have paid much attention to Ohm's law.

In conclusion, I hope that you will in your editorial comments be so good as to deal with all the points I have raised.—Yours, etc., THE ONE REFERRED TO.

Jan. 7, 1902.

[We were, of course, not informed as to the exact connection between our correspondent and the Armstrong-Orling Syndicate, but on the occasion of our visit he was put forward to answer all technical enquiries, and we can hardly be blamed for our assumption that he was the expert of the syndicate. Again, although we were not asked to criticise the system, we were, as our correspondent rightly says, expected to make whatever comments upon it we, as a technical journal, might think fit. These comments we have made, and there has been nothing in our correspondent's letter to shake our criticism in any way. It has shown to us, however, that "The One Referred To" is not so conversant as he should be with electro-capillary electrometers. For instance, he wishes in the letter above to apply Ohm's law in order to find out the current which would pass through such an instrument with a given difference of potential at its terminals. The slightest

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reference to the most generally accepted theory of these instruments, the Lippmann-Helmholtz theory, as supported by extensive experiments, would explain to him the comments in our last week's issue. This full theory would occupy too much space in answer to a correspondent, or we should be pleased to reproduce the same. Our correspondent will find it in full in the paper read by Mr. S. W. S. Smith, M.A., before the Royal Society in 1899, "On the Nature of Electro-Capillary Phenomena." He would do well at the same time to consult papers by other authors before the same society in the three or four previous years which deal with the use of these electrometers in researches in physiology. This correspondence must now cease.—ED. *E. E.*]

AUSTRALIA.

SIR,—I am desirous of obtaining a situation in Australia. I am an electrical engineer (age, 24 years), with life experience in private installation work, including dynamos and motors, and two years' experience in central station of combined traction and lighting, direct current. I should be glad if you will advise me, in your paper, as to the best way of procuring a respectable situation —ANXIOUS.

[It is not an easy matter for an electrical engineer in this country to get a position in Australia unless he can hear of some firm in this country who is sending out new plant and requiring, in consequence, someone to erect the same. If our correspondent were to write to the larger manufacturing companies, he might hear of some such opening. The other alternative is to get employment in some firm in Australia after arrival.—ED. *E. E.*]

INSTITUTION OF CIVIL ENGINEERS.

At the ordinary meeting on Dec. 17, Mr. Charles Hawksley, president, in the chair, the paper read was "Motive Power from Blast-Furnace Gases," by Mr. Bryan Donkin, M.I.C.E.

The author considered first the importance of the discovery made within the last few years that power could be produced economically and effectively by utilising the gases from blast furnaces to drive gas-engines. As the annual production of iron from blast furnaces throughout the world was 40 million tons, this new application of motive power was capable of immense development. The gases given off from these furnaces during the process of smelting iron were practically the same as weak producer gas. Till within about half a century they had all been wasted. A part was next utilised under boilers to generate steam to drive the blowing-engines, and part to heat the air-blast; but after supplying these requirements, a considerable surplus was available. Successful efforts had been made, first to use this surplus in gas-engine cylinders to obtain power, and next to discard steam-engines, boilers, and chimneys entirely, and utilise all the gas in this way.

The chemical constituents of the gases produced by smelting iron ore in blast furnaces varied according to the ore and fluxes used, the fuel burnt, and the temperature of the furnaces. They contained, however, on an average about one-third by volume of combustible gases, chiefly CO, the remainder being inert CO_2 and N. The ratio of the CO_2 to the CO varied in every furnace. The higher it was—that was, the more CO_2 the gases contained, the better the efficiency of the furnace. More gas would be produced, but it had a poor heating value, and if the percentage of CO_2 was very high, the gas would not ignite in an engine. If, however, the ratio was low and the percentage of CO high, the gas would have a relatively higher heating value. A table was given, showing the composition of the gases from six blast furnaces in England and on the Continent.

With the present methods of utilising these gases about 10 per cent. was lost by leakage, 28 per cent. was applied to heat the air-blast, 40 per cent. to the boiler, and 22 per cent. was wasted. If the latter percentage were utilised in gas-engines it would yield about 12½ horse-power hours per ton of iron melted, while if all the gases were burnt in gas-engine cylinders to produce power, about 28 horse-power hours per ton of pig iron would be available after deducting the power required for compressing the air. When burnt under boilers they gave a very poor heat efficiency, because the CO was of comparatively little value as fuel. At least four times as much power could be obtained when the gases were treated in an engine cylinder, the method of utilising them being more suitable. The store of power thus available had been calculated for English and Scotch furnaces at 2½ million horse-power per annum. The poorness of the gases was counteracted by diluting them with a smaller proportion of air than was required for richer gases. About one volume of air to one of blast-furnace gases gave the best working mixture in an engine cylinder.

Other disadvantages were the variations in pressure and composition of these gases, their low heating value, and the dust with which they were charged. The first two difficulties were overcome by passing them into a holder before sending them to the engine cylinder, while the quantities produced were so large that these fluctuations were practically annulled. Their low heating value did not give rise to the difficulties at first anticipated, because they could be compressed to a higher degree, previous to ignition, than was permissible with other kinds of gas when used to produce power. A high thermal efficiency was thus obtained, which compared favourably with that of other types of internal-combustion engines. Compressions of between 7½ and 11 atmospheres were used, and the lower the heating value the higher was the compression required.

The dust with which the gases were charged was of two kinds, the heavy metallic dust deposited in the long and large gas-mains, and the fine light dust which was partly removed by washing and cleaning, and partly blown out with the engine exhaust. At first elaborate and costly systems of washers and purifiers had been employed, but experience had shown them in most cases to be unnecessary, and the gases were seldom subjected to any further cleaning when burnt in engine cylinders than when used under boilers; the same pipes often served both systems. Sometimes they were washed with water, sometimes they were treated by dry processes. Such light dust as remained after cleaning was forced out with the exhaust by the action of the piston, and was not allowed to be deposited and clog the cylinder and valves. Among purifiers a new form of rotary washer had so far proved one of the most satisfactory. It was said to clean the gases effectually, and took up much less space and cost less than the usual array of pipes. The methods of cleaning the gases at Seraing in Belgium, Friedenshütte, Hörde, and Donnersmark in Germany, and Differdingen in Luxemburg, were described.

Two other difficulties were also considered, the production of gas-engines large enough to utilise the vast stores of power available, and the desirability of driving the air-blowing cylinders from them direct. A great impetus had been given to the construction of large motors by the discovery that blast-furnace gases could be used to drive them. They were now made in sizes up to 1,000 h.p. and 1,500 h.p., and still larger powers were in contemplation, while the difficulty of starting these large engines had been successfully overcome. To connect them direct to the blowing cylinders, which ran at a lower speed, was sometimes difficult. The subject was engaging the attention of scientific men and engineers, and success had already been partly, and doubtless in time would be fully, attained.

The author proceeded to sketch the history of this new development in engineering science. The pioneer of the movement, Mr. B. H. Thwaite, A.M.I.C.E., had driven an engine with blast-furnace gases in February, 1895, but the question had been simultaneously and independently treated at Seraing in Belgium, and at the Hörde Ironworks in Germany. Mr. Thwaite's experiments had been made at Wishaw, near Glasgow, on a 12-hp. engine driving a dynamo. The heating value of the gas used had been 126 B.T.U. per cubic foot, consumption of gas 84 cubic feet per indicated horse-power hour The fuel used was "splint coal," and the gas was comparatively rich. Another small experimental engine had been successfully worked

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for some time at Frodingham, with gas having a heating value of 110 B.T.U. per cubic foot. A larger plant had been driven at Barrow, but little had hitherto been done in England.

At the ironworks of the Société Cockerill at Seraing, three engines of 8 h.p., 200 h.p., and 650 h.p. respectively had been tested, and most important work had been done. The first trials, made on a 8-h.p. four-cycle Simplex engine, had been sufficiently satisfactory to lead the company to test a much larger engine. The 200-h.p. motor of the same type, when experimented on in 1898, had shown a consumption of gas of 116 cubic feet per brake horse-power hour, having a heating value of 110 B.T.U. per cubic foot. Thermal efficiency per brake horse-power 20 per cent. A still more important trial had been carried out in 1900 at Seraing on a 650-h.p. Simplex engine, in the presence of many authorities. The consumption of gas was 101 cubic feet per brake horse power-hour, and the thermal efficiency 26 per cent. per brake horse-power. All the engines tested were single-acting and single-cylinder engines, a type to which the Seraing authorities gave the preference, in contradistinction to the multiple-cylinder type advocated by the Deutz firm. The advantages and drawbacks of both classes of engine were contrasted by the author.

A third application of blast-furnace gases to drive a gas-motor had been made at Hörde in 1895. Here a new two-cycle type, the Oechelhaüser, which appeared to have a promising future before it for this class of work, had been tested. The engine had one long cylinder with two pistons, and an air pump; for the latter the large blowing cylinder might be substituted. Several large plants were in course of construction, but the engine had not yet been tested officially. Another important trial, made at Differdingen on a 60-h.p. four-cycle engine by Prof. Meyer in 1898, compared favourably with the Seraing experiments for care and completeness. The heating value of the gas was 105 B.T.U. per cubic foot, and the consumption about 95 cubic feet per brake horse-power hour, the thermal efficiency being 25 per cent. per brake horse-power. Trials had also been made by Köhler, in 1898, on a 40-h.p. four-cycle engine.

The author gave some account of the very rapid progress made in this class of work on the Continent. Many of the large firms in Germany and Belgium were now busily employed. The Gasmotoren-Fabrik Deutz had numerous orders for motors from 500 h.p. to 1,000 h.p., while at Seraing an aggregate of 39,000 h.p. had been bespoken. Messrs. Körting, of Hanover, had also supplied several engines, and the Deutsche Kraftgas-Gesellschaft, the makers of the Oechelhaüser, propose to construct motors up to 1,500 h.p. and 2,000 h.p. England and Scotland seemed rather slow to utilise these gases. Well-made gas-engines now gave no trouble, were as easily driven as steam-engines, and were much more economical.

A table of nine tests of blast-furnace gas-engines was added, and in an addendum to the paper mention was made of what appeared at present to be the best way of getting rid of the troublesome light dust—viz., passing the gases successively—through two centrifugal fans provided with water-jets.

ELECTRIC LIGHTING IN CANADA.

Some more than usually interesting particulars of the electric lighting industry in Canada have recently been published by Mr. George Johnson, the Dominion statistician, which show that the use of electricity for lighting in Canada is becoming more and more popular. Since 1898 the progress has been most marked. In that year there were 259 companies in the Dominion carrying on an electric lighting business, and in 1901 this number had increased to 306. The arc lights in use increased in the same period from 10,389 to 12,800, and the incandescent lamps from 463,615 to 815,676. By reckoning each arc lamp equal to 10 incandescents, the use of electricity as a light-giver has developed from 567,505 incandescent units in 1898 to 943,676 in 1901—an increase of 376,171 lamps, or over 66 per cent. The increase of 1901 over 1900 was 144,556 lamps. The province of Ontario has the largest number of electric lighting firms of any province in the Dominion—*i.e.*, 196 out of the total 306 operating companies. Also, Ontario has 6,830 arc and 384,496 incandescent lamps installed, or nearly 50 per cent. of the total for Canada. In this province there are some 78 cities, towns, and villages which have either municipal plants or are supplied by companies. Of the remaining 110 electric lighting companies, after allowing 196 for Ontario, Quebec has 50, Nova Scotia 24, British Columbia 11, New Brunswick 11, Manitoba 6, North-West Territories 5, and Prince Edward Island 3. The province of Quebec has 4,118 arc lamps and 270,120 incandescents, of which the city of Montreal accounts for 2,648 arcs and 108,210 incandescents, or more than half the total number of lamps in operation. In all, there are 42 cities, towns, and villages in Quebec which have plants for the supply of electric light. Of other provinces, the total equipment of British Columbia is 643 arcs and 63,763 incandescent lamps, distributed among 12 towns; of Nova Scotia, 465 arcs and 49,041 incandescents among 20 towns; of New Brunswick, 691 arcs and 18,131 incandescents among 10 towns; of Prince Edward Island, 92 arcs and 9,525 incandescents; of Manitoba, 22 arcs and 19,250 incandescents among six towns; and of the North-West Territories, 31 arcs and 5,875 incandescent lamps divided among six towns.

ELECTRIC LIGHTING PROVISIONAL ORDERS.

The following is a complete list of the applications for provisional orders deposited with the Board of Trade on or before Dec. 21, 1901, under the provisions of the Electric Lighting Acts, 1882 to 1890.

Title of Order and Description of Area.	Name of Promoters.
Aberdare Electric Lighting Order.—The Urban District of Aberdare.	The Urban District Council.
Abram Electric Lighting Order.—The Urban District of Abram.	The Urban District Council.
Amble Electric Lighting Order.—The Urban District of Amble.	The Northern Counties Electricity Supply Company, Limited
Ardsley East and West Electric Lighting Order.—The Urban District of Ardsley East and West.	The Urban District Council.
Barton Regis Electric Lighting Order. The Rural District of Barton Regis and the Urban District of Horfield.	The Barton Regis Rural District Council.
Beeston Urban District Council Electric Lighting Order.—The Urban District of Beeston.	The Urban District Council.
Blaydon Electric Lighting Order.—The Urban District of Blaydon.	The Urban District Council.
Bournemouth Electric Supply Order. The Parishes of Pokesdown, Southbourne, and Winton, and portion of the parish of Bournemouth, all in the Borough of Bournemouth.	The Corporation.
Carnarvon Electric Lighting Order.—The Borough of Carnarvon.	The Corporation.
Carnoustie Electric Lighting Order.—The Burgh of Carnoustie.	The Electric Supply Corporation, Limited.
Chepstow Electric Lighting and Power Order.—The Urban District of Chepstow, the parishes of St. Arvan's, St. Arvan's Grange, St. Kingsmark, Mounton, Mathern, and St. Pierre, Dinham, Caldicot, Portskewett, Caerwent-with-Crick, Ifton, and Roggiett, all in the Rural District of Chepstow, and portion of the parish of Tidenham, in the Rural District of Lydney.	The Chepstow Electric Lighting and Power Company, Limited.
Chester-le-Street Electric Lighting Order.—The Rural District of Chester-le-Street.	The County of Durham Electrical Power Distribution Company, Limited.
Chiswick (Public Purposes) Electric Lighting Order.—The Urban District of Chiswick.	The Urban District Council.
Church Stretton Electric Lighting Order.—The Urban District of Church Stretton, and the parishes of All Stretton and Little Stretton, in the Rural District of Church Stretton.	The Church Stretton Land Company, Limited.
Cowes Electric Lighting Order.—The Urban District of Cowes.	The Isle of Wight Electric Light and Power Company

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Title of Order and Description of Area.	Name of Promoters.
Dover Electric Lighting Order.—The Borough of Dover.	The Corporation.
Dumbarton Electric Lighting Order.—The Burgh of Dumbarton.	The Commissioners of the Burgh.
Edmonton Electric Lighting Order.—The Urban District of Edmonton.	The Urban District Council.
Enfield Electric Lighting Order.—The Urban District of Enfield.	The North Metropolitan Electrical Power Distribution Company, Limited.
Eston Electric Lighting Order.—The Urban District of Eston.	The Urban District Council.
Frinton-on-Sea Electric Lighting Order.—The Parish of Frinton.	The Frinton-on-Sea and District Electric Light and Power Company, Limited.
Gillingham (Kent) Electric Lighting Order.—The Urban District of Gillingham.	The Urban District Council.
Glasgow Corporation Electric Lighting (Extension) Order).—The Burgh of Kinning Park.	The Corporation.
Govan Electric Lighting (Extension) Order.—Portion of Burgh of Govan.	The Commissioners of the Burgh.
Hebden Bridge Electric Lighting Order.—The Urban District of Hebden Bridge.	The Urban District Council.
Hindhead and District Electric Lighting Order.—The Parish of Shottermill and portion of the Parish of Frensham, in the Rural District of Farnham, and portion of the Parish of Headley, in the Rural District of Alton.	John Grover, Esq.
Hitchin Electric Lighting Order.—The Urban District of Hitchin.	The Urban District Council.
Holyhead Electric Lighting Order.—The Urban District of Holyhead.	The Urban District Council.
Hucknall Torkard Electric Lighting Order.—The Urban District of Hucknall Torkard.	The Urban District Council.
Leadgate Electric Lighting Order.—The Urban District of Leadgate.	The Northern Counties Electricity Supply Company, Limited.
Leatherhead and District Electricity Supply Order.—The Rural District of Epsom and the Parish of Mickleham in the Rural District of Dorking.	The Leatherhead and District Electricity Supply Company, Limited.
Lees Electric Lighting Order.—The Urban District of Lees.	The Urban District Council.
Leyland Electric Lighting Order.—The Urban District of Leyland.	The Urban District Council.
THE COUNTY OF LONDON.	
Bermondsey Electric Lighting Order.—Portion of the Metropolitan Borough of Bermondsey.	The Corporation.
Camberwell Electric Lighting Order.—The Metropolitan Borough of Camberwell.	The Corporation.
Southwark Electric Lighting Order.—Portion of the Metropolitan Borough of Southwark.	The Corporation.
Stoke Newington Electric Lighting Order.—Portion of the Metropolitan Borough of Stoke Newington.	The Corporation.
Woolwich Electric Lighting Order.—Portion of the Metropolitan Borough of Woolwich.	The Corporation.
Louth Electric Lighting Order.—The Borough of Louth.	The Corporation.
Lower Bebington Electric Lighting Order.—The Urban District of Lower Bebington.	The Urban District Council.
Morpeth, Ashington, Newbiggin-by-the-Sea, Bedlingtonshire, and Morpeth (Rural) Electric Lighting Order.—The Urban Districts of Morpeth, Ashington, Newbiggin-by-the-Sea, and Bedlingtonshire, and so much of the Rural District of Morpeth as is included in the Parishes and Townships of Morpeth Castle, Hepscott, Pegswood, Bothal Demesne, Woodhorn, Woodhorn Demesne, and North Seaton.	The Northern Counties Electricity Supply Company, Limited.
Mytholmroyd Electric Lighting Order. The Urban District of Mytholmroyd.	The Urban District Council.
Nairn Electric Lighting Order.—The Burgh of Nairn.	The Corporation.
Newburn Electric Lighting Order.—The Urban District of Newburn.	The Newcastle and District Electric Lighting Company, Limited.
Otley Electric Lighting Order.—The Urban District of Otley.	The Urban District Council.
Paignton Electric Lighting Order.—The Urban District of Paignton.	The Provincial Electric Supply and Traction Company.
Penarth Electric Lighting Order.	The Penarth Electric Lighting Company, Limited.
Pokesdown Electric Lighting Order.—The Parish of Pokesdown in the Borough of Bournemouth.	The Bournemouth and Poole Electricity Supply Company, Limited.
Saddleworth Electric Lighting Order. The Urban District of Saddleworth.	The Urban District Council.
St. Andrews Electric Lighting Order.—The Royal Burgh of St. Andrews.	The Electric Supply Corporation, Limited.
Seghill, Earsdon, and Tynemouth (Rural) Electric Lighting Order.—The Urban Districts of Seghill and Earsdon and so much of the Rural District of Tynemouth as is included in the Parishes and Townships of West Hartford, East Hartford, Bebside, Horton, Seaton Delaval, Hartley, and Burradon.	The Northern Counties Electricity Supply Company, Limited.
Slough Electric Lighting Order.—The Urban District of Slough and the Parish of Datchet.	The Urban District Council of Slough.
South Bank in Normanby Electric Lighting Order.—The Urban District of South Bank in Normanby.	The Urban District Council.
Springhead Electric Lighting Order.—The Urban District of Springhead.	The Urban District Council.
Stanley Electric Lighting Order.—The Urban District of Stanley.	The Urban District Council.
Stanley and Tanfield Electric Lighting Order.—The Urban Districts of Stanley and Tanfield.	The Northern Counties Electricity Supply Company, Limited.
Stevenage Electric Lighting Order.—The Urban District of Stevenage.	The Urban District Council.
Stockton Rural District Electric Lighting Order.—The Rural District of Stockton.	The Rural District Council.
Tadcaster and District Electric Lighting Order.—The Townships of Tadcaster East, Tadcaster West, Grimston, and Newton Kyme-cum-Toulston, and portions of the townships of Healaugh, Catterton, Oxton, and Stutton-cum-Hazlewood in the Rural District of Tadcaster.	The Tadcaster Electricity Company, Limited.
Thornaby-on-Tees Corporation Electric Lighting Order.—The Borough of Thornaby-on-Tees.	The Corporation.
Tipton Electric Lighting Order.—The Urban District of Tipton.	The Urban District Council.
Tottenham Urban District Electric Lighting Order.—The Urban District and Parish of Tottenham.	The Urban District Council.
Trefriw Electric Lighting Order.—The Village of Trefriw and a portion of the Township of Gwydyr and Parishes of Llanrhychwyn and Trefriw in the Rural District of Geirionydd.	The Llanrwst Electricity Supply Company, Limited.
Tyldesley-with-Shakerley Electric Lighting Order.—The Urban District of Tyldesley-with-Shakerley.	The Urban District Council.
Westhoughton Electric Lighting Order.—The Urban District of Westhoughton.	The Urban District Council.
West Riding Electric Lighting Order.—The Borough of Pontefract; the Urban Districts of Normanton, Featherstone, Whitwood, and Knottingley; the Rural District of Pontefract; and the Parishes of Allerton-Bywater, Kippax, and Great and Little Preston, in the Rural District of Tadcaster.	The West Riding Tramways and Electricity Supply Company, Limited.
Wood Green Electric Lighting Order.—The Urban District of Wood Green.	The Urban District Council.

TRADE NOTICES AND NOVELTIES.

B.T.-H. Interchangeable Arc Lamps.

We have received from the British Thomson-Houston Company, Limited, Rugby, a copy of their pamphlet No. 115, which supersedes pamphlets Nos. 53 and 73. The pamphlet under notice describes and illustrates continuous and alternating current arc lamps of the firm's latest enclosed types. We are told that the company have perfected their interchangeable enclosed arc lamps, which are mechanically alike in practically every detail, with the object of having the smallest possible variety of spares and supplying a lamp that will with simple changes be applicable for use on both direct and alternating current circuits. The advantages of this interchangeability are too apparent to need explanation. The general construction

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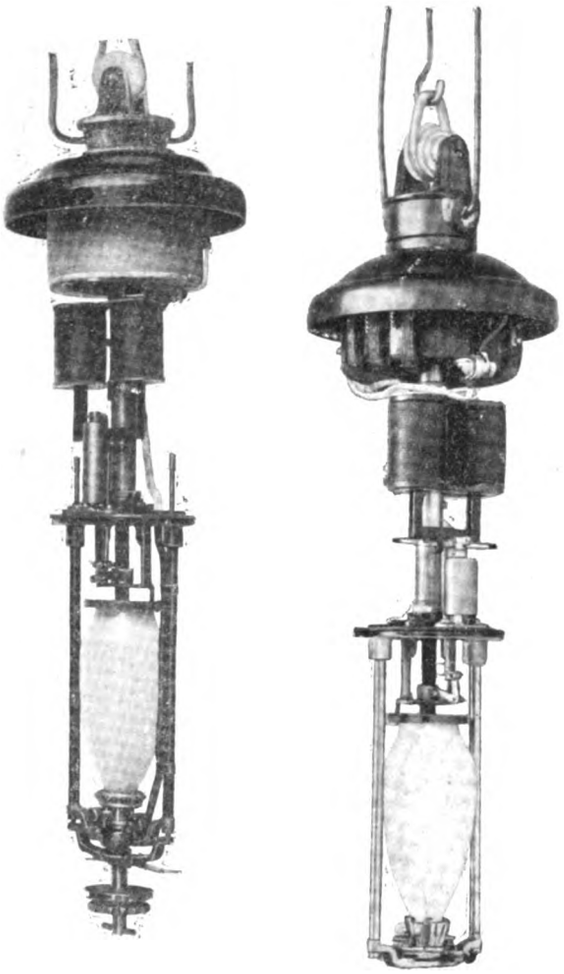
of these lamps is fully described. Each lamp has a slotted central tube, which, at its upper end, supports the lamp top and the resistance or the reactance (according as the lamp is for direct-current or alternating-current circuits), while to the lower end is attached the frame for holding the lower carbon and globe. This tube is insulated from the other parts. The holder for the upper carbon is inside the tube, and is connected to the circuit by a flexible cable, which passes through a slot in the side. Each lamp has two magnet coils, which are secured to the carbon-tube. Three standard types of lamp tops are used—one for pole-top bracket with spring suspension, another for general outdoor use, and the third for indoor use. These different tops are interchangeable, and have no outside terminals. The details of the carbon-holders have been arranged to facilitate good trimming. Special attention has also been given to the design of the cap for the enclosing globe. In the double-globe lamps the inner globe-holder is a combination globe and carbon holder, and its use enables holders fitted with clean globes and new carbons to be inserted complete in the lamp, the dirty globe with its holder being removed for subsequent cleaning. The carbons are self-centering. The first of the accompanying illustrations shows the mechanism of one of these interchangeable lamps when fitted for operating in parallel on direct-current circuits of from 100 to 125 volts. When the line voltage is 110 the arc voltage is 80, and may be adjusted somewhat higher when the terminal voltage is 115 or 125. The



resistance wire is wound on a porcelain drum, which has a spiral groove moulded on its face to prevent the wire from sagging when heated, and the consequent troubles from short-circuits. Two sizes of this lamp are made, to take 3¼ and 5 amperes respectively. In the second of the illustrations herewith is shown the mechanism of the same lamp when fitted for use in parallel, on alternating-current circuits of from 100 to 120 volts. In this case the lamp is provided with a reactive coil of the sectional type, having a number of terminals to allow of its adjustment for various periodicities. The B.T.-H. type of series direct and alternating current arc lamps are also described in the pamphlet.

Glacier Anti-Friction Metal.

The Glacier Anti-Friction Metal Company have published a small illustrated pamphlet, describing a few modes of application of this material and giving particulars of friction tests with 1,000 and 1,500 pressure per square inch, also crushing tests under 13·26 tons per square inch. In the preface it is stated that Glacier anti-friction metal has been tested and endorsed not only by engineers, railway and steamship companies, but by many Governments in the world, and that the company will be pleased to show these Government tests and endorsements to interested parties.

Union Electric Dynamos and Motors.

We have received from the Union Electric Company, Limited, 151, Queen Victoria-street, London, E.C., a copy of their newly-printed list, No. 22, dealing with eight-pole dynamos and motors. The dynamos listed range in output from 76 kw. to 405 kw., and the motors from 95 h.p. to 520 h.p. A notable feature in connection with both the dynamos and motors is that each machine is constructed upon a principle which allows the same to be supplied for five to seven different speeds without any variation in the price. This is enabled, we are told, by a carefully worked-out system of standardisation of the windings. Moreover, each machine can be finished in five different manners—*i.e.*, with provision for belt or rope driving; two bearings, a bedplate, and half coupling; one bearing, bedplate, and half coupling; one bearing (the outer one) and no bedplate, or without either bearing, bedplate, or special shaft. In the latter case the machine would be mounted on the shaft which drives it or which it drives. The catalogue under notice contains dimension tables, whereby not only the price, speed, and appearance of a machine may be readily ascertained, but also the space occupied by it.

Brett's Patent Drop Stamps.

Messrs. B. and S. Massey, Steam Hammer Works, Openshaw, Manchester, have recently issued a new illustrated catalogue of their Brett's patent drop stamps, etc. It is claimed for these stamps that the speed and force of the blows delivered can be perfectly and instantly controlled, while they will work without manual labour, and may be made to any size required. The stamps are driven by steam or compressed air. We understand that they are coming into increasing use for stamping forgings in dies. Among the numerous examples of stampings illustrated in the catalogue we notice commutator segments, boiler and crane makers' stampings, etc. Trimming pressses and bar heating furnaces are also dealt with.

Pratt's Carboy Emptier.

The carboy emptier shown herewith attached to carboy is manufactured by Messrs. John J. Griffin and Sons, Limited, 20-26, Sardinia-street, Lincoln's-inn-fields, London, W.C. It is claimed for this emptier that it can be fitted to any ordinary carboy, even if the neck be unevenly made or broken; a boy can safely empty a 10-gallon

carboy into Winchester quarts in 15 to 20 minutes; massive stands are entirely done away with; all risk of acid splashes is avoided; exact quantities of liquid can be measured out; no drips of acid can run down the outside of the neck, and hence the packing round the carboy lasts much longer; while emptying both hands are free.

Willesden Paper and Canvas.

We have seen some samples of the paper and canvas made at the Willesden Paper and Canvas Works, Willesden Junction, N.W., which appear to be useful for lining coal stores and for insulating and rendering air proof refrigerating chambers, etc. We are assured that the paper is largely used for electrical purposes as an insulating medium, it being claimed that it is less hygroscopic than the other materials in the market.

Writing-Pad.

The Hart Accumulator Company, Limited, Marshgate-lane, Stratford, E., and Manchester, are distributing a serviceable writing-pad, upon which they draw attention to their new cell for traction work and non-corrosive terminals. In a corner we find a statement "60,000 cells in use," which speaks well for the article.

Fowler's Year Book.

We have received from the Scientific Publishing Company, Manchester, a copy of "Fowler's Electrical Engineers' Year Book" for 1902.

Calendars.

We have received the annual square yard of wall calendar published by the Rugby Portland Cement Company, which is, as usual, replete with ideal landscapes peopled with saurians ranging from all strata upwards until the company's works anno 1902 are reached, when these animals have to give way to steam-engines. We also acknowledge receipt of wall calendars from Mr. John Etherington, M.I.M.E., consulting and inspecting engineer, and manufacturer of cylinder-lubricating oils, King William-street, E.C.; from the Hunslet Engine Company, Leeds, manufacturers of locomotive tank engines; from Messrs. Harold Nickson and Co., coal and cannel contractors, Manchester; and John M. Henderson and Co., King-street Engineering Works, Aberdeen, makers of cableways, hoisting and conveying

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devices; also from Messrs. Shand, Mason, and Co., 73, Upper Ground-street, E.C., makers of steam fire-engines, horse fire-escapes, fire hose, etc., and the Willesden Paper and Canvas Works, Limited, and the Granite Silicon Plaster Company, Limited, 56, King's-road, St. Pancras, N.W. Messrs. Robert Boyle and Son, Limited, ventilating engineers, 64, Holborn-viaduct, London, and 110, Bothwell-street, Glasgow, publish as usual their ivory pocket-tablet with scale. We have also received artistic wall calendars from Messrs. W. H. Willcox and Co., Limited, engineers' stores, 36, Southwark-street; the Glacier Anti-Friction Metal Company, 91, Queen Victoria-street, E.C. Messrs. Engelbert and Co., manufacturers of lubricating oils for all purposes, especially high-speed machinery for electric light works, gas-engines, etc., of 44-47, Bishopsgate-street Without, E.C., have published a rule calendar, containing scale of 12in. and 30 cm. respectively, with the usual 12 months' calendrical particulars.

LEGAL INTELLIGENCE.

ELECTRICAL ENGINEERS AND THE EMPLOYERS' LIABILITY ACT.

An important action under the Employers' Liability Act was heard at Exeter County Court on Monday before Mr. Lush-Wilson, K.C. It was a claim by A. J. Wallage, an electrical linesman, for £200 from Mr. Frank Harold Rippon, electrical engineer, for personal injuries received in his employment. The plaintiff was represented by Mr. Dunn; the defendant by Mr. J. Hardy Harris.

Mr. Dunn said that in September plaintiff was working for defendant installing the electric light in the new co-operative stores at Exeter. He was told by defendant to cut a certain wire, but previous to doing so he asked if it were "all right," and defendant replied "Yes." On plaintiff taking the pliers to cut the wire, he received such a severe shock that he was incapacitated from carrying on his occupation, as alleged, for life.

Plaintiff gave evidence in support of his case. Cross-examined, he denied that the defendant told him to see that the fuse was disconnected before he cut the wire.

Some other witnesses having been examined,

His Honour said he was sorry that the case had not been heard by a jury. He gave judgment for the plaintiff for £175. He thought that was a reasonable sum, as they did not know whether the plaintiff would ever properly recover from the effects of the shock.

ELECTRICITY SUPPLY IN THE CITY.

At the Guildhall, before Mr. Alderman Crosby, on the 3rd inst., the Charing Cross and Strand Electricity Supply Corporation, Limited, were summoned, at the instance of Mr. Edmund Woodthorpe, district surveyor for the northern division of the City, for beginning certain works without having served a notice upon him. The proceedings were taken under the 145th section of the Building Act.

Mr. Woodthorpe stated his case to be that the company had failed to give him any notice concerning a street box that was in course of erection at the corner of Bishopsgate-street Within and Wormwood-street. The chamber was enclosed within a 9in. wall, and he had pointed out certain defects of construction to the foreman. Since the issue of the summons he had been told by the foreman that the chamber had been made according to his requirements. In reply to a complaint from the surveyor with regard to no notice being given, the company had written him acknowledging his authority.

Mr. Shiress Will, K.C., for the company, argued that the special powers under which this electric lighting company carried on their works excluded them from the provisions of the Building Act. The date of that statute was 1894, while the provisional orders under which the company carried on their works were granted in 1899. All the works were carried out strictly under the supervision of the local authority, the appeal in every case, when necessary, being to the Board of Trade. Mr. Woodthorpe had referred to the danger of this particular box or chamber, but as plans had to be submitted and passed, the safety of the public was secured. The local authority in this case was the Corporation, and its officer was Mr. Ross, the engineer. The interests of the public were protected by a special code. He asked the Court to say that the box erected at the corner of Wormwood-street was necessary for the supply of energy. If that were established as a fact, it at once distinguished the case from the Whitechapel case, the decision in which was relied on by the prosecution. He would contend, from the sections of various Acts touching on the matter, that the district surveyor, under the Building Act, had no power whatever over the defendant company.

Mr. W. H. Patchell, chief engineer to the company, deposed that plans were submitted to the local authorities in connection with all the boxes erected. In this case such plans had been submitted to and approved by Mr. Ross. There was absolutely no danger, as the boxes were erected under the supervision of the local authority, and according to the code.

Mr. Alderman Crosby said he considered the matter to be a very important one, and he reserved his decision till Monday next.

New Appointment. — The Secretary of State for the Home Department, with the concurrence of the Lords Commissioners of his Majesty's Treasury, hereby gives notice that the following temporary situation under the Home Office is added to Schedule B of the Order in Council of June 4, 1870—viz., the temporary situation of electrical adviser to the chief inspector of factories.

APPOINTMENTS VACANT.

Traffic Assistant, Huddersfield Corporation Tramways, £100 per annum, Jan. 13. Full particulars in our advertisement columns.

Engineer-in-Chief, South Lancashire Electric Traction and Power Company, Limited, £500 per annum, Jan. 15. Full particulars in our advertisement columns.

Chief Electrical Engineer, Canterbury Corporation Electricity Department, £250 per annum, Jan. 11.

Electrician in Electrical Department, with good theoretical training, and practical experience in marine electric lighting. Full particulars in our advertisement columns.

Electrical and Tramway Engineer, Blackpool Corporation, Jan. 27. Full particulars in our advertisement columns.

Electrical Engineering Assistant, Sanitary Commissioners of Gibraltar, £200 a year, Jan. 18. Full particulars in our advertisement columns.

NEW COMPANIES REGISTERED.

Electric Light, Power, and Hiring Company, Limited.—Capital, £15,000. Objects: to carry on the general business of electricians, mechanical engineers, manufacturers of cables, wires, dynamos, accumulators, meters, generator distributors, etc.

J. G. Childs and Co., Limited.—Capital, £20,000. Objects: to take over the business of electrical engineers now carried on by J. G. Childs, at 145, Farringdon-road, London, as J. G. Childs and Co., and to carry on the business of electricians, electrical and mechanical engineers, manufacturers of and dealers in electrical apparatus, etc.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ghent.—The Municipality require tenders for the electric lighting of the town. Tenders must be posted before March 1, 1902.

West Bromwich.—The Council invite tenders for the reconstruction and electrical equipment of about 12 miles of tramway in the borough. Tenders by Jan. 17. Details in our advertisement columns.

Ilford.—The Urban District Council invite tenders for copper rail bonds (fixed), and stoneware cable conduits (laid and jointed), draw-boxes, etc. Tenders by Jan. 27. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of materials in connection with the equipment of the overhead construction of their lines. Tenders by Jan. 17. Details in our advertisement columns.

Barking (Essex).—The Urban District Council invite tenders for supply and erection of additional generating plant. Full particulars may be had from the Engineer, Electricity Works, East-street, Barking. Tenders by Jan. 24.

Llanelly.—The Harbour and Burry Navigation Commissioners invite tenders for the supply and erection of an electric lighting plant for their new dock at Llanelly. Tenders by Jan. 20. Full details in our advertisement columns.

Middleton (Lancs.).—The Corporation invite tenders for the electric wiring, etc., of the town hall. Specification, etc., may be obtained from Mr. Frederick Entwistle, town clerk, Town Hall, Middleton. Tenders by Jan. 16.

Brussels.—The Belgian Government Railways invite tenders for the plant, etc., for an electric lighting station at Marchienne au Pont. The estimate is 4,027,282fr. A deposit of 3,600fr. is required. Tenders by noon on Jan. 20, 1902.

Fulham.—The Establishment Committee of the Borough Council invite tenders for the supply of transformers (20 of 50 kw. each), and mains, conduits, lamp-posts, and street-boxes. Tenders by Jan. 27. Details in our advertisement columns.

Poplar.—The Establishment Committee invite tenders for the installation of electric light in the Poplar Town Hall and the Bow and Bromley Vestry Halls respectively. Tenders by Jan. 11. Details in our advertisement columns.

Cairo.—The Public Works Department require tenders for the public and private electric lighting of the towns of Suez and Damanhur. For particulars, application may be made to the Electrical Engineer's Office at the Public Works Department, Cairo, by Jan. 15.

Cardiff.—The Tramways Committee invite tenders for the supply, delivery, and erection of two vertical compound condensing engines of 1,600 i.h.p., each direct coupled to two 900-kw. generators. Tenders by Jan. 22. Details in our advertisement columns.

Ilford.—The Ilford Urban District Council invite tenders for copper rail bonds, fixed, and stoneware cable conduits, laid and jointed, draw-boxes, etc. Specification, etc., may be obtained at the offices of Mr. John W. Benton, Council Offices, Ilford. Tenders by Jan. 27

Manchester.—The Tramways Committee invite tenders for supply of overhead equipment, tools, etc. Specifications, etc., may be obtained on application to Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders by Jan. 18.

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Hornsey.—The Urban District Council invite tenders for the supply and erection of steam, exhaust, water, and other pipes, valves, tanks, footplates, and accessories, and elevator and transporter, electric motor and switch gear. Tenders by Jan. 15. Details in our advertisement columns.

Barnstaple.—The Town Council invite tenders for the erection of certain buildings in connection with their proposed electricity works in Castle-street, Barnstaple. Forms of tender, etc., may be obtained from the office of the borough surveyor, Mr. Arnold Thorne. Tenders by Jan. 16.

Belfast.—The Gas and Electric Committee invite tenders for supply of cable, laying of cables, road work (laying conduits and pipes), and supply of earthenware conduits. Specifications, etc., may be obtained on application to Mr. Victor A. H. M'Cowen, city electrical engineer. Tenders by Jan. 17.

Hunslet (Leeds).—The Guardians invite tenders for the electrical equipment of their new workhouse and infirmary at Rothwell Haigh, near Leeds. Specifications, etc., may be obtained from Messrs. Shepherd and Watney, consulting engineers, Greek-street-chambers, Leeds. Tenders by Jan. 21.

Madrid.—The Department of Agriculture invite tenders for the construction of an electric tramway from Linares to the mines of San Roque and Torilla, in the Province of Jaen. Tenders by Feb. 24. This is the extension of the tender advertised for Nov. 17, but the conditions have been modified.

Paisley.—The Corporation invite tenders for the supply, delivery, and erection of steam-engines, dynamos, switchboards, and condensers. Specifications, etc., may be had on application from Mr. C. F. Parkinson, M.I.E.E., burgh electrical engineer, Electricity Works, Blackhall, Paisley. Tenders by Jan. 13.

Lancaster.—The Corporation invite tenders for lubricating oils, engine packings and jointings, etc., for steam and water, for 12 months, commencing Feb. 1. Specification and any particulars may be obtained at the Borough Electrical Engineer's Office, Electricity Works, Lancaster. Tenders by Jan. 15.

West Ham.—The Council invite tenders for four sets of surface condensing plant, each to deal with 40,000lb. of steam per hour, complete with electrically-driven air and circulating pumps; and one travelling crane, to carry 30 tons, span 67ft. Tenders by Jan. 14. Details in our advertisement columns.

Leeds.—The Lighting Committee invite tenders for a complete 2,000-b.h.p. set of surface-condensing plant, comprising condenser, air-pumping engine, and circulating engine. Specifications, etc., may be obtained from Mr. Harold Dickinson, manager of the department, 1, Whitehall-road. Tenders by Jan. 16.

Louvain (Belgium).—The period within which proposals will be received for lighting the city of Louvain by gas or electricity, or by a combination of the two systems, has been extended from 31st inst. to Feb. 19, 1902. Proposals, marked "Lighting Contract," to be addressed the Burgomaster, Louvain, Belgium.

West Bromwich.—The Council invite tenders for the supply, delivery, and erection in their electricity works of boilers, feed pump and piping, steam dynamos and condenser, boosters, traction switchboard, and extension of lighting switchboard. Tenders by Jan. 29. Details in our advertisement columns.

St. Pancras.—The Borough Council invite tenders for supplying (Section 1) engines, dynamos, condensers, exhaust pipes; (2) boilers, feed pumps, steam and feed-water pipes, etc. Specifications, etc., may be obtained upon application at the Electricity Department Offices, 57, Pratt-street, N.W. Tenders by Jan. 17.

Birkenhead.—The Corporation invite tenders for the erection of battery-room, storeroom, and workshops at the electric lighting generating station, Bentinck-street, Birkenhead. Specification, etc., can be obtained from Mr Chas. Brownridge, A.M.I.C.E., borough engineer and surveyor, Town Hall, Birkenhead. Tenders by Jan. 13.

Grimsby.—The Corporation invite tenders for the extension of the plant at the electricity works, as follows: steam dynamos, extension of switchboard, accumulators, condenser plant and pipework, and water-tube boiler. Specification, etc., can be obtained from the borough electrical engineer, Mr. W. A. Vignoles. Tenders by Jan. 20.

Horley (Surrey).—The London County Council invite tenders for wiring and fittings for the electric lighting of the new buildings now being erected at the Farmfield Reformatory for Female Inebriates, near Horley, Surrey. Specification, etc., can be obtained at the Chief Engineer's Department, County Hall, Spring-gardens. Tenders by Jan. 14.

Liverpool.—The Directors of the South Lancashire Electric Traction and Power Company, Limited, Liverpool, invite tenders for three-phase high-tension motor-generators, positive and negative boosters, battery-charging boosters, etc., and batteries of accumulators with accessories. Tenders by Jan. 29. Details in our advertisement columns.

Barnstaple.—The Town Council invite tenders for the supply and erection of three straight water-tube or Economic boilers, fittings, steam and exhaust piping, condensers, three high-speed engines (220 i.h.p. each), three 125-kw. c.c. dynamos, switchboard, underground mains, lamp-posts, etc., meters, accumulators, crane, etc., artesian well. Tenders by Jan. 16. Details in our advertisement columns.

Madrid.—The Public Works Department invite tenders for an electric tramway from San Sebastion to Toloso, with power to work same for a maximum of 60 years, after which the undertaking becomes Government property without compensation. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m. Tenders by Jan. 27.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Stuart-street generating station of (a) main high-tension three-phase switchboards at generating station, (b) exciter and auxiliary switchboards at generating station, (c) high-tension three-phase switchboards at 10 sub-stations, (d) low-tension switchboards at 10 sub-stations. Tenders by Jan. 21. Details in our advertisement columns.

Hartlepool.—The Corporation invite tenders for the erection of a generating station and the supply and erection of plant—viz., erection of buildings, boilers (two of marine type), engines and dynamos, steam, feed, and exhaust pipes, valves, and other apparatus, storage battery, switchboard, arc lamps, feeder mains, arc light leads, etc., arc lamp columns and brackets, and overhead travelling crane. Specification, etc., may be obtained from the borough accountant (Mr. C. Robson). Tenders by Jan. 25.

Middlesbrough.—The Electric Lighting Committee invite tenders for the supply and erection of—engine-house plant: one 300-kw. high-speed steam dynamo and accessories; switchboard panels: panels and instruments for dealing with the above plant, and three new feeders; condensing apparatus and pipework: ejector condenser for dealing with 8,100lb. of steam per hour, and steam, exhaust, and feed pipes; feed pump and economiser: one feed pump and extension to existing economiser. Tenders by Jan. 21. Details in our advertisement columns.

Leytonstone.—The West Ham Board of Guardians invite tenders for the supply, delivery, and fixing at their new infirmary, Forest House, Leytonstone, N.E., of three direct-coupled engines and dynamos and one motor-booster, one battery of accumulators; all engine and battery room accessories; the whole of the feeders, distribution mains, junction boxes, main and sub-distribution boards; and all wiring, fittings, lamps, &c., for about 1,756 lamps. Specification, etc., may be inspected on and after Jan. 6 at the Clerk's Office at the Workhouse between 10 and 4. Tenders by Jan. 22.

London.—The London County Council invite tenders for the supply of about (a) 3,250 tons of track rails; (b) 1,850 tons of slot rails; (c) 670 tons of conductor tee rails; together with (d) the fishplates, bolts, nuts, etc., required in connection with the reconstruction of the London County Council tramways for electrical traction. Alternative tenders must be submitted for the supply of smaller quantities as follows of the articles above specified: (a) 2,280 tons; (b) 1,300 tons; and (c) 475 tons, with the necessary accessories. Specifications and other particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by Jan. 28.

Rockhampton (Queensland).—The Municipality invite applications from companies desirous of undertaking the construction and working a system of electric tramways under the Queensland Tramways Act of 1882 and the Amendment Act of 1890, within the municipality of Rockhampton aforesaid. Rockhampton, with a population of 15,461, is a rising town, and is situated on the Fitzroy River, about 40 miles from the sea coast, and is the second largest town in Queensland. Particulars of construction, maintenance, and working of tramways are contained in the Queensland Tramways Act of 1882 and the Amendment Act of 1890, copies of which may be seen at the office of this paper. Applications to be forwarded to Mr. H. W. Johnson, mayor, Municipal Chambers, Rockhampton, Queensland, Australia, by March 31.

RESULTS OF TENDERS.

Sheffield.—The tender of W. T. Glover and Co. for 15 miles of cable at £7,780 has been accepted by the Corporation.

Shrewsbury.—The Town Council have accepted the tender of E. Danks and Co., Oldbury, for the supply and erection of a new boiler at the electricity works.

Batley.—The Town Council have accepted the tender of Messrs. Clayton, Son, and Co., of Hunslet, Leeds, for the supply and fixing of boilers, steam-pipes, etc., at the electricity generating station.

Maidstone.—The Corporation have accepted the following tenders for wiring the public buildings: Haynes Bros., for surveyor's office and stores and police and fire stations, at £60. 10s., and Morris Jones and Co., for town hall, baths, and corn exchange, at £262. 8s.

Poplar.—The Borough Council have accepted the following tenders: Weston and Co., for an electric lighting installation at the public baths and wash-houses, at £453; Ferranti Limited, for electricity meters; and the Schattner Meter Company for demand indicators.

Bray (Ireland).—The Urban District Council have received the following tenders for the supply of a 60 to 70 kw. alternator: High-Speed Engine Company, £286; Electric Construction Company, alternator with exciter £560, without exciter £510; Witting Bros., with exciter £270, without £240; General Electric Company, £286, £6. 5s. extra if pulley be required; Lahmeyer Electrical Company, with exciter £298, without £253. The tenders have been referred to Mr. Hammond, consulting engineer.

Manchester.—The Electricity Committee have agreed to give the contract for the construction of subways for cables, etc., from the Stuart-street works to Ashton New-road to Messrs. C. H. Normanton and Son, the tender offered by that firm being the lowest. Messrs. Normanton are already engaged in the building of the Stuart-street generating station, and they have intimated that whilst tendering for both sections of the subways they will be unable to complete them in the time specified in the contract. Under these circumstances, the committee have now relieved Messrs. Normanton of the contract for Section C D, and given it to Mr. E. Nuttall, whose tender was the next in amount to Messrs. Normanton and Son's. Mr. Nuttall has given the necessary guarantee to perform the work within the time arranged, and Messrs. Normanton and Son will therefore take the work of Section A B in addition to constructing the new generating works at Stuart-street.

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Maidenhead.—The following tenders have been received for plant in connection with the electric lighting :—

Contract No. 4.—Steam and exhaust pipes.

Aiton and Co., Western Works, Hythe-road, Willesden Junction, N.W. (accepted)	£1,747 0 0
W. H. Allen, Sons and Co., Queen's Engineering Works, Bedford	2,445 0 0
Alley and Maclellan, Sentinel Works, Polmadie-road, Glasgow	2,013 0 0
Babcock and Wilcox, Oriel House, Farringdon-street, E.C.	1,997 7 0
R. W. Blackwell and Co., 59, City-road, E.C.	2,094 15 0
Crompton and Co., Salisbury House, London-wall, E.C.	1,837 15 0
Couper, Schwarz, and Co., 4, Old Hall-street, Liverpool	1,978 5 0
Davey, Paxman, and Co., Standard Ironworks, Colchester	1,681 10 0
E. Danks and Co., Oldbury Boiler Works, Birmingham (late)	3,058 0 0
Johnson and Phillips, Victoria Works, Old Charlton, Kent	1,585 0 0
Mather and Platt, Salford Ironworks, Manchester	2,027 0 0
Mechan and Sons, Scotstoun Ironworks, Glasgow	2,040 0 0
J. Spencer, Globe Tube and Engineering Works, Wednesbury (late)	1,846 2 6
Wheeler Condenser and Engineering Company, 179, Queen Victoria-street, E.C. (not complete)	1,251 0 0

Engineer's estimate, £1,500.

Contract No. 5.—Balancing transformers.

Allgemeine Electric Company, 25, Victoria-street, S.W.	444 0 0
Brush Electrical Engineering Company, 49, Queen Victoria-street, E.C.	587 0 0
British Schuckert Electric Company, Clun House, Surrey-street, Strand, W.C.	604 11 0
Bruce Peebles and Co., Tay Works, Bonnington, Edinburgh	815 0 0
Clayton Engineering and Electrical Company, Newton, Hyde, Manchester	935 0 0
Crompton and Co., Salisbury House, London-wall, E.C.	738 0 0
Cox-Walkers, North-Eastern Electric Works, Darlington	655 0 0
Electric Construction Company, Dashwood House, 9, New Broad-street, E.C.	744 0 0
J. Fowler and Co., Steam Plough Works, Leeds	848 0 0
International Electrical Engineering Company, Clun House, Surrey-street, Strand, W.C.	650 0 0
Johnson and Phillips, Victoria Works, Old Charlton, Kent	700 0 0
P. R. Jackson and Co., Salford Rolling Mills, Manchester	742 0 0
Lahmeyer Electrical Company, 109 and 111, New Oxford-street, W. (late)	745 0 0
Laurence, Scott, and Co., Gothic Works, Norwich	745 0 0
Mather and Platt, Salford Ironworks, Manchester	732 0 0
Mavor and Coulson, 47, King-street, Mile End, Glasgow	588 14 0
Newton Electrical Works, Taunton (accepted)	572 10 0
T. Parker, Limited, Wolverhampton	825 0 0
Paterson, Cooper, and Co., Patella Works, Paisley, N.B.	781 10 0
Rosling, Appleby, and Fynn, Trafalgar Works, Bradford	762 0 0
Royce, Cooke-street, Hulme, Manchester	625 0 0
E. Scott and Mountain, Close Works, Newcastle-on-Tyne	876 0 0
Siemens Bros. and Co., York Mansion, York-street, Westminster, S.W.	806 0 0
Thames Ironworks, Shipbuilding, and Engineering Company, Orchard Yard, Blackwall, E.	661 0 0
B. Thomas, Cornbrook Telegraph Works, Worsley-street, Hulme, Manchester	676 10 0
Veritys, Limited, King-street, Covent Garden, W.C.	749 0 0
Westminster Engineering Company, Victoria-road, Willesden Junction, N.W.	644 0 0

Engineer's estimate, £700.

Contract No. 6.—Storage batteries.

Ashmore, Benson, Pease, and Co., Stockton-on-Tees	1,364 10 0
British Power, Traction, and Lighting Company, Hull-road Works, York	911 2 0
Chloride Electrical Storage Syndicate, Clifton Junction, near Manchester	1,201 0 0
D.P. Battery Company, 11, Victoria-street, S.W.	1,132 9 5
Electrical Power Storage Company, 4, Great Winchester-street, E.C.	998 16 6
Hart Accumulator Company, Marshgate-lane, Stratford, E. (accepted)	846 19 0
A. Kramer, Norfolk House, Norfolk-street, W.C	975 0 0
E. Lomer, 12, St. Mary-axe, E.C.	975 0 0
W. O. Rooper and Co., Victoria Works, Stafford	1,043 17 0
Tudor Accumulator Company, 16, Victoria-street, S.W.	1,193 0 0
Veritys, Limited, King-street, Covent Garden, W.C.	955 0 0

Engineer's estimate, £1,100.

Contract No. 7.—Switchboard.

Allgemeine Electric Company, 25, Victoria-street, S.W.	459 0 0
British Schuckert Electric Company, Clun House, Surrey-street, Strand, W.C.	655 0 0
Brush Electrical Engineering Company, 49, Queen Victoria-street, E.C.	975 0 0
Brook, Hirst, and Co., Northgate Electrical Works, Victoria-road, Chester	947 0 0
Britannia Company, Britannia Works, Colchester	1,021 5 8
Crompton and Co., Salisbury House, London-wall, E.C.	1,050 0 0
Clayton and Co., Union Works, Huddersfield (late)	1,040 0 0
Cox-Walkers, North-Eastern Electric Works, Darlington	985 0 0
Cowans, Limited, Springfield-lane, Salford, Manchester	874 0 0
Electric Construction Company, Dashwood House, New Broad-street, E.C.	975 0 0
Edison and Swan Company, 36 and 37, Queen-street, Cheapside, E.C.	906 10 0
Elliott Bros., Century Works, Lewisham, S.E.	1,245 0 0
J. Fowler and Co., Steam Plough Works, Leeds	1,054 0 0
General Electric Company, 69, Queen Victoria-street, E.C.	1,136 0 0
S. H. Heywood, 37A, Fountain-street, Manchester	979 0 0
Hodges and Todd, 30, Hampstead-road, N.	1,350 0 0
Johnson and Phillips, Victoria Works, Old Charlton, Kent (accepted)	772 0 0
Kelvin and J. White, Limited, 16-20, Cambridge-street, Glasgow	991 0 0
Lahmeyer Electrical Company, 109 and 111, New Oxford-street, W. (late)	1,300 0 0
Mechan and Sons, Scotstoun Ironworks, Glasgow	1,220 0 0
Nalder Bros. and Thompson, 34, Queen-street, Cheapside, E.C.	1,010 0 0
T. Parker, Limited, Wolverhampton	1,048 0 0
Siemens Bros. and Co., York Mansion, York-street, Westminster, S.W.	1,217 0 0
J. G. Statter and Co., 109, Colmore-row, Birmingham	826 5 0
B. Thomas, Cornbrook Telegraph Works, Worsley-street, Hulme, Manchester	740 0 0
Veritys, Limited, King-street, Covent Garden, W.C.	996 0 0
Vaughan and Brown, 16, Kirby-street, Hatton-garden, E.C.	1,300 0 0
Walsall Electrical Company, 57, Bridge-street, Walsall	1,215 0 0
Williamson and Joseph, Northampton Works, Northampton-grove, Canonbury, N.	961 10 0

Engineer's estimate, £900.

Contract No. 8.—Arc lamps.

British Schuckert Electric Company, Clun House, Surrey-street, Strand, W.C. (accepted)	304 0 0
Brush Electrical Engineering Company, 49, Queen Victoria-street, E.C.	488 5 0
Brockie-Pell Arc Lamp, Limited, 60, Worship-street, E.C.	482 3 9
G. Braulik, 217 and 218, Upper Thames-street, E.C.	400 0 0
Crompton and Co., Salisbury House, London-wall, E.C.	384 0 0
General Electric Company, 69, Queen Victoria-street, E.C.	385 0 0
Gilbert Arc Lamp Company, Chingford, Essex	380 0 0
Improved Electric Glow Lamp Company, 7, Great Newport-street, W.C.	436 0 0 391 0 0
Johnson and Phillips, Victoria Works, Old Charlton, Kent	487 0 0
W. Lucy and Co., Eagle Ironworks, Oxford	471 2 6
New Century Arc Light Company, 28, Victoria-street, S.W. (late)	414 1 6
Ditto (if double-carbon lamps)	475 1 6
Oliver and Co., Cambridge-place, Burrage-road, Woolwich	335 8 6
Siemens Bros. and Co., York Mansion, York-street, Westminster, S.W.	390 0 0
Union Electric Company, 151, Queen Victoria-street, E.C.	480 0 0
Westminster Engineering Company, Victoria-road, Willesden Junction, N.W.	580 15 0
Walsall Electrical Company, 57, Bridge-street, Walsall	527 15 0

Engineer's estimate, £350.

Contract No. 9.—Cable work.

Anchor Cable Company, Leigh, Lancashire	3,857 6 5
Allgemeine Electric Company, 25, Victoria-street, S.W.	4,955 13 0
British Insulated Wire Company, Prescot, Lancashire	4,244 19 4
Callender's Cable and Construction Company, Hamilton House, Victoria-embankment, E.C. (accepted)	3,685 0 8
W. F. Dennis and Co., 23, Billiter-street, E.C.	4,278 19 3
W. T. Henley's Telegraph Works Company, 27, Martin's-lane, Cannon-street, E.C.	3,833 11 2
St. Helens Cable Company, 32, Victoria-street, Westminster, S.W.	4,013 8 2
Johnson and Phillips, Victoria Works, Old Charlton, Kent (late)	4,057 0 9
Siemens Bros. and Co., 12, Queen Anne's-gate, S.W.	4,614 13 4
Telegraph Manufacturing Company, Britannia Telegraph Works, Helsby, near Warrington	4,122 13 10
Western Electric Company, North Woolwich, E.	3,693 8 1

Engineer's estimate, £4,123.

Contract No. 10.—Road work.

G. Wimpey and Co., The Grove, Hammersmith, W.	3,645 8 4
Callender's Cable and Construction Company, Hamilton House, Victoria-embankment, E.C. (accepted)	2,997 15 4
T. Free and Sons, Grenfell-road, Maidenhead	3,368 6 3
T. Kavanagh, Surbiton Hill, Surrey	3,307 14 6

Engineer's estimate, £3,248 (including work already executed).

Contract No. 11.—Travelling crane.

T. Broadhurst and Sons, Central Ironworks, Huddersfield	165 0 0
J. Booth and Bros., Rodley, Leeds	225 0 0
Carrick and Ritchie, Waverley Engineering Works, Edinburgh	159 0 0
J. Carrick and Sons, Dalry Ironworks, Edinburgh	148 0 0
Chatteris Engineering Works Company, 158, Gresham House, Old Broad-street, E.C. (accepted)	105 0 0
Fairbairn, Lawson, Combe, and Barbour, 52, Lime-street, E.C.	195 0 0
W. H. and A. H. Haines, Lower Fazeley-street, Birmingham	260 10 0
J. Hetherington and Sons, Ancoats Works, Pollard-street, Manchester	245 0 0
J. Hitchen and Son, Hall-street Ironworks, Halifax	150 10 0
Ditto	130 10 0
Isles, Limited, Steam Crane Works, Stanningley, Leeds	170 0 0

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Jessop and Appleby Bros., 22, Walbrook, E.C	200	0	0
T. Larmuth and Co., Todleben Ironworks, Salford, Manchester	144	0	0
	166	0	0
A. Reichwald, Dashwood House, 9, New Broad-st., E.C.	111	0	0
Rodgers and Kaye, Listerhills-road, Bradford	200	0	0
Rushworth Bros., Primet Bridge Foundry, Colne	185	0	0
J. Spencer and Co., 5, Dowgate-hill, Cannon-street, E.C.	150	0	0
Stephens, Smith, and Co., Cuba-street, Milwall, E.....	385	0	0

Engineer's estimate, £160.

Water Softeners.—The Desrumaux Water-Softening Company, of 5, Queen Victoria-street, E.C., have received from the British Thomson-Houston Company a contract for the water-softening apparatus required in connection with the Great Northern and City Railway scheme. The plant is to treat 8,500 gallons per hour of Regent's Canal water, and to be erected at the new generating station at Poole-street, New North-road, London. The British Thomson-Houston Company have also placed with the Desrumaux Company a further order for water-softening apparatus for the Chatham tramways scheme.

BUSINESS NOTES.

TRACTION.

Shoreham.—The Urban District Council have agreed to oppose the Brighton and Shoreham tramway scheme.

Durham.—The electric tramway proposed between Durham and Brandon is the next municipal improvement to be taken in hand.

Burton.—A petition urging the convening of a town's meeting to further consider the tramway scheme for this place has been refused.

Leeds.—The tramway receipts for the past year amounted to £211,661, as compared with £169,254 in 1900, an increase of £42,407.

Berlin.—It is stated that as the result of the adoption of 1d. fares the receipts of the Berlin Tramway Company were increased by over £100,000 last year.

Bradford.—The experiment of a reduced service of tramcars between Bradford and Idle and Thackley has proved a failure, and the old time-table has been reverted to.

Wrexham.—A draft agreement has been drawn up as to the supply of current from the Corporation generating station for the working of Wrexham and district electric trams.

Southwick.—It was agreed at a meeting of the Urban District Council on Tuesday not to support the Bill of the Brighton and Worthing and District Tramways Company.

Cardiff.—Mr. Ellis, the borough electrical engineer, is confident that, given good weather, the whole work of reconstruction of the tramways will be completed within six months.

Erdington.—By a resolution passed at a special meeting of the Council on Wednesday, the promotion of a Bill for powers to construct and work tramways in the district is confirmed.

Edinburgh.—The Edinburgh and District Tramways directors have conceded the employés' demands for an increase for all cable car drivers and conductors, together with time and a half for the Sunday labour.

Luton.—It is understood that the official enquiry into the application of a syndicate for a light railways order has been fixed for Feb. 5. A special meeting of the Town Council has been called to consider the matter.

Newcastle.—The Town Council have sealed the authority to the Public Works Loan Commissioners to deliver a certificate for £50,000, the residue of the loan of £350,000 for tramway construction, to the city treasurer.

Camberwell.—Clauses having now been arranged in agreement with the views of the Borough Council, this body are recommended to petition in favour of the London County Council Tramways and Improvements Bill.

Hebden Bridge.—The dispute between the Urban District Council and the Halifax Tramways Committee as to which side of the street tram poles shall be erected in Hebden Bridge streets has been referred to the Board of Trade.

Colchester.—The Town Council have agreed to give formal notice of objection to the Southend and District, Bradwell-on-Sea, and Colchester light railway order authorising the construction of a light railway from West Mersey to Colchester.

Canterbury.—Under the Canterbury and Herne Bay light railway scheme it is proposed to establish an electricity station at Sturry, and the Town Council are taking steps so that it shall not come into competition with the works at Canterbury.

Loughborough.—The Board of Trade have, after modification, confirmed an order made by the Light Railway Commissioners authorising the construction of light railways in the county of Leicester from Loughborough to Mountsorrel.

St. Annes.—The specification of the Blackpool Electric Tramways (South) for the supply of mains, cables, pilot wires, telephone and test wires, arc and incandescent lamp wires, has been referred by the Urban District Council to the engineer for his report.

Salford.—A new route on the Corporation electric tramways has been opened. Cars now leave Blackfriars Bridge every 12 minutes for Kersal, *via* Blackfriars-road and Great Clowes-street to the Prestwich boundary. The whole run is about three miles long.

Batley.—We learn that the negotiations with the British Electric Traction Company for a lease of the tramways which the Corporation have obtained power to purchase and extend are proceeding without hitch, and that a draft agreement is being prepared.

Motor Mails.—We understand that an agreement between the Post Office and the Manchester Haulage Company has just been concluded for the conveyance of the night mails from Manchester to Liverpool and from Liverpool to Manchester by the company's motors.

Dundee.—In view of the report of the deputation to England with reference to the construction of an electric tramway from the centre of Dundee over a steep gradient to the north end of the town, the Town Council have decided to go on with the work and to take up tenders immediately.

Blackburn.—A financial statement just issued shows the development of the tramways in the town since 1899. In that year the total receipts were £21,159; in 1900, £23,584; and in 1901, £26,379. This works out at 11·98d. per car mile in 1899, 11·86d. in 1900, and 11·22d. in 1901.

Nottingham.—The Improvement Committee have asked for and been granted further time to deliberate on the scheme for the formation of a new street from Sneinton-road to Manvers-street, and the laying of the electric tramways thereon, and continuing the same to Sneinton-boulevard.

Blackpool Electric Tramways (South), Limited.—On Monday a meeting of the debenture stockholders of this Company was held at the Hotel Cecil. The proceedings were private, the Press not being admitted; and at the close of the meeting the secretary stated that no report would be issued.

Motor Highways.—A Paris telegram states that the King of the Belgians has promised to consider the feasibility of constructing a special highway exclusively for motorcars from Ostend to a point which would converge on the French frontier with the termination of another similar road from Paris.

Sunderland.—The Tramways Committee of the Corporation has received from the British Electric Traction Company notice of a Bill authorising the construction of tramways between South Shields and Sunderland and other places. The committee recommend the Town Council to oppose the application.

Newent.—A letter was read at the last meeting of the Rural District Council from the Worcestershire County Council relative to the Light Railway Bill for providing a railway through a district including Radmarley and Hartpury. A resolution that the District Council take no action in the matter was carried.

Bournemouth.—A committee representative of persons interested in carriage traffic in the town has been formed to wait upon the Tramways Committee with reference to the decision of the municipal authorities to lay wood paving throughout the main road from the County Gates to Pokesdown in connection with the tramways scheme.

Burnley.—The overhead equipment of the tramway to Padiham has now been completed. The Tramways Committee are endeavouring to get the inspectors to visit the place early so as to get the section running for public benefit as expeditiously as may be, and in the meantime strenuous efforts will be made to open out the Burnley-lane section.

Darlaston.—The Highway Committee of the District Council have considered plans prepared by the South Staffordshire Tramways (Lessee) Company for the line from the Bullstake, Darlaston, to Moxley, to be electrically equipped, and they recommend that the Council sanction the undertaking being carried out as expeditiously as possible.

Maidenhead.—The borough surveyor has been instructed to forthwith prepare plans and estimates of cost of a municipal system of light railways for the town in view of an application to the Light Railway Commissioners in May next for an order. The necessary provision for running a tramway load has been made in the machinery for the electricity station.

Scarborough.—It has been decided by the Parliamentary Bills Sub-Committee to ask the promoters of the Scarborough Tramway Bill to so alter their plans as to provide three intersecting sets of lines in Newborough-street instead of double lines, as originally proposed. This is a concession to the tradesmen of that thoroughfare, who are opposed to double lines.

Stourbridge.—In consequence of the resolution of the Urban District Council in the matter, the British Electric Traction Company have given instructions for the terms of the agreement with the Council as to cars in the Upper High-street to be strictly observed, and the service with Dudley has been reduced from one car every eight minutes to one car every 10 minutes.

Isle of Man.—The sale by the liquidators of the Isle of Man Tramway and Electric Power Company, Limited, of the electrical sections of the company's lines to Herbert Kidson, of Manchester, for £252,000 has been approved by the Manx Chancery Court. When the sale is completed it is authoritatively stated that a second dividend of 3s. 4d. in the £ will be paid the creditors.

Darlington.—The present tramway system at Darlington on Monday passed into the hands of the Corporation, who have bought it from the Imperial Tramway Company for £7,000. The Corporation have let the working of the tramway to Mr. O'Dowd, the manager under the company, who will work them until the new electric system, which is to be undertaken, comes into operation.

Rhondda Tramways Scheme.—The Bill of the Urban District Council has now been duly deposited for the next session of Parliament, by which powers are sought to construct tramways of an aggregate length of 18 miles 6 furlongs 6 chains. Borrowing powers are also asked for in respect of £170,000 for tramway construction, £135,000 for electrical equipment, and £58,000 for new roads and widenings.

London County Council Tramways.—The first section of the London County Council's southern tramways to be equipped with the

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conduit system of electric traction is that between Tooting and Westminster, and we learn that the work will be begun about the middle of March next. The contract price for the conversion of this route is £171,000, and it is hoped that the electric cars will be running on it in about 10 months' time.

Warrington.—In reply to a communication from the British Electric Traction Company, the town clerk has been instructed to inform the company that if they would submit their proposals with respect to the leasing of the tramways in writing, the same should be considered at an early date. Mr. W. H. Grimsdale, engineer in the electricity department, has been appointed (*pro tem.*) the manager of the tramways department.

Gloucester.—The City Council on Wednesday resolved to purchase for £26,000 the undertaking of the Gloucester Tramway Company, subject to the sanction of the Board of Trade, and to the granting by the Light Railway Commissioners of an order similar to that already secured by the tramway company, and which would empower the Corporation to construct and work an extended system of electric trains in the city and environs.

Grimsby.—An accident occurred to an electric tramcar in Cleethorpe-road a few days ago. The car was proceeding towards Cleethorpes, and just before arriving at the railway crossing the trolley pole became detached from the overhead conductor, and swung against a pillar in the middle of the road. The top of the pole was smashed, and the end of the trolley tore down the guard wire overhead. The car had to be towed by another to the depôt.

Geneva.—The Geneva Tramway Company have just introduced a new scale of fares. A feature of the innovation is that for 2s. a monthly ticket can now be bought entitling a passenger to two 1d. journeys a day, and for 4s. a month any number of 1d. journeys may be made during the day, Sundays and public holidays excepted. School children for 1s. 8d. per month can travel any distance up to two miles, and for 3s. 4d. they have the run over the whole tramway system.

Leicester.—The Corporation have now formally taken over the management of the tramways undertaking from the old company. The Council bought up the system in June last, since which time the directors have carried the business on in the interests of the town. The Tramways Committee of the Town Council have just completed their arrangements, and a Bill has been lodged in Parliament for substituting electric for horse traction, and for considerably enlarging the system.

Hartlepool.—Announcement was made at Wednesday's meeting of the Town Council that Mr. Paris, of the electric tramway company, had attended a meeting of the Tramways Committee, and submitted his views with regard to the duplication of the lines, the proposed extension of the system in the borough, and the terms on which the Corporation should be asked to waive their powers of purchase. It was agreed that pending further reply from the tramway company no action be taken.

Brighton.—The Town Council have instructed the town clerk to take all necessary steps to oppose the London and Brighton Electric Railway Bill in Parliament with a view to obtaining the insertion therein of clauses necessary for protecting the interests of the Corporation. One councillor declared that no scheme could have been brought before the ratepayers which would be a greater boon to them, and it was not going to cost them anything. The Hove Town Council have adopted a resolution on the same lines.

Heanor.—With reference to the Mansfield and district light railway scheme, a letter was read from the solicitors at the last meeting of the Urban District Council, stating that if the Council would support their clients' application, and the same were granted, the promoters would give the Council an undertaking to apply in May for a line from Heanor through Eastwood to Nottingham, and to construct such line at the same time as those included in the present application. The subject was referred to the Highway Committee.

Aberdeen.—The Town Council have resolved to carry out a series of works estimated to cost in all £34,446 for the electrical equipment of Albyn-place and Queen's-road, King-street, and Holburn-street car routes, and for other works connected with the extensions. The Town Council have appointed a sub-committee to consider the Echt and Skene light railway scheme. With reference to the proposed suburban tramways, the City Council have now lodged formal objections to the scheme pending a discussion with the District Committee on the matter.

Halifax.—Plans have been adopted by the Tramways Committee of the Corporation for the laying of tramways through the Pye Nest Estate to Sowerby Bridge. It is understood that powers will be obtained in the Halifax Corporation Bill of next session to carry out the extension. A special meeting of the Town Council has decided in favour of the insertion of a clause in the proposed Holmfield and Southowram light railway order, authorising the Corporation to advance to the company, either by way of loan or as part of the share capital, the sum of £10,000.

The Wages Question.—The employés engaged on the electric trams in Dudley and district have petitioned their directors for better terms. They complain that the hours are long and the pay poor. Motormen get 3s. 8d. and conductors 2s. 8d. a day. Motormen ask for 5½d. an hour for the first six months' service, 6d. for the second period, 6½d. after 12 months' service, and 7d. as the maximum after two years' service. Conductors ask for 4d. for the first six months, 4½d. for the second, and 5d. maximum after 12 months' service. Time and half rate is asked for Sundays.

Wigan.—As the result of lengthy negotiations, which, as noted last week, the Town Council were about to withdraw, the offer of the Corporation to buy the undertaking of the Wigan and District Tramways Company for £45,000 has been accepted. The committee of the Town Council dealing with the matter have agreed to this sum, and decided to make application to borrow £10,000 for new motors. The work of constructing the tramway up Library-street is to be proceeded with. The length of the lines shortly to become the property of the town is just over six miles.

Wolverhampton.—The official inspection will shortly take place of the section of the new Corporation electric tramway, which has been laid from Cleveland-road, along Bilston-road, to the borough boundary, and on which the test will be made as to the practicability of the Lorain traction system which is being laid down. Another trial has been made with a car over a portion of this line, the occasion being a visit of inspection by a number of engineers and other professional gentlemen. The car ran to the borough boundary and back, and the run was considered fairly successful.

Birmingham.—The City Council on Tuesday authorised the General Purposes Committee to prepare an amended omnibus Bill for conferring further powers upon the Corporation. It will be remembered that the original Bill, which included a proposal to construct electric tramways in Edgbaston and Harborne, was rejected by the City Council a week or two ago. A long discussion took place on Tuesday with reference to the inclusion of this proposal in the new Bill, but no division was taken on the subject. The matter now rests with the Parliamentary Sub-Committee, who will draw up the new Bill.

Proposed Tube Railway for Manchester.—Messrs. W. Percy Justyne and W. A. Jackson, the engineers to the above scheme, have prepared a detailed estimate of the cost, which has been lodged in Parliament. The line of the proposed "tube" is 2 miles 4 furlongs 4·32 chains in length, and it is estimated that the work of tunnelling alone will work out at £420,000. Stations are put down at £150,000, and land and buildings to be acquired at £429,921. Permanent way, sidings, junctions, culverts, etc., are expected to cost £24,000, and 15 per cent. extra for contingencies, brings up the total to £1,112,763.

St. Helens.—The recommendation of the Tramways Committee with reference to the carriage of goods by the tramways company came up for consideration before the Town Council on the 2nd inst. As noted in last week's issue, the proposed arrangement is that the rent payable by the tramways company for the privilege of carrying goods on the St. Helens system shall be at the rate of 2d. for every truck or car (laden or empty), and 1d. for every car entering or leaving or passing from point to point within the borough. Eventually the matter was referred back to be discussed by a joint committee of the Tramways and Parliamentary Committees.

Eastbourne.—A meeting of the Town Council was held on Monday, at which the principal matter discussed was the tramway scheme. On the recommendation of the committee, that the route should be from Fort-road, along Seaside, Seaside-road, South-street, Grove-road, to the junction of Water-lane, a long debate ensued, and eventually the matter was referred back for further consideration. A resolution was also carried that it be an instruction to the Electric Light Committee to bring up a report showing the estimated expenditure for the laying of tramways from the Archery Hotel to the bottom of Victoria-place, and from Susan's-road to Terminus-place.

Wallsend.—Messrs. Dick, Kerr, and Co., the contractors, have now made a commencement with the work of laying down the lines for the electric cars at Wallsend. The Tyneside Electric Tramways and Tramroads Company have obtained running powers through Wallsend and Willington Quay to North Shields in an easterly direction, and to Gosforth in a north-westerly direction. In addition, the company are promoting a Bill in which they seek for the powers in the Wallsend district and in the outlying areas. The entire length of rails will be about 11 miles, and the contractors hope to complete the work in about five months with favourable weather.

Cheltenham.—A hitch has arisen in connection with the application of the promoters of the light railway scheme to extend the railway to Charlton Kings and Leckhampton. In order to embrace these suburbs in the scheme the sanction of the Corporation is required, and from a report which the Tramways Committee presented to the Town Council on Monday, it appears that they absolutely refuse to further consider the draft agreement with the promoters regarding these extensions until the latter have carried out to their satisfaction certain alterations and amendments to the existing railway which the borough surveyor and the electrical engineer to the Corporation have recommended.

Hastings.—The following resolution has been passed by a meeting of ratepayers in reference to Mr. Murphy's "front-line" scheme of tramways: "That this meeting of frontagers and others expresses its strong disapproval of the proposal of the Hastings Tramway Company to construct tramways along the sea-front from Grosvenor-crescent, through Robertson-street, to the Memorial, as, in the opinion of the meeting, it would be disastrous to the best interests of the town, and would greatly depreciate the value of the most important property in the borough, and requests the Hastings Corporation to oppose the Bill." A committee has been formed to oppose the Bill in Parliament.

Walkley.—An indignation meeting has been held to protest against the "through system" of trams instituted by the Corporation of Sheffield, on the ground that since the system was initiated the people of Walkley have been worse served than under the arrangement which formerly existed. Other districts have also complained. A resolution was adopted: "That in view of the great overcrowding, unpunctuality, and utter lack of accommodation on the Walkley section of the Corporation tramways, the ratepayers, passengers, and excluded would-be passengers in public meeting assembled, strongly protest against the serious irregularities, and call upon the authorities to provide a proper service without further loss of time."

Portsmouth.—The tramways, so far as the reconstruction of permanent way and overhead equipment are concerned, having now been practically completed, the Board of Trade have been asked for sanction to run the cars over the new route. These include some important sections—Lake-road, Park-road to the Dockyard, Albert-road, and Clarendon-road being amongst them. The traffic return of the

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municipal tramways for the week ending Saturday last is of a particularly gratifying character. Notwithstanding that the trams were running only six days out of the seven, no fewer than 82,161 more passengers were carried than in the corresponding week last year, and the increased takings amounted to £321.

Prestwich.—It was reported at the meeting of the District Council on Wednesday, that the Manchester Corporation Tramways Committee had arrived at the conclusion that there was no probability that Manchester would in the near future be in a position to carry out the proposed agreement with reference to the tramways, owing to the insufficiency of their supply of electrical energy, and, further, that the hope of a service of trams on the Bury Old-road by May next could not be fulfilled. The District Council have in consequence decided to ask the Manchester Corporation to return the draft agreement now in their possession without prejudice to further negotiations between the Corporation and the Prestwich Committee.

Stretford.—Correspondence between the clerk and the Manchester tramways general manager was submitted at the last meeting of the District Council, with report of an interview by the chairman with the general manager, who stated that his committee were desirous of completing the Old Trafford and Brooks's Bar sections of their system as early as possible. With that view they proposed to give notice to the Manchester Carriage Company to work those sections for six months, from May 31, 1902, and in the event of the Stretford Council not being in a position to supply electrical energy, the Corporation would be prepared to afford a tentative supply until such time as the Council was in a position to supply its own electrical energy. This action of the chairman was approved.

City and Brixton Railway Co.—The City and Brixton Railway Company, which was incorporated in 1898, has deposited two Bills for promotion in the coming session of Parliament. In the preamble of the first, the Company state that they have not been able to raise their capital, and have not exercised any of their powers for the compulsory purchase of lands, and that it is expedient that the undertaking should be abandoned and the Company wound up. Under the second Bill, the authorised scheme is proposed to be only partially abandoned, and an extension of time is sought for the construction of the railway as modified. The share and loan capital of the Company is to be reduced, and power is sought to enter into agreements with the City and South London Railway for transferring to it the modified scheme.

Bristol.—As will be seen from our advertisement columns this week, the Bristol Tramways and Carriage Company are closing their suburban power station at St. George, Bristol, and are desirous of disposing, as a whole, of the electric traction plant therein installed. This step is being taken in consequence of the opening of the company's new central power station for the working of their entire system at Bristol by electricity. The plant which is now offered for sale is of quite recent date, having been supplied by the General Electric Company, of America, and installed by the British Thomson-Houston Company. It is estimated that the machinery would meet the wants of an undertaking operating from 50 to 70 cars. The Bristol Company have always had one of the four units in the station in reserve, and have used the plant for regularly operating a service of about 50 double-track cars.

Accrington.—The committee of the Town Council dealing with the subject of the Accrington and Burnley light railway order have resolved that the Council should themselves construct and own all tramways or light railways within the borough. Further, that in order to give effect to this resolution, the promoters of the Accrington and Burnley light railway order be required to withdraw such part of their scheme as provides for the laying of light railways within the borough, and that the Council be recommended under powers to be obtained, either by Bill or order as may be hereafter determined, to construct tramways in Burnley-road to connect by a physical junction with the light railway to be constructed under the above order, and that subject to terms and reciprocal running powers being granted to the Corporation, the promoters of the above order be granted reasonable facilities for through traffic to a convenient point within the borough.

Middlesex Light Railways.—The scheme of light railways for Middlesex, which has been developing the last two years, has now assumed tangible shape, and we understand that some of the contracts will shortly be advertised. As an instance of the defective means of locomotion in the suburbs in this quarter of London, it may be mentioned that the journey from Tottenham to Hendon at present involves a tramway and two railway journeys, the time occupied being about equal to that of a fast run from London to Bournemouth. It is this unsatisfactory state of things that the County Council of Middlesex is proceeding to remedy. The Council, however, will not work the lines themselves, having, as already announced, made agreements with the Metropolitan Tramways and Omnibus Company to lease the system to that company. The scheme, which is being engineered by Mr. H. T. Wakelam, M.I.C.E., the county engineer, is approximately estimated to cost about £2,000,000.

Aston.—The Tramways and Electric Light Committee of the District Council report that for some time past they have been in negotiation with the Birmingham and Aston Tramways Company for the purchase by private treaty of the undertaking of the company in furtherance of the notice authorised by the Council to be served upon the company. The committee are unable to agree upon the sum to be paid for the undertaking, and they therefore recommend that the Council do join with the company in an application to the Board of Trade for the appointment of a referee to determine the value. The same committee will lay upon the table at the next meeting plans and estimate by Mr. Wilson for the erection of a generating station and cables for electric lighting and tramway purposes, and recommend that the same be approved, and that the clerk be instructed to apply to the Local Government Board for sanction to a loan of £65,000, the estimated cost of the work. The committee have obtained and considered tenders for the above work, but for various reasons, more particularly the fact that the price of some of the materials on which the tenders are based has since been considerably reduced, they deem it in the interest of the Council to defer the further consideration of the tenders until February next.

Tees-side.—Application will be made by the Imperial Tramway Company to the Light Railway Commissioners, in May next, to authorise a scheme for the extension of their Middlesbrough, Stockton, and Thornaby electric tramways, the particulars of which are now nearly complete. It is proposed that the lines shall be continued from Stockton to Portrack, Billingham, and Port Clarence, and from here across country to Seaton Carew and Hartlepool; whilst, on the south side of the river, it is intended to extend the present system from North Ormesby to South Bank and Grove-hill, with a loop line along Clairville-road and Park-road to Parliament-road, Middlesbrough. It is also stated that there will be a connecting line between Middlesbrough and Port Clarence, which will involve the consideration of either bridging or tunnelling the Tees. In addition, during the forthcoming session of Parliament, a Bill will be introduced on behalf of a local syndicate for the construction of a tramway to connect North Ormesby, South Bank, and Grangetown.

South Shields.—There has just been lodged in the Private Bill Office of the House of Commons a Bill under which it is proposed to incorporate the North and South Shields Electric Railway Company with powers to construct a railway over six furlongs in length under the River Tyne, between a point in Tynemouth near the intersection of Bedford-street and Wellington-street to Stanhope-street in South Shields. The railway is to be constructed in a single tunnel with a diameter of 13ft. between the stations and 30ft. at the stations, and is to be worked by electrical power supplied from a generating station to be erected in South Shields. The capital of the company is proposed to be £180,000. The time sought for the construction of the railway is five years from the passing of the Act, and in order to facilitate the raising of the necessary capital it is proposed to expend £16,200 in the payment of interest out of capital during the period of construction. The rates for passengers are to be 2d. per single journey first class and 1d. second class. Among the promoters of the scheme who are named in the Bill are Mr. Emile Garcke, Mr. Joseph Robinson, Mr. Roland Philipson, and Mr. John Robert Hogg. It was decided by the Town Council on Wednesday to present a memorial against the South Shields, Sunderland, and District Tramways Bill complaining of non-compliance with standing orders.

London-Brighton Electric Railway.—Further particulars of the powers sought under the Bill to be promoted in the next session by the London and Brighton Electric Railway Company are to hand. The Bill proposes to confer powers on the company to construct a practically straight line of railway, 45 miles in length, from a point at 37, Ranelagh-road, Pimlico, to St. Mary's Home in Queen's-square, Brighton. It will only be necessary to close six public highways, of which five are at Brighton Only two churchyards will be touched along the whole route of the line, one being St. George's, Battersea, and the other St. Nicholas, Brighton. The generating station will be erected at Worth. The promoters of the scheme include Sir Henry Knight, Sir William Treloar, Mr. Francis Barnes, J.P., and Mr. Harding Cox, who, with three others, will be the first directors. The share and loan capital is fixed at £12,000,000. The time sought within which to complete the railway is five years from the passing of the Act, but all powers for the compulsory purchase of lands are to cease after the expiration of three years from the same period. During the time required for construction the company asks for power to pay interest to shareholders out of capital, provided that the aggregate amount so paid for interest shall not exceed £900,000. The maximum fares to be charged are the usual mileage rates of 1d., 2d., and 3d. per mile for third, second, and first class passengers respectively. The Bill will be opposed by the London, Brighton, and South Coast Railway Company on the ground of non-compliance with the standing orders as well as on the merits of the scheme. The South-Eastern Railway Company will also join in the opposition in so far as the scheme affects their traffic at Redhill.

Liverpool Overhead Railway Fire.—At a meeting of the Watch Committee of the Liverpool Corporation a letter was received from Mr. S. B. Cottrell, engineer and manager of the Overhead Railway Company, thanking the fire brigade, general police, and the salvage brigade for the prompt manner in which they arrived at the fire, and the smart manner in which they got to work, and the energy and ability that was applied by them generally. Mr. Cottrell concluded: "I am absolutely correct in stating that they did everything that was possible to do." The inquest on the bodies of the four officials of the company and the two passengers who lost their lives in the fire, was concluded at Liverpool on Wednesday before Mr. Sampson, coroner. Practically the whole of the evidence was directed to show that all the passengers on the train might have escaped to the open streets if they had left the tunnel immediately after the outbreak, instead of, as some did, stopping to watch the conflagration. Several of the passengers, called as witnesses on Wednesday, substantiated this view, one and all agreeing that had the passengers gone out in the ordinary course they would have suffered little inconvenience. The evidence of some of the officials of the line who were on the spot at the time of the fire, went to show that there were no obstructions at Dingle Station which could have prevented the passengers reaching the streets in the ordinary way. In the result the jury returned a verdict of death from suffocation, but were of opinion that there had been great oversight in storing sleepers in such a dangerous place. A silver medal was presented by the Fire Brigade Association to the boy Gough in recognition of his brave efforts to rescue passengers from the burning train.

Sheffield.—Owing to the want of more machinery at the Kelham Island electricity station, which supplies the current for the working of the municipal trams, the five generators which are installed there

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have had to be worked at over-pressure, with the result that some of the machines have broken down. Thus, No. 1 machine is out of action altogether, No. 2 has failed, but has been temporarily repaired, and two others are defective. Only one remains in a quite sound condition, but four out of the five are able to be used. It has been found necessary, however, to curtail the service of cars in order to repair the defective machinery, and the number of running cars had been reduced from 115 to 95 for all sections. As explained by Mr. Fell, the manager of the tramways, to a Press representative, there is no need for anxiety, and when the new generator which is under order is got to work the engines will be able to give sufficient power for all purposes. At the meeting of the City Council on Wednesday Alderman Clegg, chairman of the Tramways Committee, made a statement with reference to the "through" tramway service, which is arousing much dissatisfaction among the residents of the suburban districts of the city. Complaint is chiefly made on account of the irregularity of the cars. Alderman Clegg attributed this in part to the fact that some of the motormen and conductors were not in favour of the through service, and it was mainly in consequence of the determination of those men that the system should not be effective that the committee had had to suffer a large proportion of the difficulty. He concluded by saying that the through service would be carried out, and the sooner the men recognised the fact the sooner would the service be effective. At the same meeting it was announced that the committee had given an order for 100 lifeguards for the tramcars.

LIGHTING AND GENERAL.

Shrewsbury.—An extension of electric mains is to be made at a cost of £95.

Durham.—The electric light was at last installed in the city on Saturday night, and many places of business were lighted.

Sunderland.—The discussion on the question of a municipal telephone system for the borough has been further adjourned until next month.

Portsmouth.—The Corporation have received sanction to borrow £26,000 for 25 years in order to establish a municipal telephone exchange.

Mexborough.—The electrical engineer (Mr. H. Waring) in his last report states that the contractors hoped to dispatch both sets of engines by the end of this week.

Insult by Telephone.—In Paris the first case on record of "insult by telephone" came before the courts yesterday, the plaintiff being the Mayor of St. Mandé.

Dartmouth.—Approval has been given by the Town Council to the old quarry at Sand Quay being used as a site for the electric light works, which are to be started by a company.

Removal.—The offices of the Vacuum Oil Company, Limited, of which Mr. Howard B. Case is the managing director, have been removed to York House, Norfolk-street, Strand, W.C.

Ladysmith.—There is a scheme on foot for the lighting of the town, but the report of the consulting electrical engineer to the Council has been delayed owing to that gentleman's illness.

Telegraph Appointment.—Mr. I. W. Plackett, for 20 years an inspecting telegraphist for the north-eastern district of England, has been appointed to the controllership of telegraphs at the Edinburgh Post Office.

Brighouse.—At another meeting of the telephone subscribers, held a few days ago, it was decided to petition the Postmaster-General for Brighouse subscribers to be given the option of the Halifax area instead of Huddersfield.

Redditch.—In the Lighting Committee's report which was submitted to the Urban District Council on Tuesday, it was stated that the new engine and generating set would be in working order at the end of the current week.

Farnham.—An adjourned discussion was announced for last night's meeting of the Urban District Council with regard to a motion as to what steps, if any, should be taken to give effect to the Council's provisional electric lighting order.

Bury St. Edmunds.—Messrs. Hall and Hackblock, electrical engineers, of Ipswich, who recently contracted for the electric lighting installation at the West Suffolk Hospital, has just completed the work, and a great improvement has been effected.

Stafford.—The Town Council haae decided to hold a special meeting for the purpose of passing a motion for application being made to the Board of Trade for a license to supply the outlying districts beyond the borough boundary with the electric light.

Accidents.—Both the Charing Cross Electric Lighting Company and the City of London Electric Lighting Company had explosions in their manholes in the same district within 24 hours at the end of last week. Both accidents were due to leakage of gas.

Portishead.—The Bristol Corporation's application for powers to light several outlying districts by electricity, including Portishead, is being discussed by the General Purposes Committee in order to recommend as to what steps the Urban District Council shall take.

Tees Conservancy.—The Tees Conservancy Commissioners have withdrawn the demand of 10s. per annum proposed to be paid to the Commissioners by the Postmaster-General for the right of laying cables across the river, and have approved of the draft agreement as finally amended.

Canterbury.—A rental of 10s. per annum is to be paid for the electric lighting cable laid in South Canterbury Railway-road for such period until the road is taken over. Mr. Staniland, who has been appointed to Hornsey, having resigned, applications will be advertised for the vacancy.

Stroud.—The Urban District Council are discussing the advisability of opposing the Gloucestershire Electric Power Bill, in order to obtain certain concessions. The clause providing the agreement for the Council to take the electric light for at least seven years is attracting special attention.

Batley.—The Sanitary Committee have decided to ask the Town Council to approve an installation of refuse destructors of modern type, with forced draught, at New Ing Fields, with arrangements for utilising the surplus steam from the new destructors in the working of the proposed electric plant.

Ambleeote.—The Midland Electric Lighting Corporation for Power, Limited, have nearly completed their installation at Ockerhill. The chief delay is caused by the laying of the mains, but the company have no doubt as to being able to supply electric current by the beginning of March next.

Drury Lane.—The elaborate electrical effects of the great fan scene in the Drury Lane pantomime are installed on the E.L.B. system. Several thousand lamps are used nightly. The application of the system to theatrical work has mainly found favour on account of the rapidity of installation.

Copper.—The prices for copper fell from Tuesday, Dec. 31, when they stood at £48. 17s. 6d. spot per ton, and £49. 10s. three months forward per ton, to £47. 10s. and £47. 17s. 6d. respectively on Jan. 7 in the London market. The American prices declined from 13 cents to 12½ cents during that period.

Montrose.—The Lighting Committee reported to the Town Council on Tuesday that a petition had been received from 37 shopkeepers and traders in Castle-street asking for an extension of the arc lamps along Castle-street. The electric light company also intimated that they intended to lay mains in various streets.

Kensington.—Notices and plans received from the Brompton and Kensington Electricity Supply Company relative to proposed extensions of their mains in Drayton-gardens, Eardley-crescent, Cathcart-road, Abingdon-road, and Kensington-crescent have been agreed to by the Borough Council subject to the usual conditions.

Poulton.—A letter from the secretary of the Blackpool Tradesmen's Association, forwarding a copy of the resolution passed in favour of a system of municipal telephones for the Fylde by the recent conference of authorities and local subscribers at Blackpool, and asking for the Council's consideration and support, has been referred to a committee of the Urban District Council.

Railway Signalling.—The London and North-Western Railway Company is applying electrical energy to almost all its machinery in the Crewe railway workshops. The latest application of electrical energy is to the heavy cranes which lift the engine boilers and heavy weights through the shops. The company has also applied electrical energy to more than 20 miles of signalling.

Aston.—The plans and estimate of Mr. Wilson for the erection of a generating station and cables for electric lighting and tramway purposes have been approved, and the Council will apply for sanction to the necessary loan of £65,000. Tenders have been obtained for the electric lighting, but have not yet been considered. The work will be commenced about the middle of April.

Woolwich.—The Borough Council have assented to the application of the Blackheath and Greenwich Electric Light Company, Limited, to the Board of Trade for a license to supply electricity for public and private purposes within the area of the parish of Eltham on certain conditions for one year, on the understanding that the Council are not put to any expense in connection with the application.

Carnarvon.—At the last meeting of the Town Council it was resolved, on the recommendation of the Electricity Committee, that for the purposes of the provisional order the sums proposed to be expended be given as £15,000 for the electricity works and £3,000 for the refuse destructor in connection therewith. It was also resolved to thank Sir William Preece for advising the committee on this point.

York.—At the last meeting of the City Council Alderman Dodsworth, speaking on the report of the Electric Lighting Committee, of which he is chairman, said he was glad to be able to announce that he could recommend the committee to provide the arc lamps in the city at a cost of £15 yearly so soon as the number (which at present is 63) reached 100. That was a reduction of £5 upon what they started.

New Searchlight.—The Diamond Shoal lightship off Cape Hatteras will in future, in addition to the usual lights, use a new electric searchlight. By the use of a mirror a pillar of light is projected skyward, which, it is expected, will be seen 40 miles off. It is stated that if this experiment proves a success, the new mariners' beacon will be installed at Fire Island, Sandy Hook, and all other principal American stations.

Hornsey.—Mr. Norman Staniland has been appointed electrical engineer at a salary of £250 a year, to be raised to £300 a year on the starting of the supply of electricity. The Council have adopted a charge of 7d. per unit for the first 100 hours, and one of 2d. per unit beyond instead of corresponding charges of 6d. and 3d., the amended scale of charge offering greater inducement for general use of the electric light.

Greenock.—In connection with the vacancy in the post of burgh electrical engineer, a sub-committee have elected a short leet of the seven following gentlemen: Herbert Foster, Dover; Henley L. Howard, Leicester; Ernest Marples, Liverpool; H. R. Forbes Mackay, Edinburgh; W. M. Nelson, Greenock; R. W. L. Phillips, Bristol; and J. Gray Scott, Whitehaven. There were originally 56 applicants. The salary is £300 a year.

Newark.—The Urban District Council having refused the offer of the Notts and Derby Power Company to supply electricity, will now proceed to carry out their provisional order themselves, and applica-

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tion is to be made for borrowing powers. The proposed terms of supply are 5d. per unit for light and 2d. for power, with a discount to large consumers, and steps will be taken to ascertain the probable consumption and to prepare estimates.

Chester-le-Street.—The Rural District Council recently assented to an application from the Durham County Electrical Power Distribution Company, Limited, for a provisional order authorising the company to supply electricity for industrial and general purposes in the district. At the conclusion of the meeting, however, notice of motion was handed in to rescind the motion just then passed, so that the whole matter will have to be discussed again.

Latham and Burscough.—A committee of the Urban District Council is discussing a letter from the town clerk of Southport in respect of the Corporation's application to the Postmaster-General for a license to establish municipal telephones, and asking the Council to grant them facilities to enter their district—facilities which, under certain conditions, the Skelmersdale Urban Council and the West Lancashire Rural Council had already granted.

North Metropolitan Electric Power Co.—This Company, which was incorporated in 1900 to supply electricity in bulk for power purposes, has deposited a Bill for next session to amend its Act so as to supply electricity for public and domestic purposes in Tottenham, Edmonton, Enfield, Wood Green, and Southgate. Power is also sought to raise £250,000 additional share capital, with the right to borrow £84,000 by the issue of debenture stock.

Belfast.—In reference to the terms of the offer for supply of current to Messrs. Harland and Wolff's new engine works, it has been decided to add the following to the conditions regulating the charges for electricity: "Any consumer taking current for power purposes for not less than 20 hours per day on five days of the week, to the extent of an average demand of not less than half of the consumer's maximum demand, shall be charged a uniform rate of 1d. per unit."

Colchester.—The surveyor is preparing estimates of the cost of erecting a few lamps for electric light in Maldon-road; also a report as to the best mode of lighting the corner of St. Botolph's and Osborne-streets by means of a 50-c.p. incandescent electric lamp. A number of other extensions, at a cost of £705, have been sanctioned. The output of electricity during November was reported to be 28,421 units, against 17,699 in November, 1900, and 7,990 in November, 1899.

Hartlepool.—The Town Council have adopted a recommendation to the effect that application be made for a telephone license for 25 years, and that experts be asked to advise on the promotion and carrying out of the scheme for telephone service in the two boroughs; that the town clerks enquire as to terms for preparing plans and estimates and carrying out the scheme; and that the expenses of the joint administrative staff be borne in proportion to the rental of the telephone instruments.

Darlington.—Mr. J. R. P. Lunn in his last report states that the number of consumers connected during December was nine, making a total of 136. The number of 8-c.p. lamps connected during the month was 369, making a total of 10,180. He had applications from 11 consumers, who required 590 8-c.p. lamps. The number of units generated during the month was 25,300, and the cost per metered unit for coal was ·48d. The electric lighting mains are to be extended along a large number of streets.

American Trusts.—The Everett-Moore Syndicate, a huge trust with £26,000,000 capital, is reported to be in serious financial difficulties, and at the end of last week the whole of the property was turned over to a committee representing the creditors. The syndicate owned the Federal United States and Cryhoga Telephone Companies and electric tramway lines in Cleveland, Detroit, Toledo, and other cities. The liabilities are not yet known, but it is estimated that they amount to several millions.

Stafford.—The Town Council have increased the salary of Mr. Hubert Pooley to £400 per year, and have decided that in view of the fact that the electricity department were now in a position to meet the demand for the supply of electricity outside the borough, and as the obtaining of a provisional order could not be obtained for a considerable period, that steps be taken to apply to the Board of Trade for a license to supply electricity to the surrounding districts, including Rowley Park, Coton Hill, Creswell, Sandon-road, Lichfield-road, Newport-road, etc.

Warrington.—The borough surveyor (Mr. Thomas Longdin) on Tuesday submitted a report to the Street Improvement and Lighting Committee on the comparative cost of lighting streets with electric light and gas. Taking as the basis of his calculation the cost of lighting per mile of street, and comparing the electric lighting of Sankey-street and Bridge-street with the incandescent light of Wilderspool Causeway, he found that the cost per candle-power per annum for the electric arc lights was 2·64d., and for the incandescent gas lights, if lowered at midnight, 5·14d. per candle-power.

Underground Wires.—At a recent meeting of the council of the Liverpool Chamber of Commerce it was reported that the Postmaster-General had been asked to establish a direct wire between Liverpool and Emden, in Germany, in view of the fact that the latter place is a great distributing centre for telegrams for many parts of the Continent. It was further stated that Lord Londonderry had promised to have the matter carefully investigated. The importance of having the wires underground was again urged, and it was suggested that a town's meeting should be held to urge the system on the Government. The council delayed consideration of the suggestion.

Deal and Walmer.—The Deal Town Council have discussed the Kent Electrical Power Bill, also an invitation from the Dover Town Council suggesting a meeting of the authorities in Kent, with a view to opposing the Bill. They finally decided to reply that, not having seen the Bill, they were not disposed to object at present. The question as a whole will now be considered by the Electric Lighting Committee. A letter similar to that produced at the Deal Council meeting was read at the meeting of the Walmer District Council on Thursday week, and Mr. T. Denne was deputed to attend the meeting of representatives and watch the matter in the interests of Walmer.

Accrington.—The electrical engineer's last report states that the machinery and mains continued to work satisfactorily. The first new steam dynamo ran its trial at Messrs. Browett and Lindley's on the 23rd ult., and was generally satisfactory. The units delivered to mains for the week ending Dec. 7 were 4,082, the total for the year to that date being 80,172. The number of consumers connected or to be connected to the mains was 107. There were 48 applications for the post of assistant engineer, and the present switchboard attendant, Mr. A. W. Clegg, will be appointed to the post. The Town Hall and Market Committees are to be supplied with electrical energy in bulk at the rate of 4d. per unit.

King's Lynn.—The Guardians have adopted a proposal made by Mr. Pilling, the Corporation electrical engineer, on behalf of the Corporation, to complete the installation of 200 electric lights. The scheme is to include the whole of the workhouse infirmary and vagrants' ward. The circuits are to be arranged so that the lights should be under the control of the master in his office, whereby he could shut off those lights which were only required before bedtime, leaving on those lights which were only needed after bedtime. Mr. Pilling estimates that the work could be done at once at actual cost price, which would not exceed £148, and that the annual cost of the light, if ordinary care was exercised, would not exceed that of gas.

Manchester.—At the last meeting of the Electricity Committee of the Corporation it was reported that during the past fortnight the output of electrical energy had been 716,165 units as compared with 491,060 units in the corresponding period of last year. This result, it was stated, had been achieved although the number of men now employed was 457 against 571 12 months ago, and the amount of wages paid £1,300, against £1,370. The committee considered the report highly satisfactory. On Jan. 24 last year the Electricity Committee passed a resolution deferring applications for supplies of current for motor purposes. The committee are in a position to rescind that resolution, and to consider applications for the supply of current for motors.

Durban (Natal).—The Town Council have decided to inform the Natal Telephone Company that it is their intention to acquire by purchase the undertaking, plant, and business of the company on the expiration of three months' notice, in terms of Section 14 of Act 31, 1897. During November seven new connections were made to the electric light system, making the total to date 869. The total number of 8-c.p. lamps applied for was 622, making the total 42,966, exclusive of 380 16-c.p. incandescent and 79 2,000-c.p. arc street lamps. The total number of units consumed during the previous month of October was 52,818. A 600-h.p. Willans set has been erected temporarily at the Point station. This is one of three ordered for the new station in Alice-street.

St. Helens.—The new plant at the Cropper's-hill station was started and the new engine named on the 2nd inst. by Colonel W. W. Pilkington (mayor). A 600-h.p. Willans engine, coupled to a generator by the English Electrical Manufacturing Company, Preston, and an extra cooling tower are the principal items of the new plant, while an additional feeder cable, 1,500 yards long, has been laid from Cropper's-hill to the subway in Church-street. In calling upon the Mayor to start the new engine, Alderman Beecham, chairman of the Electric Supply Committee, said that electrical progress in St. Helens had been so great that they now had under consideration the idea of erecting another generating-house. With the new engine the present house was already full of electrical machinery.

Gloucestershire Electric Power Co.—A Bill has been deposited by this Company for the purpose of supplying electricity in bulk for power only in Stroud, Dursley, Wheatenhurst, Westbury-on-Severn, Aylburton, Alvington, St. Briavels and Hewelsfield, Hill, Ham and Stone, Alkington, Berkeley, Breadstone, Hamfallow, and Hinton, and so much of the unions of Monmouth and Tetbury as lie within Gloucestershire. The Company will supply electricity to authorised undertakers and to persons requiring a supply for power. The Company will not supply any electricity for lighting purposes except through authorised undertakers, provided that any persons taking electricity for power purposes may light the premises on which the power is utilised. The Company's capital is to be £250,000, in 250,000 £1 shares.

Beckenham.—An application from Messrs. Charles Peacock and Co., asking the Council to extend the cables to Trinity-road and Parish-lane, has been deferred until after the additional machinery now on order has been erected. With the assent of the British Insulated Wire Company, the Council propose to give consumers the benefit of such an alteration in the wiring charge as will enable them to use lamps up to any candle-power not exceeding 32 at the same minimum price per annum as the present agreed charge for the equivalent of 8-c.p. lamps—namely, 1s. 6d. per lamp per annum. Queen Anne-avenue is about to be made up, and enquiries are being made from the various householders if they are likely to require a supply of current, so that a cable may be laid at the same time. This is an example which might be followed in the Metropolis with advantage to everybody.

Battersea.—The Lighting Committee have agreed to an application for the supply of electrical energy to the Janus Works, in a private thoroughfare leading out of Queen's-road. Advertisements are to be issued inviting tenders for engine-room stores (including oils), electricity meters, carbons for arc lamps, and coal. The temporary offices provided for the electricity department have been discontinued, and two of the offices at the central electric generating station are being furnished at a cost of £80. The electrical engineer's last report states that up to the present time the number of applications for the supply

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of electricity, including the Council buildings, amount to 132, with an aggregate equivalent to 11,667 8-c.p. lamps; the number of actual consumers being 108, with an aggregate equivalent to 9,046 8-c.p. lamps. Applications for motive power equivalent to 48¾ h.p. have been received, and motive power equivalent to 7¼ h.p. is being actually used.

Fulham.—On Wednesday the borough electrical engineer reported that from Nov. 30 to Dec. 30, 1901, applications equivalent to 1,511 8 c.p. lamps had been received, making a total in all of 27,466 8-c.p. lamps, and that 298 services had been completed and connected to the mains, representing an equivalent of 12,594 8-c.p. lamps. The borough electrical engineer also submitted the following statement as to the refuse destroyed and clinker sold from Nov. 30 to Dec. 28, 1901: 2,904 loads of refuse (2,157 tons 2cwt. 2qr.), at 1s. 2d. per load, £169. 8s.; 208 loads of picked clinker, sold at 1s. per load, £10. 8s.; eight loads of unpicked clinker, sold at 6d. per load, 4s.; 371 loads of fine ash clinker, sold at 8d. per load, £12. 7s. 4d; 10 loads of trade refuse, burnt at 1s. 6d. per load, 15s.—total, £193. 2s. 4d., less 438 tons 11cwt. clinker, barged away at 2s. per ton, £48. 7s., making £144. 15s. 4d. Wages came to £184. 5s. 1d., to which must be added 10 per cent. for salaries and management, £18. 8s. 6d.; thus leaving a debit balance of £57. 18s. 3d.

Halifax Telephones.—The borough engineer (Mr. James Lord) has reported to the Finance Committee of the Corporation, estimating the cost of providing a municipal telephone exchange and 500 instruments at £5,450, and of laying underground cables and distributing wires to subscribers, allowing five-eighths of a mile for each, £8,000. In the report Mr. Lord recommends that a central exchange be erected in the Old Market, or other such convenient place, at a cost of £1,000; he estimates the cost of fitting-up at £500; three switchboards for local service, £1.200; one trunk-board, £300; a test-board and cross connecting board (including all the latest devices), £380; switch cable £70; connecting up power, with storage battery, etc., £250; 500 instruments, £1,750; laying of underground cables, distributing wires, etc. (including wayleaves), £8,000—total estimated cost, £13,450. The annual cost of management and supervision is put down at £1,212, and of maintenance at £300. The committee have instructed the town clerk to apply to the Postmaster-General for a license to enable the Corporation to construct and work a municipal telephone exchange.

Poplar.—The Council have decided that the paragraph contained in the resolution of the late Board of Works for the Poplar District, passed on the 9th January, 1899, that the charges to consumers be 5d. per unit for the first hour of the maximum demand per day, 4d. per unit for the second hour, and 3d. per unit for all further consumption for lighting, and 3d. per unit for the first hour of the maximum demand per day, and 1½d. per unit for all subsequent consumption for power, be altered to the following extent and effect—viz.: "That from Sept. 30 last, until further decision by the Council, the charges for electric current supplied by the Council for private lighting be at the rate of 5d. per unit for the first hour's use of the maximum demand per day, and 3d. per unit for all subsequent consumption; that the power rates to consumers of 250,000 units per annum and over be reduced to 1½d. per unit net, and that all accounts for electricity (except accounts for street-lighting and for power consumption at 1½d. per unit) be subject to 5 per cent. discount, upon condition that the accounts be paid at the works within 14 days of the receipt of the account by the consumer."

South Wales Electric Distribution Co.—A special general meeting will be held at the office of the Company, 5, Great George-street, Westminster, S.W., on Jan. 28 at 4.30 p.m., to consider the Bill applied for by the Company in the present session of Parliament, enabling them to erect generating stations, etc., at places outside the limits of their present Act. It is proposed to have one generating station at Panteg, Monmouthshire, and another in the parish of Merthyr Tydfil. The first station is for the supply of power to the patent nut and bolt works of Messrs. Guest, Keen, and Co., as well as for other purposes. A similar object is also in view in the case of the Merthyr station, for it is the intention to furnish electrical energy to the works of Messrs. Guest, Keen, and Co. at Dowlais and Cyfarthfa. The electric distribution company have powers in their present Act to erect a generating station at Treforest, where they intend to spend about £250,000 to supply current for the electric tramways, and also the lighting of the district of Pontypridd. The contract for a portion of the machinery is let, and the contract for the remainder will be let very shortly.

Stock Exchange.—The Stock Exchange Committee have appointed Jan. 15 as a special settling day for Electrolytic Alkali Company's 122,985 ordinary shares of £1 each fully paid, Nos. 1 to 35,000, 58,147 to 68,913, and 75,001 to 152,218, and 50,000 7 per cent. cumulative preference shares of £1 each fully paid, Nos. 1 to 50,000, and ordered the said securities to be quoted in the official list. Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to National Telephone Company's £983,333 preferred stock, and £1,966,667 deferred stock, in lieu of the ordinary shares now quoted, and £200,000 6 per cent. preferred shares of £5 each, £2 paid. The committee have also been asked to appoint a special settling day in Central Electric Supply Company's £250,000 4 per cent. guaranteed debenture stock, and Marconi's Wireless Telegraph Company's 12,735 shares of £1 each fully paid, Nos. 137,084 to 149,819. The committee have further been asked to allow the City and South London Railway Company's £150,000 5 per cent. perpetual preference stock, 1901, to be quoted in the official list.

Middlesbrough.—The North-Eastern Railway Company are at the present time engaged upon large alterations and extensions to the existing dock accommodation, and electricity will be largely utilised for both motive and illuminating power. The generating-house recently erected close to the docks is one of the largest in the North of England. The steam cranes formerly used on the quays are now being replaced by 67 powerful electric cranes, which are of great height, the distance from the quay to the centre of the pulley at the end of the jib being 60ft., whilst the radius is 44ft. 9in. Each crane is carried on a pedestal which will run on the railway lines alongside the quay. It is operated by an electric motor placed on the lower part of the pedestal. Separate motors are provided for hoisting and revolving, the current being supplied by underground cables through coupling boxes placed at convenient distances along the quay. The load is lifted at 150ft. per minute, half loads being lifted at 225ft. a minute. The revolving speed at the hook is 400ft. per minute, and the travelling speed 40ft. These speeds, however, can be reduced as required, whilst, in addition, an automatic brake is provided in case of failure of the current.

Newcastle Electric Supply Co.—This Company seeks power to extend its area of supply so as to comprise the rural district of Castle Ward, the urban districts of Newburn, Benwell and Fenham, Cramlington, Westslade, Seghill, Earsdon, Whitley and Monkseaton, Cowpen, and Blyth; the rural district of Tynemouth (with the exception of the parishes of Long Benton and Willington); the borough of Morpeth, the urban districts of Newbiggin-by-the-Sea, Ashington, and Bedlingtonshire, and the rural district of Morpeth. The Bill also proposes to establish a sliding scale between the price charged for energy and the dividend payable by the Company. The standard dividend is for this purpose to be fixed at 8 per cent. per annum, with the power to increase it by 4s. per cent. in respect of every 1¼ per cent. by which the average price charged by the Company has been below the standard price. A corresponding decrease in the dividend is to take place for every 1¼ per cent. by which the average price obtained by the Company has been above the standard price. Power is, however, given to make good any deficiency in any dividends which fall below the standard rate of dividend, and to create a reserve fund for the purpose.

Eastbourne.—The proposed municipal telephone scheme was on Monday last postponed for two months, when it will be discussed at a meeting specially convened for the purpose. Mr. A. R. Bennett, the engineer, in his report states that Grove Hall would be the most suitable place for a municipal exchange, and that an outlay of £10,800 would include a route to Willingdon. With regard to tariffs he says: "An average of receipt of £5. 7s. 6d. per line per annum is desirable at first, although I should expect a reduction to £5, or even £4 per annum would be found possible after a short experience." Mr. Bennett puts the estimated annual revenue (580 subscribers at £5. 7s. 6d. average receipt) at £3,269. 10s. and the expenditure at £2,988; net revenue, £280. 10s. 4d. The Corporation would also save the £70. 15s. paid annually to the National Telephone Company, and the £30 paid annually to the contractor for the upkeep of the borough telephone and fire-bell lines. The Telephone Sub-Committee reported to the Council on Monday that the cost of acquiring the National Telephone Company's system in Eastbourne was prohibitive. The committee recommended that Mr. Bennett be engaged as engineer, and that the Council apply to the Local Government Board for power to borrow £10,800 as set out in his report.

Doncaster.—Colonel Hepper has held an enquiry into an application of the Town Council for power to borrow a further sum of £16,487 for purposes of electric lighting. The town clerk (Mr. T. B. Sugden) said the application could be put under three heads—to make good the excess over what was estimated to be their expenditure when they applied for their first loan; then for additions which had been carried out during the construction of the works either for the purpose of improving or making the works more economical in their working, or on account of the extensions which grew up as the works were in course of erection; and the third was for further extensions, and particularly for the purpose of putting down the plant in order to enable the electricity works to supply current to the tramways undertaking, which was in course of construction. The Corporation, under the Light Railways Act, had obtained an order, under which they had power to construct a series of light railways or electric trams not only within the borough, but running out to Balby, Hexthorpe, Bentley, and Wheatley. In several of those districts the Corporation owned estates, and the tramway would be a considerable benefit to them. The Electricity Committee would supply the Tramways Committee with electric current, but in order to enable them to do so they required further plant. Dealing with the excess of their original estimate of £29,240, he said they exceeded that by £1,614, or, to be absolutely fair, they should deduct from the £29,240, £600, for work which they did not actually carry out, so that their estimate was exceeded in actual expenditure by £2,214, which was not a very great excess in an expenditure of £30,000. At the time they carried out the works it was at the top of the boom, and it was almost impossible to get quotations for work. The contractor for one item only told them that in a few weeks the price of material had gone up 30 per cent., and now they had got contracts for constructing car-sheds which would cover a larger area of roof at a less price than was obtained for a previous contract.

Swansea.—At the last meeting of the Swansea Electric Lighting Committee Mr. Prusmann, the resident engineer, reported that the number of consumers on the books was 182. He referred to the necessity for extensions in the plant and the mains, and reviewed the successful work during the heavy Christmas demand. He saw no reason why the street-lighting should not be completed in a few days. As soon as the high-tension plant was installed it would be necessary to run three shifts during the 24 hours, and no time must be lost in commencing the alternating work. With regard to the cost of street-lighting, he said the arc lamps gave 25 per cent. more light than usual, while the cost was £25 per lamp, the actual cost of the current being £18. 18s. 2d. These figures just covered with a small

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margin of profit all the expenses incurred. He was already prepared to supply a day load. The position of the consulting engineers (Messrs. Kincaid, Waller, and Manville) was discussed, and it was tated that the remaining work they had in hand was the extension to Sketty and Morriston, for which they had been asked to prepare specifications. It was agreed that 4d. per unit should be charged to churches and chapels.

Leicestershire and Warwickshire Electric Power Bill.—A Bill has been deposited by which power is sought to incorporate a new electric power company for the supply of electricity within a large area, comprising parts of the counties of Leicester and Warwick. The capital of the company is fixed at £750,000, with the right to increase this amount to £1,000,000 by the issue of £250,000 debenture stock. The company seeks power to erect six generating stations at Cathiron Spinneys, in Newbould-on-Avon; at Leek Wootton; Whitacre Station; and on other lands in Leicestershire, at Hinckley, Glenfield, and Measham. It is, however, provided that no power for the compulsory purchase of these lands shall be put in force until £100,000 of the capital shall have been subscribed. Provision is made to enable the company to apply for provisional orders within its area of supply, which comprises the whole or parts of the parishes in Warwickshire within the unions of Stratford-on-Avon, Southam, Rugby, Warwick, Solihull, Meriden, Coventry, Foleshill, Lutterworth, Nuneaton, Atherstone, Tamworth, and so much of the union of Aston as is not comprised within the county borough of Birmingham. In Leicestershire the area of supply comprises all or parts of the unions of Hinckley, Market Harborough, Uppingham, Billesden, Blaby, Leicester, Market Bosworth, Barrow-upon-Soar, Ashby-de-la-Zouch, Shardlow, Loughborough, Melton Mowbray, and so much of the Lutterworth and Atherstone unions as are comprised in the county of Leicester.

Worthing.—The work in connection with the erection of the generating station is practically completed, and the cost has been about £5,100. Having regard to the additional work which has devolved on the surveyor outside his ordinary duties in connection with the construction of the works, and to the satisfactory results which had followed his employment for the purpose, by which a sum amounting to over £1,700 has been saved to the Corporation (the lowest tender received of contractors for the execution of the work was £6,870), the Electric Lighting Committee have advised the Council to increase his salary for the current year by the sum of 100 guineas. The consulting engineers and the borough surveyor have reported upon a scheme prepared by the latter providing for the construction of a shallow well on the station premises about 25ft. in depth, lined with concrete tubes, into which the water used for condensing purposes could be discharged under pressure from the condensers, and by means of a stoneware overflow pipe, 18in. in diameter, carried along Lyndhurst-road to the sewage outfall works, and be there connected with the old sewer outfall and discharged into the sea. In order that the overflow pipe might be used at convenient periods, it was proposed to construct a pond at the outfall works sufficient to hold a supply of water equal to four hours' pumping. The scheme submitted has been prepared with the main object of avoiding the larger outlay which it would be necessary to incur if provision were made for carrying the water at high pressure direct to the sewage outfall (a course which would render necessary the laying of cast-iron mains for the purpose, so as to withstand the pressure), and the cost of carrying it out was estimated by the borough surveyor at £2,600. On Tuesday the Council approved of the scheme, subject to the Local Government Board sanctioning a loan, and the borough surveyor was directed to prepare detailed plans and estimates.

Wrexham.—The resident engineer has submitted returns of the work done by the refuse destructor, which, after being shut down on Oct. 23 for cleaning and overhauling, commenced supplying steam on Nov. 7. It worked in November 21 days, as follows: in combination with the Babcock boilers, seven days; exclusively, 14 days—generating 7,481 units. There was an immediate improvement on Nov. 18, after the flues had been cleaned with special tools, and such improvement continued although the demand for steam rose as high as 843 units on the 30th. In the boiler flues the dust was found to be from 9in. to 12in. deep after six days' work, and must have been a serious hindrance on all heads when allowed to accumulate for three months without cleaning, as suggested by the makers. To the above must be added steam used as follows: condenser engine pump, water-softener and well pumps, together with steam blowers of furnaces, that alone consumed 15 to 20 per cent. of steam generated. The improvement continued, and the demand for more power had further increased to 931 units for Dec. 11, and showed that the destructor was working remarkably well under all heads. The destructor had worked in December exclusively 14 days, generating 9,409 units; and in November 7,481 units—total, 16,890 units for 28 days, not including Sundays. Increase in December, 14 days over November, 1,928 units generated with destructor alone. It was recommended that no further test be made by Messrs. Meldrum Bros., and the engineer was congratulated on the results obtained, and was left at liberty to accede to Messrs. Meldrum's request to be allowed to publish his figures. The town clerk's statements show the cost of destruction of refuse as compared with deposit at tips as follows: total charge in capital expenditure on the destructor was £2,229. 16s. 2d.; cost of removal of house and shop refuse for the half-year ended Sept. 30, 1900, £509. 19s. 6d.; cost of removal for the half-year ended Sept. 29, 1901, £531. 4s. 4d.; statement of cost for destroying refuse for the half-year ended Sept. 30, 1901, including half-year's instalment of loan and interest (£55. 1s. 6d.), £351. 3s. 9d.

Long Eaton.—Colonel W. Langton Coke has held an enquiry in the High-street Board School, Long Eaton, relative to an application by the Long Eaton Urban District Council to borrow £15,000 for work of electric installation. Mr. E. Williams, clerk to the Council, said Mr. F. Worrall, C.E., surveyor to the Council, had submitted a report setting forth that, in point of the compact area of the parish, it was specially suitable for the electric light. Mr. Crowther, of Wallasey, had also submitted a report to the Council, and it was practically endorsed by Messrs. Hopkinson and Talbot, engineers. A provisional order was obtained, and in May, 1900, Mr. Crowther's scheme was accepted by the Council. Application was made to the Board of Trade, and sanction was obtained. Tenders were then received as follows: Messrs. Danks and Co., £925; Lancashire Dynamo Company, £4,240; and British Insulated Wire Company. £2,156; lamp and street-making, £750; buildings, chimney, etc., £2,700; boilers, etc., £925; and together with other matters brought the sum to £15,000. Mr. Williams concluded by stating that time and customers had been lost, and unless this matter were expeditiously carried on, probably other customers would fall off. Mr. J. H. Crowther, electrical engineer, Wallasey, said he submitted a three-wire scheme for the Council. It was proposed to use steam for generating purposes. The engines and boilers were sufficiently large to allow for extension. It was proposed to utilise the present gas lamps for street-lighting, a small sum having been included for alteration. The estimate of running the double lamp was £3. 10s. per annum. There would be 1,920 yards of feeder cable and 2,300 yards of distributing cable. He calculated that they would get 7s. 6d. per lamp, and £350 revenue for motors. He expected the cost of generating would be 1¼d. per unit. That would include all working expenses, but not office expenses. He did not think this was a low estimate, with the probability of getting cheap fuel. Long Eaton was, in his opinion, far more favourable for the electric light than Llandudno. The Council would be able to provide for depreciation after a time. Meter rents would pay for the cost, so he had not allowed anything for that.

Hackney.—The report of Electric Lighting Committee submitted last night contained a report of the consulting engineer on the question of three additional boilers and water-softening apparatus, in which he referred to the fact that his original scheme provided plant for dealing with a load of 50,000 8-c.p. lamps all burning at one time, permitting the fixing on consumers' premises of about 75,000 8-c.p. lamps. This corresponded to an active load of 1,500 kw., to which must be added a certain percentage to allow for loss in the mains and current used for lighting and power in the works. The total capacity of plant provided, including the battery, amounted to 2,100 kw., of which about 1,800 kw. represented the steam-driven plant, the larger sets each having a capacity of 600 kw. The total capacity of the works was, therefore, sufficient to sustain a load of 1,500 kw. with one large set of steam plant in reserve. To provide for the generation of 1,500 kw., Mr. Hammond says: "I specified for boilers of a capacity, when coal-fired, of 60,000lb. of steam per hour, and at the time I contemplated placing the whole of these boilers in the refuse destructor works, as had been done in the two combined refuse destructor and electricity works then erected in London, the idea being to work boilers, during the bulk of the 24 hours, with the fumes from the refuse destructors, and to coal-fire them during the period of top load. In finally setting out the plant, however, it struck me that if the business assumed important proportions in Hackney, the time would come when the larger part of the generation would be done by boilers exclusively coal-fired, and with a view to the future I considered it wise to detach three of the boilers from the refuse destructor house and to use them to form the nucleus of a coal-fired boiler-house. Now, in view of the excellent prospects which there appear to be before the works, I recommend that tenders should at once be obtained for a further three boilers, which erected during the summer, will be ready to go into commission next autumn. By the provision of these three boilers it will not be necessary, except in the case of very great emergency, to coal-fire any of the destructor boilers. This will tend to minimise the works costs, because all the coal-fired boilers will be fed with coal automatically, whereas in the case of the destructor boilers the coal must be wheeled in from the outside. A suitable water-softening plant would cost from £500 to £800 according to size. The smaller plant would be sufficient for present purposes, but the larger plant would suffice for all the boilers which could conveniently be disposed on the present site. The difference in price is so small that the larger plant is, in my opinion, to be preferred. We have now had some experience of the East London water, and although our purifiers are working splendidly, I feel confident that capital sunk in a softening plant would not be thrown away. My estimate of the total cost of the three additional boilers, superheaters, pipework, water softener, etc., is £7,500." In accordance with this advice, the committee recommended that three additional boilers, superheaters, pipework, water-softener, etc., be provided, and that advertisements inviting tenders for the work be issued.

PROVISIONAL PATENTS, 1901.

DEC. 21.

26087. An improved rebate system for the sale of electric energy. George Marinier, 15, Park-mansions, Battersea, London.

26095. Improvements in the construction of combination pocket wire-cutters. John Roberts Watts, 17, Haymarket, Sheffield.

26098. Improvements in apparatus for controlling electric motors. John Henry Hindle, 130, Hyde-road, Gorton, Manchester.

26112. Improvements in primary electric cells or batteries. Samuel George Wider, 73, Dunard-street, New City-road, Glasgow.

26119. A fuse carrier with spring action for use on distribution boards used for electric lighting and power purposes. George Turnock, Park View-cottages, Thornton Hough, Cheshire.

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26131. Improvements in electric insulators for high-potential lines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles E. Barry, United States.) (Complete specification.)

26132. Improvements in electric circuit breakers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett and Charles C. Badeau, United States.) (Complete specification.)

26133. Improvements in glowers for pyroelectric lamps and process of making the same. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

26134. Improvements in means for transmitting synchronous motion to distant points. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Louis Saxon, United States.) (Complete specification.)

26135. Improvements in means for starting alternating-current dynamo-electric machines. The Thomson-Houston Company, Limited, 83, Cannon-street, London. (Jonathan E. Woodbridge, United States.) (Complete specification.)

26136. Improvements in ground detectors for electric circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles C. Badeau, United States.) (Complete specification.)

26137. Improvements in electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William B. Potter, United States.) (Complete specification.)

26138. Improvements in electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William B. Potter, United States.) (Complete specification.)

26139. Improvements in electrolytic arc lights. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William T. Dean, United States.) (Complete specification.)

26159. A new or improved electric trumpet. Edward Robert Dale, 55, Chancery-lane, London.

26161. Improvements in hoods for use in connection with telephones. Edwin William Smith, Fife House, Kingston-on-Thames.

DEC. 23.

26197. Improvements in electric arc lamps. Emile Batault, 10, Rue Sénébier, Geneva, Switzerland.

26203. Improvements in horseshoe electromagnets. Paul Schneider, 62, St. Vincent-street, Glasgow. (Complete specification.)

26227. Improvements relating to electromagnetic switches and to methods of controlling or operating the same. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (McElroy-Grunow Electric Railway System, United States.) (Complete specification.)

26229. Improvements in or relating to secondary electric batteries. Harry White, 45, Southampton-buildings, Chancery-lane, London.

26232. Improvements in dynamo machines. Conrad Knowles Dumas, 21, Finsbury-pavement, London.

26237. Improvements in accumulators. Frédéric Nicolas Blanc, 24, Southampton-buildings, Chancery-lane, London.

26241. Improvements in apparatus for signalling between ships, shore, and other objects by means of electric or Hertzian waves. George Hughes, 55, Chancery-lane, London. (M. A. Moray, Trinidad.)

26251. Improved means and appliance for starting electric lamps of the "Nernst" kind. Emanuel Cervenka, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26255. Improvements in or relating to electric railways. Alfred Julius Boult, 111, Hatton-garden, London. (Luigi Negro, Italy.)

DEC. 24.

26285. Improvements in electric switches. Henri Pieper, 24, Temple-row, Birmingham.

26286. Improvements in contact makers for use in connection with electrically-fired internal-combustion engines. Henri Frenay, 24, Temple-row, Birmingham. (Complete specification.)

26307. Improvements in connection with message counters for telephone exchanges. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actiengesellschaft Mix und Genest, Germany.)

26316. Improvements in means for regulating electrical oscillations. John Ambrose Fleming, the Electrical Laboratory, University College, Gower-street, London.

26328. Means of performing electro-chemical reactions. Richard Pearson and Octavius March, 53, Chancery-lane, London.

26340. Improvements in controllers for electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Otto Holtz, United States.) (Complete specification.)

26341. Improvements in multiple conductors for electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Alexander D. Lunt, United States.) (Complete specification.)

26342. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Elihu Thomson, United States.) (Complete specification.)

26343. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Albert G. Davis, United States.) (Complete specification.)

26344. Improvements in insulated electric conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William Le Roy Emmet and Wallace S. Clark, United States.) (Complete specification.)

26345. Improvements in means for transmitting electrical energy. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Jonathan E. Woodbridge, United States.) (Complete specification.)

26346. Improvements in controllers for electric automobile vehicles. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Hermann Lemp, United States.) (Complete specification.)

26347. Improvements in systems of electric generation and distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

26348. Improvements in starting alternating electric current machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Jonathan E. Woodbridge, United States.) (Complete specification.)

26349. Improvements in electric transmission of power. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

26358. Improvements in or relating to circuit breakers for electric current circuits. Ernest Francis Moy, Percy Henry Bastie, and Ernest F. Moy, Limited, 37, Essex-street, Strand, London.

26363. An improved insulating material and process of manufacture of same. Victor Karavodine, 72, Cannon-street, London.

26369. Method of and means for transmitting power from electromagnetic devices to movable bodies. Richard Thomas Glascodine and Henry Harding Kenshole, 46, Lincoln's-inn-fields, London.

36373. Improvements in microphones or microphone transmitters for electrical sound transmission. Friedrich William Senkbeil, 6, Lord-street, Liverpool. (Complete specification.)

26377. Improvements in induction electric meters. Otto Titus Bláthy, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26380. Improvements in and relating to telegraph poles. William Blackwell Crossland, 77, Chancery-lane, London. (Complete specification.)

26387. A new or improved maximum demand indicator for electric currents. William George Hibbins, 9, Regent-street, London.

26393. Improvements in telephonic transmission and in apparatus therefor. Douglas Hubert Sturman, Norfolk House, Norfolk-street, Strand, London.

DEC. 27.

26420. Improvements in the method of and means for ascertaining and recording the consumption of current in electrical traction. Charles Hibbert Berry and William Thomas Hill, 5, John Dalton-street, Manchester.

26436. A new or improved reflector or shade for electric lamps and the like. Osmond Yeadon Rhodes, Commercial-street, Halifax. (Complete specification.)

26472. An improvement in single-phase alternating-current motors. James Burke, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26474. Improvements in electrical valve apparatus for actuating the air brakes of railway trains. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

26475. Improvements in maximum demand indicators for measuring and recording electrical currents. William Reginald Ridings and Veritys, Limited, 165, Queen Victoria-street, London.

26476. An improved electric switch. Sidney Benjamin Marshall, 165, Queen Victoria-street, London.

26482. Improvements in electric telegraphy. Anthony Bernard Tubini, 173, Fleet-street, London.

26483. Improvements in electric demand indicators. James Grieve Lorrain, Norfolk House, Norfolk-street, Strand, London. (Hector Alan Macdonald, France.)

26487. Carbide electrodes for arc lamps and process of manufacturing the same. Robert Hopfelt, 53, Chancery-lane, London.

26484. Improvements relating to electric railway systems. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Central Electric Construction Company, United States.) (Complete specification.)

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26485. Improvements relating to electric railway systems. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Central Electric Construction Company, United States.) (Complete specification.)

DEC. 28.

26496. A frame former or jig for winding coils for the armatures of dynamo-electric machines. Montague Tabor Pickstone, of the firm of D. Bruce Peebles and Co., Tay Works, Bonnington, Edinburgh. (Complete specification.)

26510. An improved "resistance ball" applicable to overhead tramway wires. John Arthur Penny, 4, St. Ann's-square, Manchester.

26512. Improvements in or in connection with trolleys, switches, junctions, or the like used in connection with overhead wires for electric traction. David Blythe Foster, 6, Lord-street, Liverpool.

26517. Improvements in or connected with apparatus for electrically igniting miners' safety lamps. William Best, 33, Chancery-lane, London.

26524. Improvements relating to the laying of underground electric conductors for lighting and power. William Phillips Thompson, 6, Lord-street, Liverpool. (Frank Davis, Belgium.) (Complete specification.)

26535. Improvements in and in the manufacture of carbide electrodes for arc lamps. Robert Hopfelt, 53, Chancery-lane, London.

DEC. 30.

26553. Improvements in cable drum wagons. Samuel Rawlinson, William Rawlinson, and John Rawlinson, Penny Bank-chambers, Halifax.

26566. Party-line telephone system. Frank Eugene Mayberry, 1, Broad-street-buildings, Liverpool-street, London. (Complete specification.)

26590. Improvements in windings for electrical machines. Benjamin Garver Lamme, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, June 26, 1901, being date of application in United States.)

26600. Improvements in and relating to telegraphic and telephonic systems. Louis Maiche, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, July 19, 1901, being date of application in France.) (Complete specification.)

26604. Improvements in instruments for recording varying magnetic fields or the currents producing them. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

26626. Improvements in electric telegraphy. Anthony Bernard Tubini, 173, Fleet-street, London.

26634. Means for connecting an alarm bell in a local system to the telephone exchange. Parnell Rabbidge, 40, Chancery-lane, London.

DEC. 31.

26646. Improved method of and means for lubricating the axles or bearings of tramcars and wagons used on electric tramways and light railways. Edward John Saner, Longport, Stoke-on-Trent.

26655. Improvements connected with electric collector trolleys. Owen Richard Owen, 10, St. George's-crescent, Liverpool.

26658. Improvements in apparatus for hermetically enclosing and insulating the junctions of conductors for electric currents and other purposes. Victor Bornand and Frederick Charles Lynde, Old Exchange, King-street, Manchester.

26659. Improvements in electric light brackets or pendants. Roughsedge Wallwork and Charles Henry Wallwork, 64, Barton-arcade, Manchester.

26673. Improvements in apparatus for the generation and electrolytic application of electric currents. Francis Edward Elmore, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

26678. Improvements in and relating to electro-mechanical controlling mechanism for looms for weaving. John Couper Edwards, 55, Chancery-lane, London. (Complete specification.)

26690. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Elihu Thomson, United States.) (Complete specification.)

26691. Improvements in electric circuit controllers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. Edward M. Hewlett, United States.) (Complete specification.)

26692. Improvements in electric current limiting devices. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Samuel L. G. Knox, United States.) (Complete specification.)

26693. Improvements in electric circuit breakers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Robert H. Read, United States.) (Complete specification.)

26694. Improvements in electric circuit breakers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Robert H. Read, United States.) (Complete specification.)

26695. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Henry Geisenhoner, United States.) (Complete specification.)

26696. Improvements in electric rheostats. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (John L. Hall, United States.) (Complete specification.)

26697. Improvements in electric rheostats. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William C. Yates, United States.) (Complete specification.)

26698. Improvements in systems of electric distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

26699. Improvements in the manufacture of filaments for incandescent electric lamps. William Lawrence Voelker, Clun House, Surrey-street, Strand, London.

26700. Improvements relating to the electric lighting of railway trains and to apparatus therefor. David Carl Henry, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26702. Improvements in controlling devices for connecting storage batteries with a charging circuit. Joseph Woodman Stover and Nathan Harry Suren, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26714. Improvements in or relating to electric accumulators regenerative by gases. Otto Zöpke, 322, High Holborn, London.

26721. Improvements in material and devices for electric insulation and the formation and protection of electric distributing systems, cables, and the like. William Windle Pilkington and William Reginald Ormandy, 6, Lord-street, Liverpool.

26729. Improvements in electric battery. Thomas Jefferson Bain and Jesse Orra Hunt, 40, Chancery-lane, London. (Complete specification.)

26731. Improvements in controlling attachments for the trolley poles of electric tramways. Robert John Barry, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26743. Improvements in electric arc lamps. Joseph Henrik Hallberg, 18, Buckingham-street, Strand, London. (Complete specification.)

26746. A new or improved process or method of manufacturing electric or other lamp globes. Ernest Bohm, 99, Cannon-street, London.

26748. Safety indicating apparatus for electric line wire circuits. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

26749. Improvements in safety fuses. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

26754. Improvements in apparatus for use in charging storage batteries. Joseph Woodman Stover and Nathan Harry Suren, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

26759. Improvements in or relating to means for supplying current to electric vehicles. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Maschinenfabrik Oerlikon, Switzerland.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Jan. 18.

1900.

23432. Electric bells. Lambert and Veritys, Limited.

23491. Means for extinguishing arcs formed on the breakage of electric circuits. Minshall.

23492. Methods for testing electric circuits. Minshall.

23610. Signalling jacks for multiple telephone exchanges. Ericsson.

23729. Secondary batteries. D'Arnoult. (Date applied for under International Convention, June 22, 1900.)

23743. Windings for use in alternating electric current systems. Arnold, Bragstad, and La Cour.

23790. Means for the avoidance of hunting of synchronous alternate-current machinery running in parallel. Leake.

1901.

2171. Controlling mechanism applicable for use with electrically-driven air pumps. Hill. (Date applied for under International Convention, July 2, 1900.)

2877. Safety devices for guard wires of trolley wires and other conductors. Munro.

4429. Electric storage batteries or accumulators. Chaplet.

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23387. Device for automatically breaking circuit of trolley wires. Barber and Ulmann.

4586. Primary batteries. Gauzentis.

23804. Electric motor systems. British Thomson-Houston Company, Limited. (Baker.)

23805. Electric circuit breakers. British Thomson-Houston Company, Limited. (Badeau.)

23990. Poles for electric railways, electric lights, and telephone and telegraph lines. Conger.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	Jan. 4	948	899	+ 48	—	—
Birmingham Tramways	—	—	—	—	—	—
Birkenhead Corporation	—	—	—	—	—	—
Blackburn Corporation	,, 3	769	678	+ 91	—	—
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 6	197	193	+ 4	—	—
Bolton Corporation	,, 5	2,059	1,800	+ 259	—	—
Bradford Corporation	,, 5	821	717	+ 104	—	—
Bristol Tramways Company	,, 3	4,304	3,685	+ 619	—	—
Carlisle Tramways Company	,, 4	164	145	+ 19	—	—
Central London Railway	,, 4	6,108	5,847	+ 261	—	—
City and South London Railway	,, 5	3,176	2,204	+ 1,152	—	—
Cork E. T. and L. Company	,, 2	113	158	− 45	—	—
Darwen Corporation	,, 3	258	197	+ 61	—	—
Dover Corporation	,, 4	193	180	− 13	—	—
Dublin & Lucan Electric Railway	,, 5	68	69	− 1	—	—
Dublin U. T., electric cars	,, 3	1,615	1,447	+ 168	—	—
Dublin S. District, Electric	,, 3	317	310	+ 7	—	—
Dundee Tramways Company	,, 1	806	661	+ 145	—	—
Glasgow Corporation	,, 4	13,015	11,534	+ 1,481	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 4	1,766	1,621	+ 145	—	—
Liverpool Corporation	Dec. 28	9,144	9,104	+ 40	—	—
Liverpool Overhead Railway	Jan. 5	1,402	1,543	− 141	—	—
Newcastle-on-Tyne Corporation	,, 4	1,271	—	—	—	—
Portsmouth Corporation	,, 4	1,051	663	+ 388	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 5	3,973	—	—	—	—
Southampton Corporation	,, 2	821	657	+ 163	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £397 decrease.

Barcelona Ensanche y Gracia, £2 increase. Barcelona, £357 increase.

Brisbane, £267 increase (month of Dec., £1,322 increase).

Buenos Ayres and Belgrano Electric, £48 decrease.

Calcutta, £20 decrease.

Cape Town (month of Oct.), receipts, £14,063; expenditure, £6,817.

La Capital Traction and Electric, Buenos Ayres (month of Nov.), £1,973 increase.

Mexico Electric (month of Nov.), receipts, £17,300; expenditure, £10,500.

Perth Electric, £238 increase.

Port Elizabeth (month of Oct.), receipts, £3,240; expenditure, £1,960.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Tramways.—	£	£
Anglo-Argentine, 1-260,007	5 ..	3⅞-3¾
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-126 xd
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2¼-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	101-103 xd
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6¼-7
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9-9¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13¼-14½
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12-12¼
—— 5 per cent. Perpetual Debenture Stock	100 ..	126-129
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1¾-2
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106 xd
—— Prov. Cert., all paid	100 ..	97-100 xd
Cape Electric Tramways, Nos. 1-400,000	1 ..	1⅞-2⅛
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11-12
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22¼
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	102-104 xd
New General Traction, Ordinary	5 ..	2¼-3¼
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	96-100 xd
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	8s. ..	7/16
—— £250,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	40 p.c. ..	40 p.c.
Commercial and Industrial.—		
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅝-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅜-½
—— Ordinary, 1-125,000	1 ..	⅜-½ xd
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	108 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	7⅛-8⅛
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5⅝-6⅛
—— 5 per cent. Mortgage Debentures	100 ..	101-104 xd
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5¼-5⅜
Brush Electrical Engineering, Ordinary	2 ..	1⅜-1⅝
—— Nos. 90,001-105,731	2 ..	1⅜-1⅝
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	97-100 xd
Callender's Cable, Debentures	100 ..	110-114 xd
—— Ordinary	5 ..	16¼-17½
—— 5 per cent. Pref.	5 ..	5⅜-6 xd
Crompton and Co.	3 ..	3-3¼
—— 5 per cent. Debentures	— ..	99-104 xd
Edison and Swan United, Ordinary	3 ..	⅛-¼
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	78-83 xd
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	84-89
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼ xd
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16¼-17½
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	112-116
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22 xd
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15¼-16½
Telegraph Construction and Maintenance	12 ..	36-40
—— 5 per cent. Bonds	100 ..	102-104 xd
Telegraph Manufacturing, Ordinary	5 ..	10¼-11½
—— 5 per cent. Cum. Pref.	5 ..	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	9¼-10¼
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	103-106
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	97-102
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9¼-10½
—— Debenture Stock, Red.	100 ..	100-103 xd
Brompton and Kensington, Ordinary	5 ..	8¾-9¼
—— 7 per cent. Preference	5 ..	8¾-9¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7⅛-8⅛
—— Nos. 20,001-30,000	5 ..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14¼ xd
—— ,, ,, £10 Ord.	6 ..	10¾ xd
Charing Cross and Strand ,, ,,	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5-5¼
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	103-106
Chelsea Electricity Supply	5 ..	5⅛-6
—— 40,501-50,936	5 ..	5⅛-6
—— 4½ per cent. Debentures	100 ..	108-111 xd
City of London, Ordinary	10 ..	9-10
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	121-126 xd
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104 xd
County of London and Brush Provincial, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	104-107 xd
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5⅛-6
—— 6 per cent. Cum. Pref.	5 ..	5⅛-6
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-4⅜
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5⅜
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	103-106
Kensington and Knightsbridge and Notting Hill	100 ..	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	94-98
Metropolitan, Ordinary	10 ..	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-115 xd
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	96-99 xd
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9½
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7⅛-8
—— £4½ Shares, New	4½ ..	6¾-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-2¼
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15¼-16½
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	97-100 xd
Westminster, Ordinary	5 ..	11¼-12¼
Electric Railways.—		
Central London, Ordinary	100 ..	105-108
—— 4 per cent. Pref.	100 ..	105-108
—— ,, ,, deferred	100 ..	106-109
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-119
City and South London, Consolidated Ordinary	100 ..	62-64
—— Ordinary	10 ..	6-6¼
—— Nos. 60,001-70,000	10 ..	6-6¼
—— 4 per cent. Debenture Stock	100 ..	113-117
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Telephones.—		
National Telephone, Ordinary	5 ..	3¼-3⅜
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-5
—— 4 per cent. Deb. Stock, Red.	100 ..	94-97 xd
—— 3½ per cent. Deb. Stock, Red.	100 ..	93-103 xd
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

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NOTES.

Royal Institution.—After the discourse by Lord Rayleigh on "Interference of Sound," to-night, at the Royal Institution, his Grace the Duke of Northumberland (president) will unveil and present to the institution, on behalf of the subscribers, a bust by Mr. Onslow Ford, R.A., of Sir Frederick Bramwell, Bart., D.C.L., F.R.S., who filled the position of hon. secretary to the Royal Institution from 1885 to 1900.

British Exhibition in Russia.—We understand that the Russian Administrative Committee of the British Exhibition at St. Petersburg has appointed as manager and secretary for Russia Mr J. H. Johnson, of 12, Voznisensky-prospect, St. Petersburg. Mr. Johnson will be in attendance at the London offices of the British Commissioner, 22, Conduit-street, W., from 20th inst. to Feb. 1, in order to afford information to intending exhibitors.

Birmingham Local Section.—At the ordinary meeting of this section of the Institution of Electrical Engineers on the 22nd inst., a paper will be contributed by Mr. W. Kingsland dealing with "Surface-Contact Systems of Electrical Traction." We understand that the discussion of Dr. Sumpner's "Note on Alternate-Current Diagrams," and his paper on "The Testing of Motor Losses," read at the meeting on Dec. 11 will be taken at the meeting fixed for the 12th proximo.

Exhibition in the Bahamas.—Some time ago we announced the intention of certain influential gentlemen in the Bahama Islands to hold an exhibition there with a view mainly to promoting the interests of British manufactures in that quarter. We are now advised that the exhibition has been postponed for one month, and will be opened at the beginning of March. This delay, we are informed, has been caused by the fact that some of the firms who have intimated their desire to be represented at the exhibition have found the time too short to prepare samples.

Faraday House.—As the result of the recent scholarship examination, the Board of Control of the Electrical Standardising, Testing, and Training Institution have made the following awards: to Alfred Thomas Morris, of Bedford Modern School, a Maxwell scholarship, value 50 guineas, tenable for two years; to William Leighton Chubb, of Dunheved College, Launceston, an exhibition value 30 guineas, tenable for two years; to Alban Cecil Whish, of Hillmartin College, an exhibition value 20 guineas, tenable for two years; to Herbert William Swann, a special prize of 15 guineas; and to Eustace Blackburne Ritson, of Shrewsbury Public School, a special prize of 10 guineas.

Photographing Electric Sparks.—Experiments to show the effect of an electric spark applied to a photographic plate have been carried out in America with successful results. The tests were made in a darkened room under a deep red light. The plate was held between the electrodes of the machine by means of a non-conductor, with the sensitive side of the plate toward the discharging conductor. The photographs thus secured are said to be really photographs of miniature lightning. The electric charge struck the plate, and went around it to the other conductor, following the line of the least resistance, and left an irregular line of light, quite like a photograph of lightning.

Heating of Railway Carriages.—We understand that a few saloon cars of the Great Central Railway are now using electrical heaters for maintaining an even temperature. The energy used is obtained in the same way as that required for electric lighting—*i.e.*, by means of a small dynamo driven from the axle of the train. In parallel with this machine is a battery of accumulators, which maintains the current while the train is standing in stations. It would be interesting to know if this system of heating is calling for an appreciable increase in the coal required on the locomotive. Even if this is so, as is to be expected, the convenience of the electrical method of heating may more than compensate for the slight additional cost.

Electric Traction in Berlin.—It is announced that the overhead scheme for the Berlin electric railway has had to be abandoned, on account of the opposition of the Charlottenburg residents. Another reason for relinquishing the overhead system is the consideration of the future need of continuing the line through the centre of the town. As at present planned the railway will extend between the Warsaw Bridge and the Potsdamer Platz, on a normal gauge. A service of 2½ minutes is contemplated. A train will consist of three carriages, with a total seating capacity for 120 passengers. There will be two motors on each train. The arrangements will be such that, if required, a fourth carriage may be added, or double trains run. At the present time the journey between the Silesian Gate and the Zoological Gardens occupies 42 minutes by the available means of transport, but the Berlin Electric is to cover the distance in half that time.

Marconi Experiments.—Mr. Marconi, who is now in mid-ocean on his way here from New York, has announced his intention of assuming the direction of a series of experiments to see what effect the telegraph and telephone wires of the great Metropolis will have upon wireless telegraphy. To this end the tests will be made between Chelmsford, in Essex, and a town in Dorsetshire, so that the signals in order to reach either station will have to cross London. No attempt has up to the present been made to send wireless telegraphic messages over London, and it is thought by some that the presence of a great network of telegraph and telephone wires such as exists in the Metropolis will have a weakening effect on the clearness and accuracy of the signals. We learn that at the Chelmsford station four poles, each over 100ft. in height, are being erected, and that the experiments will commence immediately after Mr. Marconi's arrival in London. The results should be instructive.

Electric Tramways for Adelaide.—An interesting report on the electric tramway systems of Europe, America, and Australia has been published by Mr. Thomas Roberts, the chief mechanical engineer of the South Australian Government Railways, who was appointed to visit those continents for a study of the various methods of tramway construction and working generally. While crediting Hamburg with having one of the largest and best tramway systems on the Continent, he is of opinion that the Sydney electric tramway system is one of the finest examples of overhead construction in the world. Probably it is on the strength of this conclusion that he recommends overhead trolley construction for the city of Adelaide in preference to the conduit or surface-contact systems. Mr. Roberts estimates that Adelaide could be provided with an efficient system, including power-house, permanent way, feeder cables, overhead construction, cars, etc., for £10,000 per mile. In those streets where wood paving would be adopted, however, this cost would be materially increased.

Institution of Junior Engineers.—A large party consisting of members of this institution visited the extensive factories of the Mazawattee Tea Company at New Cross on the 9th inst. The works contain many features of engineering interest, and a very instructive afternoon was spent. Nearly five acres are occupied by

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the area of the factories, a prominent feature in their exterior being the chimney, 150ft. high. Electric driving and lighting is employed, the steam plant installed having an aggregate horse-power of about 1,000. Water is obtained from an artesian well 460ft. deep, worked by compressed air, the delivery from which is about 4,000 gallons per hour. The electric generating and distributing plant, tea leadfoil-rolling plant, sprinkler installation, condensing plant, etc., were all in their turn inspected, the many ingenious devices in connection therewith attracting much attention. The next meeting of this institution takes place at the Westminster Palace Hotel on Friday, 7th prox., when a paper will be read by Mr. W. J. Cooper on "The Electric Passenger Elevator."

Alternating-Current Meter.—Mr. K. O. F. Schrottke, of Berlin, has recently been granted a patent for an alternating-current meter, which has for its object the provision of an improved means for adjusting the phase difference between the shunt field and the voltage impressed upon the shunt circuit. The principle is applied to a motor meter with a ring field having four projecting poles 90deg. apart, and may be described as follows: Designating the legs of a three-phase circuit by the numerals 1, 2, and 3, the leg 1 is in series with the windings on two opposite poles; the other two opposite poles each carry a separate shunt winding, one of which is connected across the legs 1 and 3, and the other across the legs 1 and 2. The two shunt coils are wound in opposite directions. The field due to the coil 1-3 is dampened, and that due to the coil 1-2 is strengthened in order to maintain the desired displacement of 90deg. To obtain a resultant field perpendicular to either of the shunt voltages, the ratio of the ampere-turns between the coils is changed until the displacement of the resultant field has reached its desired magnitude.

The Electrical Crisis in Germany.—The annual report of one of the large electrical companies of Germany, whose name we, for obvious reasons, prefer to withhold, affords an excellent illustration of the present stagnation of the electrical manufacturing industry in that country. The state of affairs as it will be presented to the shareholders is, indeed, a bad one. For instance, the company's report shows an actual deficit for the year of over £400,000, the share capital of the concern being but one million. Of this total deficit, £77,800 represents the loss on working. As compared with a profit of £163,575 in the previous year, this is most telling. It has been found necessary, indeed, to write down stocks to the extent of £114,518 and investments by £112,802, and in order to reduce the deficit to £245,320, the directors have drawn upon the reserve fund to the extent of £151,461, and also on two other accounts. They attribute the present critical state of the company's finances to the diminution in the value of the securities held by them, the decline in the value of raw materials, and the heavy amounts which have had to be written off for depreciation.

Electrical Conductivity of Sodium.—The current number of the *Journal* of the Chemical Society abstracts a paper on the above subject by Mr. Giuseppe di Ciommo as follows: "The author has measured the electrical conductivities of solutions of various concentrations and at various temperatures of sodium and potassium hydroxides in 96 per cent. glycerol, the method of measurement being that of Kohlrausch. The results, which are given in the form both of tables and curves, show that the conductivities are much less than those of aqueous solutions of the hydroxides, the maximum values in glycerol being less than one-millionth of those in water. At the temperatures employed, 14deg. to 30deg., the maximum conductivity of sodium hydroxide in glycerol occurs with a concentration of 5 per cent, the corresponding concentration for potassium hydroxide being 7·03 per cent. These concentrations are directly proportional to the molecular weights of the two hydroxides, a relation which does not hold in the case of aqueous solutions. The temperature coefficients of the conductivities are very high, reaching the values 0·21 and 0·17 for sodium and potassium hydroxides, whilst for aqueous solutions the maximum values of these coefficients are 0·03 and 0·07 respectively. In both glycerol and water the maxima of conductivity correspond with weaker solutions of sodium than of potassium hydroxide.

Lectures on Railway Subjects.—Our attention is called to three courses of lectures on railway subjects shortly to be given at the London School of Economics and Political Science, 10, Adelphi-terrace, W.C. The first course, consisting of six lectures, begins on Wednesday next at 6.30 p.m. Mr. W. M. Acworth, M.A., is the lecturer, his subject being "The Economics of Railway Administration." Prof. W. A. S. Hewins, M.A., the director of the school, will deliver the second course on Friday evenings on "The Policy of Different Countries in Relation to Railways." The first of these will be given to-night at 6 p.m. The third course is on "Electric Traction on Railways," and will be delivered by Mr. Lynden Macassey, B.A., LL.B., on Mondays at 6.15 p.m. In this course, which commences on the 10th prox., the lecturer is expected to refer to the necessity, in many cases, for improvement in motive power on railways, the peculiar advantages of and economy resulting from electric traction, and the conditions most favourable for its adoption. Mention will also be made of the various systems of electric traction in use, together with an enumeration of their individual advantages and limitations. Some general information may be added as to the extent to which electric traction has been adopted on the railways of the world, and the results, so far as is possible to ascertain, obtained thereby.

Division of Power in Isolated Plants.—In many isolated electrical power plants there is a period when only a part of the maximum output is required, as in the case of a hotel, where during the day only a few lamps are burning and perhaps one or two lifts running, while at night the full load is demanded. Writing in the *American Electrician* for January, Mr. H. F. Schmidt suggests a method by which a heavy and light load can be obtained at the smallest first cost and yet the equipment be operated at very good efficiency. His proposal is to have two engines between which the dynamo is placed, this being coupled to the engines by two electric clutches, one at each end of the dynamo shaft. The engines for preference are of two sizes, although they may be of the same size, in which case each would be equal to one-half the rated capacity of the dynamo. They may be arranged in two different ways. Thus, in the first case, the large engine may be equal to the rated capacity of the dynamo and the smaller engine just large enough to carry the day load, one engine being run at a time. Alternatively, the size of the engines may be so chosen that the sum of their separate powers is equal to the capacity of the dynamo, the smaller of the two being run for the light load and both together for the full load. In each case the engine would be used at its maximum efficiency and the dynamo at a very good efficiency, both of which results, according to the writer, are obtained at small first cost. To put on the second engine when the first is running, it is only necessary to bring it up to full speed and then apply the clutch through the action of a small rheostat, this taking on the load without shock. The smaller engine is then disconnected

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by releasing its electric clutch. This plan was tried and proved a failure at the works of the City of London Electric Lighting Company. The difficulties with the magnetic clutches proved fatal to the system.

Reduction of Copper by Solutions of Ferrous Salts.—The precipitation of copper by solutions of ferrous salts is a reversible action, the direction of which in any case is determined by the relative concentration of the ferrous, ferric, and copper (cuprous and cupric) ions. This statement is justified by the following experimental evidence, abstracted from a paper by Mr. H. C. Biddle, in the current number of the *Journal* of the Chemical Society. In a solution containing an appreciable quantity of ferric ions, or in which these would be formed in the course of the reaction, copper is not deposited; this is shown by the fact that ferrous chloride and sulphate are incapable of reducing the corresponding copper salts. In a solution containing a few ferric ions, and in which the reaction does not cause an appreciable increase of them, a sufficient concentration of ferrous and copper ions will produce the deposition of copper. The tendeney of ferrous salts to reduce those of copper is shown by the precipitation of cuprous thiocyanate when ammonium thiocyanate is added to a solution of ferrous and cupric chlorides. From a mixture of ferrous and cupric hydroxides crystals of cuprous oxide slowly separate. When an excess of ammonium carbonate is added to a solution of ferrous and cupric chlorides a yellow liquid is obtained, which gradually deposits a mirror of metallic copper. If a solution of cupric and ferrous chlorides is treated with sodium carbonate in slight excess, or with potassium hydrogen carbonate, reduction slowly takes place with loss of carbon dioxide and formation of basic ferric carbonate and copper.

Proposed Cable to Scotland.—An interesting suggestion is to be brought before the Postmaster-General by a joint deputation from the Edinburgh and Glasgow Chambers of Commerce with regard to telegraphic interruptions between London and Scotland. It is that the Post Office should lay a submarine cable from the Thames to the Firth of Forth, with connections for Glasgow and Edinburgh. A cable of this character is estimated to cost about £110,000, and in view of the loss to commercial interests through the frequent breakdowns due to storms in the telegraphic service to Scotland, this outlay seems insignificant. As an instance of the heavy loss which often falls upon private individuals through these breakdowns, we could give no better illustration than the case quoted at the conference on London telephones at the Guildhall on Monday. It will be seen from our account of these proceedings, that during the severe interruptions to the telegraphic service between London and Birmingham and London and Manchester in November and December last, certain newspapers who lease private wires from the Post Office at heavy annual rentals were deprived of the use of the same for 19 days, and had in consequence to bear the very great expense of sending their London "copy" over the public wires, and then only with serious delay. Reverting to the case of Scotland, the feeling of the representative citizens of Glasgow in this matter was well reflected at a meeting of the Chamber of Commerce in that city last Monday. Intense indignation, we read, was expressed at the repeated telegraphic breakdowns, and it was shown that in November and December last the loss to the Post Office on this account was about a quarter of a million, outside the loss to commercial interests. The deputation which has been appointed to wait upon Lord Londonderry will, we understand, press for the adoption of underground telegraphic and telephonic communication with Scotland as well as urge the importance of a submarine cable round the coast. We are afraid that a submarine cable, on account of the slower rate of transmission, would not greatly help matters in the case of a total breakdown of the land lines.

Secondary Reactions in Electrolysis.—A Franklin Institute paper by Mr. J. W. Richards on this subject is abstracted in the *Electrical World* of New York as follows: The author defines primary electrolysis as the action of the current whereby it directs the ions towards the electrodes and liberates them as ions at the electrodes; secondary reactions are such reactions of the ions upon themselves, or the electrodes, or the electrolyte, whereby substances other than the ions come into existence at the electrodes. The work done during electrolysis is of two kinds: (1) the work done in overcoming the ohmic resistance of the bath; (2) the work done which is rendered latent as chemical energy. The latter energy includes not only the chemical energy expended in the primary electrolysis, but also the energy expended in the secondary reaction. The total chemical work of the current is represented by that required to transform the original ingredients into the compounds of substances which come into existence by the electrolysis, whether of primary or secondary origin. He discusses the calculation of the voltage required for an electro-chemical reaction from the thermo-chemical data. He classifies the secondary reactions into the following four types: the ions polymerise into more complex forms; the ions decompose or dissociate into simpler forms; the ions react upon the electrodes; the ions react upon the electrolyte. The action at the cathode is a reducing action, at the anode an oxidising action. Instead of oxidising in this general sense, he recommends calling it "perducing," the reverse of "reducing." A large number of examples are given, when the product at the electrodes is either a gas, or a liquid, or a solid soluble or not in the electrolyte. For all these cases the equations are given, and the voltage is calculated from the thermo-chemical data. Among the processes discussed are Salom's lead reduction by using lead sulphide as cathode in an acid solution, the Castner cell for producing caustic soda, and many others.

Royal Institution Christmas Lectures.—The series of Christmas lectures delivered by Dr. J. A. Fleming at the Royal Institution on waves and ripples has proved a great success, and the lecture theatre of the institution has been regularly filled by appreciative audiences. This was only to be expected in view of Prof. Fleming's reputation as a skilful experimenter. The numerous experiments which were given on waves and ripples in air, water, and other media and the experiments on æther waves were most interesting, and attracted the attention of the juvenile portion of the audiences. We noticed on the occasions we were able to be present that sitting with the children was a considerable number of our foremost scientists and engineers, who took a keen interest in the remarks of the lecturer. The last two afternoons were devoted more particularly to electrical oscillations and waves, and on these occasions considerable mention was made of wireless telegraphy. In view of the intimate association which exists between the lecturer and Mr. Marconi, we naturally expected some reference to the Transatlantic experiment. The information given, however, was often of a negative character. For instance, we were shown a Marconi coherer in use, and the beauties of this delicate apparatus were fully explained to the audience, but we were then informed that this was not of the type of coherer used in the Transatlantic experiment. Again, Dr. Fleming explained that with the frequency employed by Mr. Marconi in his signalling to

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Newfoundland, the wave-length came out at about 1,000ft. long. He then explained that the distance between the two signalling stations was 1,800 nautical miles, and that a straight line between them would penetrate 110 miles below he surface of the earth. The interesting question then arose as to the actual path taken by the waves, and did they follow the curvature of the earth? By experiment it was shown to the audience that water is a non-conductor of these ætheric waves, and soon damps them out. They are, however, reflected at the surface of water. The same thing applies to the rarefied air of the upper atmosphere. Hence Dr. Fleming suggested that it was by the successive reflections of the waves between the surface of the Atlantic Ocean and the rarefied upper layers of the atmosphere, that the waves were successfully made to follow the curvature of the earth.

Central-Station Rules.—We give elsewhere in this issue a reprint of the regulations as to the supply of electrical energy which Mr. C. H. Wordingham has drawn up for the Stretford Urban District Council. The first point that strikes one in perusing these is that Mr. Wordingham has made a step towards standardisation, in that he has not attempted to include wiring regulations in the same. Instead of this, he requires that all wiring shall be done in accordance with the rules and regulations of the Institution of Electrical Engineers. This is distinctly the right course, and the rules which are now before us, dealing only with such matters as will affect the regularity of the supply, can obviously be enforced by the powers of the electric lighting order. In reading through the rules it will be noticed that the system of charging is based on a fixed sum per quarter per kilowatt capacity installed, and an additional charge of 1½d. per Board of Trade unit. While this is quite clear to electrical engineers, we think that for the benefit of the non-technical consumers it would be better expressed in a fixed charge per 8-c.p. or 16-c.p. lamp installed per quarter. It is obvious that in making out this charge the engineer will have to assume a certain number of watts per candle for the lamps installed, and in consequence the charge will really become in lighting installations so much per lamp per quarter. Of course, the schedule which we reproduce as to the average price per Board of Trade unit should be fairly clear to consumers, but no one knows quite without previous experience how many hours per annum he will use his maximum demand. We observe that in the case of motors which have to be kept running for more than 48 hours per week, the fixed charge is limited so that the quantity can only cost 1½d. per Board of Trade unit. This is the correct step towards increasing the motor load on the station. It will also be seen that under these regulations the Corporation have to provide the main switch in each building, which, we believe, is a somewhat novel course. The insulation resistance required before an installation will be connected to the mains is fixed at 50 megohms, divided by the number of lamps, or, say, by the number of wiring points, which is the correct basis. In the case of arc lamps being mixed with incandescents, one arc lamp is taken as equivalent to 10 wiring points. In the case of motors, one megohm of insulation resistance is required between earth and any part of the motor carrying current. Further on will be seen a regulation, No. 19, for preventing the disturbance of the voltage of supply by suddenly switching-on motors without first inserting resistance. These regulations are to be commended as being reasonable in design and moderate in their requirements.

Tramways and Light Railways.—Sir C. Rivers Wilson, G.C.M.G., C.B., made a very interesting speech at the second general meeting of the Tramways and Light Railways Association, which was held on Thursday week at Hamilton House, Victoria-embankment. His remarks were particularly directed to a consideration of the electric tramway and light railway industries from the legislative point of view. He pointed out that if schemes were promoted in Parliament by private Bill or under the Tramways Act, they were liable to be blocked by the veto of local authorities; if they were promoted under the Light Railways Act, the opposition of any railway company was practically fatal. In view of this state of things Sir Rivers Wilson suggested that it would be for the general advantage of the industry that there should be a means of bringing every scheme of electric tramways or light railways before a responsible tribunal, which would hold a local enquiry and be empowered to decide on the broad ground of public interest. He next referred to a short Bill which was entrusted to Mr. Gerald Balfour late last session, in which some of the proposals of the above association were embodied. Even this short and weak measure, however, was never considered by Parliament. After a lapse of nearly six months, and on the eve of another session, the President of the Board of Trade had appointed a departmental committee to consider proposals for the amendment and extension of last year's Bill. Their association respectfully hoped that the committee would have the courage to deal with the question boldly, and that the Government would pass into law the recommendations made to them. Sir Rivers Wilson went on in forcible language to attribute the present inefficiency of the electric traction industry in this country to the restrictions devised by the Legislature itself. In spite of all obstacles, however, electric traction had made considerable progress during the past year. Last January there were 1,200 miles of tramways in operation in the United Kingdom, including horse, steam, and electric traction. The latest figures for electric traction alone showed that there were 777 miles actually constructed, 533 miles in course of construction, and 927 miles authorised and about to be constructed, making a total of 2,237 miles. They were a long way from the figures of their American and Continental friends, but progress had been made, and he believed that public opinion was awakening to the beneficial results to be obtained from this species of enterprise. He announced that in July next the Union Internationale Permanente de Tramways would meet in London, and that in connection with the visit an exhibition of tramcars and light locomotives would be held at the Agricultural Hall, Islington. The following gentlemen have been elected to fill the vacancies on the council: Messrs. T. O. Callender, C. H. Gadsby, Hugh C. Godfray, F. J. Trewitt, A. M Willcox, and Thomas Howe.

All-British Cables.—The Pacific cable scheme which the British Government have in hand for providing direct communication with Australia and New Zealand by means of exclusively British lines, has provided an interesting topic of discussion as to the advantages arising from State-owned submarine cables. In a consideration of the subject, the question of tariff is an all-important factor, and the scheme which Sir Sandford Fleming has submitted to the Canadian Postmaster-General urging the importance of a British State-owned cable between England and Canada furnishes some valuable information on this subject. In the first place, he estimates that such a cable would cost, in round figures, about £400,000, and that the charges for interest, etc., together with cost of maintenance and operation, calculated on the basis adopted by the Imperial Committee for the Pacific cable, would reach the tota

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sum of about £33,200 per annum. In his reckoning of what the annual return on this outlay would be, Sir Sandford Fleming considers the case of a cable capable of transmitting something like 20 paying words per minute working duplex, and being employed continuously throughout the 24 hours of every day of the year. On this basis he estimates that the State-owned Atlantic cable would be capable of transmitting a maximum of 10,000,000 paying words per annum. This volume of traffic, reckoned at the exceedingly small rate of 1d. per word, would give a gross return of £40,000, a sum in excess of the total annual charges referred to above for maintaining and operating the line. With regard to Sir Sandford Fleming's assumption of a continuous load on the cable for 24 hours each day, we gather from his proposals which have reached this country that this could be obtained without much difficulty. A large majority of persons would be satisfied, he assumes, to have Transatlantic messages delivered within the day on which they might be dispatched, provided the cost be reduced to, say, one-fifth of the rate now charged by the companies, and, in brief, his proposal for ensuring a 24-hour load is that urgent messages should be subjected to an extra charge, while those messages which would be dispatched in the order in which they were received should be charged at the low rate. In view of these considerations, Sir Sandford Fleming can see no reason why the standard rate chargeable for transmission by the State cable should not in the first instance be made 2½d. per word for ordinary messages and 1s. for urgent messages. In his opinion, a low tariff such as this would revolutionise Transatlantic correspondence, greatly tend to promote and augment business, and exercise a powerful influence in bringing about closer union. The sources of business for the new cable would be three-fold—*i.e.*, Australian, Canadian, and United States. It would, in fact, become an indispensable adjunct to the Pacific cable, which is to be completed and in operation within the present year, as most of the traffic would require to pass across the Atlantic and through Canada. On the other hand, the Canadian Transatlantic cable would not be established for the purpose of competing with existing lines for United States traffic; its objects would be national. Sir Sandford Fleming also advocates the acquisition by the Dominion Government of all the land telegraphs in Canada.

Discharge from Glowing Carbon.—In a paper recently presented to the American Association for the Advancement of Science, Mr. E. Rutherford gives the results of an investigation of the discharge of electricity from glowing platinum and the velocity of the ions. From a theoretical consideration of the subject the author is led to the following conclusions. Firstly, that the current is independent of the intensity of the ionisation—*i.e.*, of the temperature of the plate—beyond a certain limiting value; for the equation giving the current does not involve the intensity of the ionisation at the surface of the plate. Secondly, that the current is directly proportional to the square of the voltage between the plate: and thirdly, that the current is directly proportional to the velocity of the ions and inversely as the cube of the distance between the plates. The apparatus used for carrying out the experiments consisted of a piece of platinum foil 14cm. long, 7·5cm. wide, and ·002cm. thick. This was secured at either end to copper plates, and a current of electricity passed through it in order to heat it up to various temperatures. The whole system of the dynamo, regulating resistance, and ammeter supplying this strip of platinum was raised to a certain voltage above earth by means of a battery of accumulators. The apparatus was, of course, insulated. Then opposite the strip of platinum were placed two copper plates, which were connected with earth through a galvanometer. In order to obtain uniform electrostatic field these copper plates were surrounded by guard rings. The galvanometer was compensated for magnetic disturbances due to the large current circulating in the main leads. Experimenting with this apparatus the author found that the platinum plate when charged at 600 volts above earth commenced to discharge positive electricity at a temperature just below red heat. The deflection for a given potential difference between the plates increased rapidly with rise of temperature. The effect of increase of temperature of the platinum plate on the amount of current for a given potential difference varied with the distance between the plates. For a distance of 3cm. and over the current first increased rapidly to a maximum, remained practically constant over a short range, and then steadily diminished with increase of temperature to a white heat. For a distance of 2cm. and under the current first increased rapidly and then more slowly with rise of temperature, but did not pass through any maximum. Curves are given in the paper showing the results, and how the discharge varied with voltage and with the distance between the platinum and copper plates. When working with a negative charge no discharge was appreciable until the platinum plate had reached nearly a white heat. Curves for the negative discharge are also given by the author. From the results obtained he then determines the velocity of the ions. His conclusions are summarised as follows: The velocity of the positive ions drawn from glowing platinum is not a constant for given conditions, but may vary within wide limits. The velocities of the ions increase with increase of the temperature of the gas through which they pass. Further, the velocities calculated from the theoretical formula are too small. For 2cm. distance between the plates the difference between the theoretical and experimental values is not large, but the difference increases with distance apart of the plates. For 5cm. the calculated velocity is less than one-half of the average velocity. The final conclusion which the author draws from the results is that the velocity of the ions deduced from measure of the limiting current does not necessarily represent the average velocity, and is much less than the maximum value of the velocity. The author goes on to compare the values of the velocity of the positive ions drawn from flames as determined by Mr. C. D. Child, and published in the *Physical Review* for February and March last year, with those drawn from glowing platinum. He shows, for instance, that the calculated velocities of the positive ion in both cases are not very different for distances of 4cm. to 7cm. The velocity of the flame ions is, however, considerably smaller for distances of 2cm. to 4cm. As already stated, however, the calculated values given by the author for the platinum ions are far too small, on account of the divergencies between experimental and ideal conditions. The method which was employed by Mr. Child is a very simple and accurate one of determining velocities, provided the ions all travel with the same velocity—*i.e.*, are all of the same size. The presence, however, of some slow-moving carriers between the electrodes may diminish the value of the current, and the resultant calculated velocity may be much too small. Whether such slow-moving carriers are produced in the case of flames as in the case of glowing platinum, cannot be definitely answered without a special investigation. The presence of even a small number of large nuclei, such as are produced by smoke or fumes, tend to make the calculated velocities too small. For these reasons the author is of opinion that the measurements of velocity of the ions close to the electric arc must be interpreted with great caution.

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ELECTRIC LIGHT AND POWER INSTALLATION AT THE LANCASHIRE COUNTY ASYLUM, RAINHILL.

In the following article is described the arrangement of an electric plant installed at the Lancashire County Asylum, Rainhill, for supplying the lighting and power requirements of the establishment. The history of this installation may be said to date from October, 1898, when Mr. Thos. L. Miller, M.I.C.E., of Liverpool, reported to the Committee of Visitors on the lighting of the asylum by electricity. In September, 1899, Mr. Miller was instructed to prepare plans and specifications, and application was made to the Local Government Board for a grant of £24,000 with which to carry out the work. The asylum consists of (1) the main building, which contains the medical

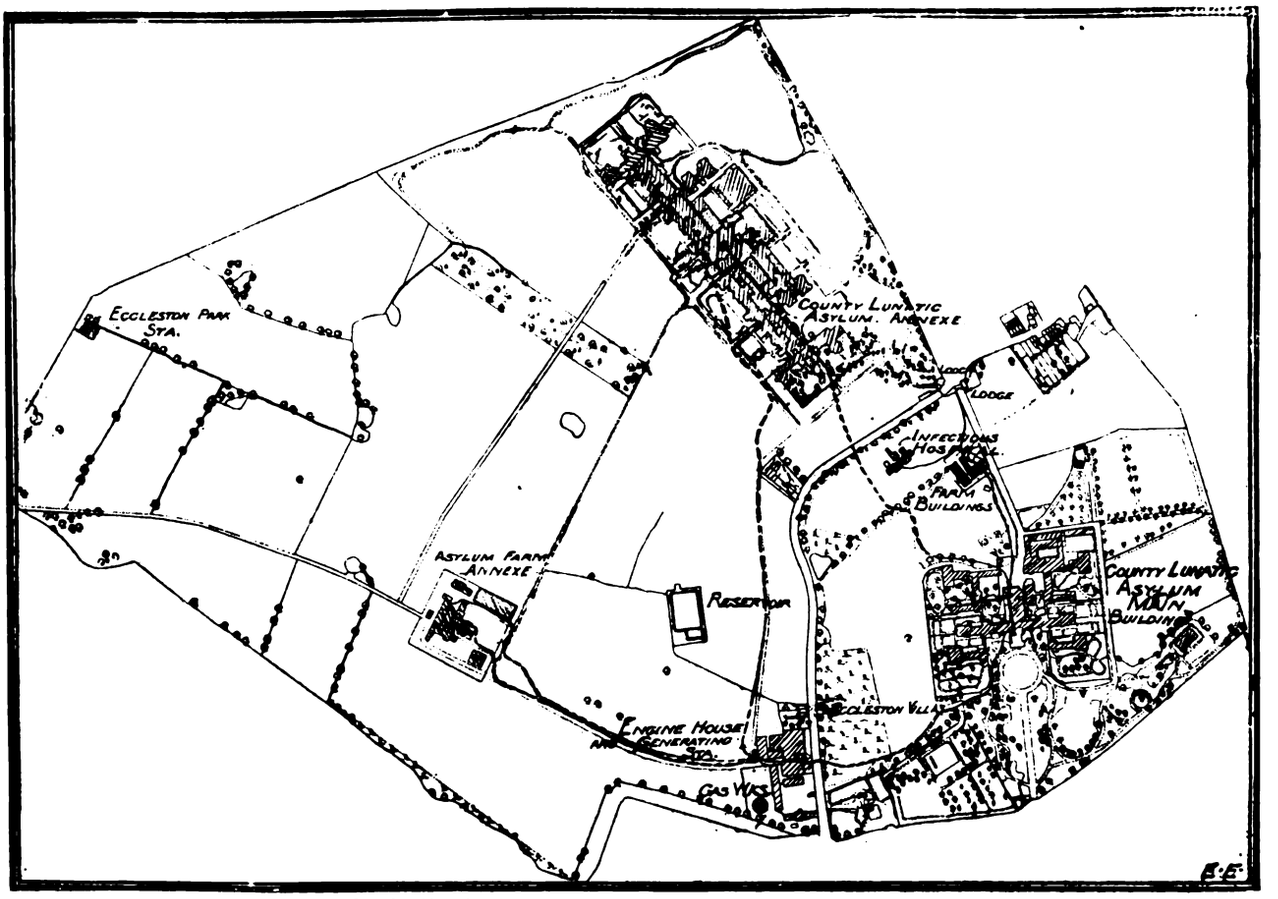

Fig. 1.—Plan showing position of Buildings, Lancashire County Asylum.

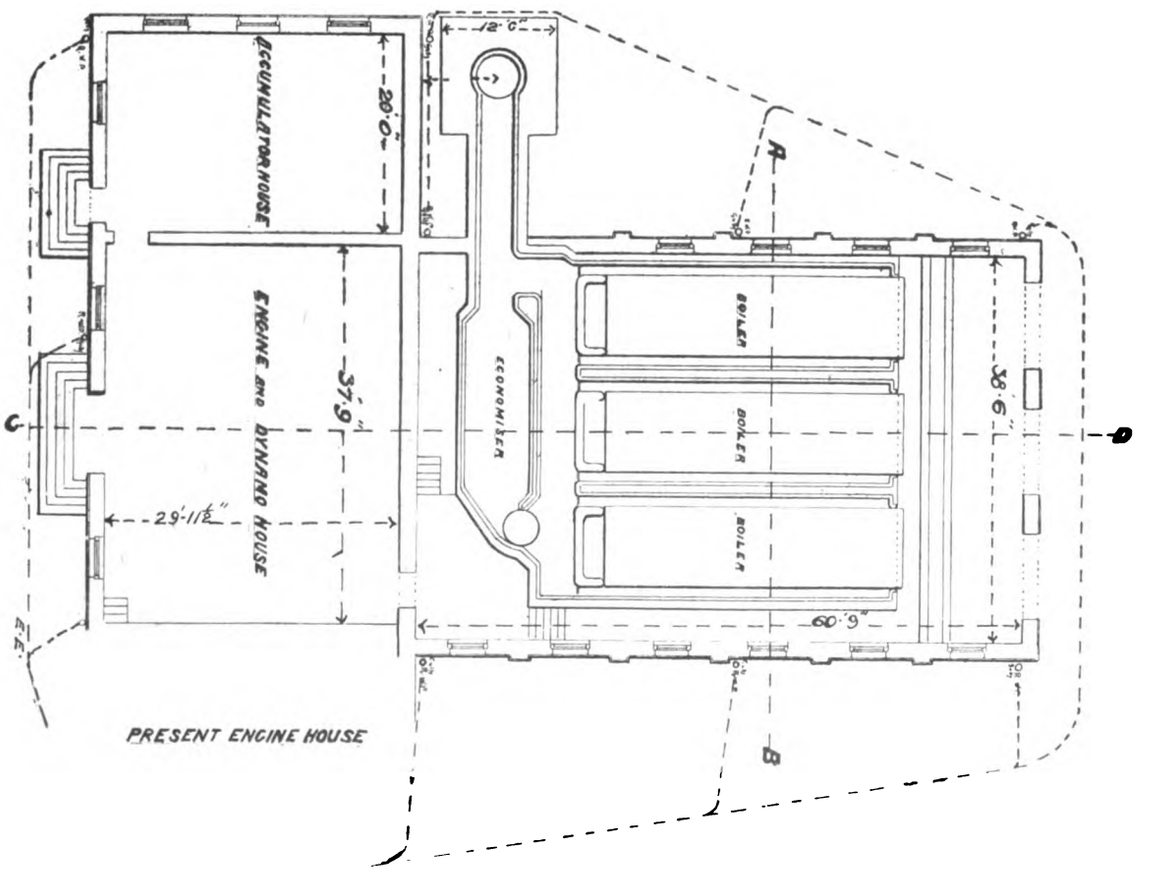

Fig. 2.—Ground Plan of Station Buildings, Lancashire County Asylum.

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superintendent's house, the administrative offices, doctors' quarters, 19 wards (10 male and nine female), reception wards

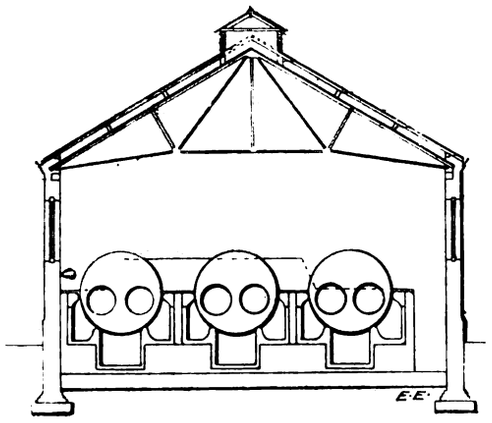

FIG. 3.—Section of Boiler-House through A B.

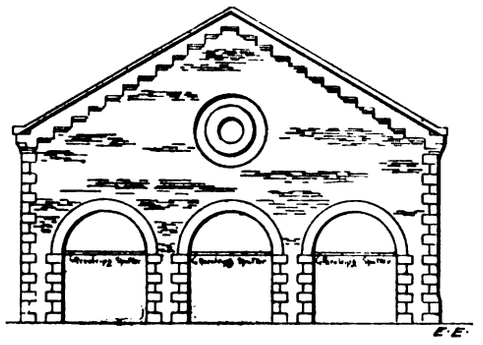

FIG. 4.—West Elevation of Boiler-House.

for both sexes, laundry, pathological museum, workshops, nurses' home, and chapel; (2) main building farm; (3) infectious hospital; (4) the annexe building, which contains the administrative offices, doctors' quarters, deputy medical superintendent's house, 16 wards (eight male and eight female), reception wards for both sexes, workshops, laundry, and Catholic chapel; (5) annexe farm buildings; (6) the electricity works, workshops, and engineer's house. The positions of the various buildings are shown on the map (Fig. 1).

Station Buildings.—The electricity works are situated at the pumping station, the engine-house forming an extension of the pumping-engine house, as shown on accompanying plan

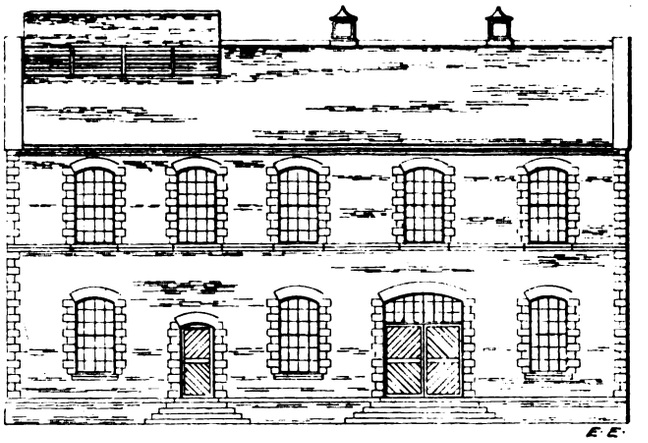

FIG. 5.—South Elevation of Engine and Dynamo House.

(Fig. 2), and as the boilers for the pumping engine were about worn out, the new boilers were made of ample power to supply steam both to the steam dynamo and the pumping engines. Referring back to Fig. 1, it will be noted that the electricity works are very centrally situated in relation to the several departments. The details of the station buildings are clearly shown in Figs. 2, 3, 4, 5, 6, 7, and 8. It may be mentioned that the engine-house walls are lined with white glazed bricks.

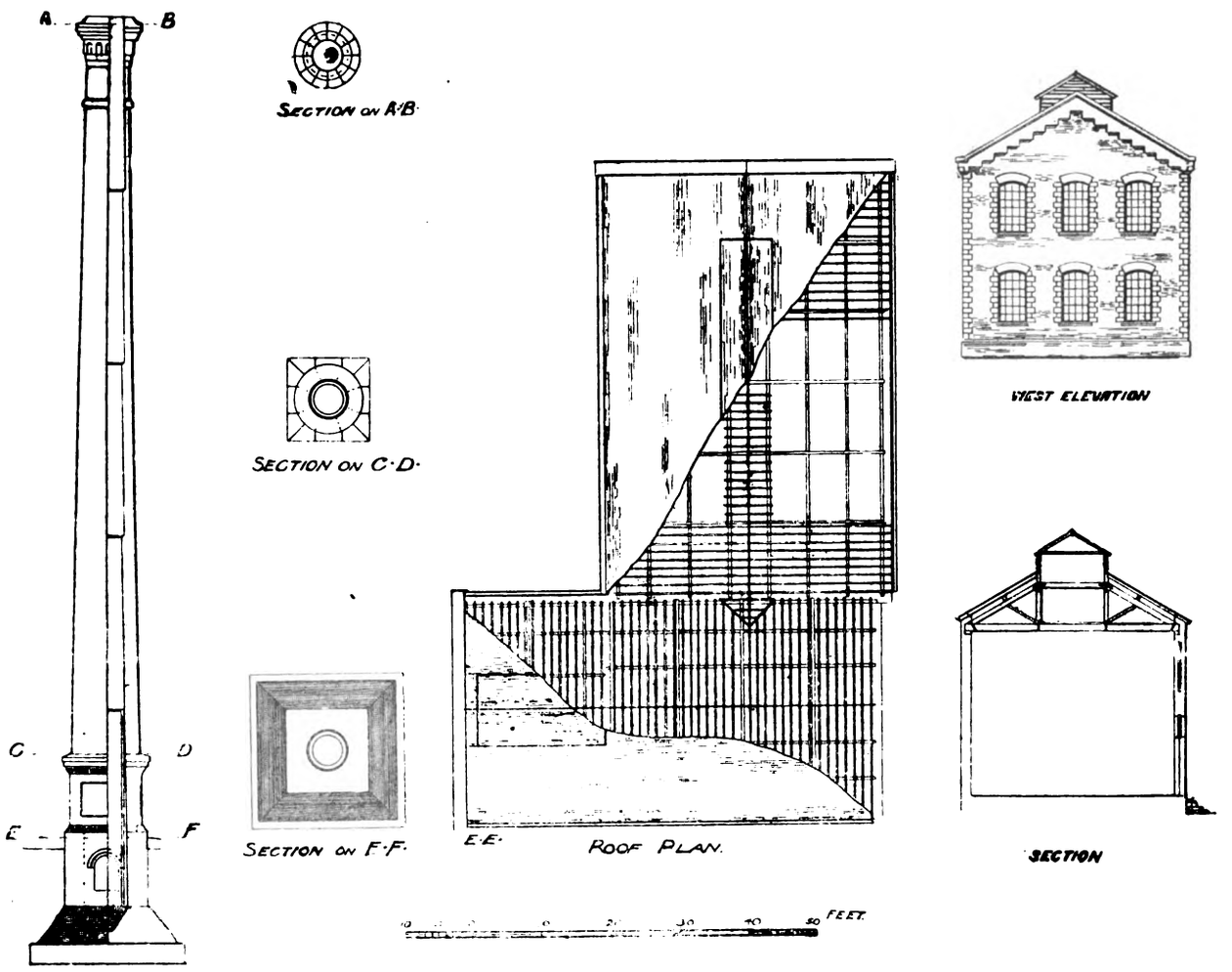

FIG. 6. Details of Chimney Shaft and Station Buildings.

Boilers.—The boilers are three in number, 8ft. diameter by 30ft. long, of the Lancashire type, each having two

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flues 3ft. 2in. diameter at the furnace end, tapering to 2ft. 8in. diameter at the back end. The shell plates are $\frac{7}{8}$in. thick, end plates $\frac{13}{16}$in. thick, front end angles $5\frac{1}{2}$in. by $5\frac{1}{2}$in. by $\frac{13}{16}$in.; flues $\frac{11}{16}$in. thick for first ring, remaining rings $\frac{9}{16}$in. thick. The boilers are fitted with the usual mountings of Hopkinson's make. Each boiler is seated on "Poulton" blocks, and fitted with a Musgrave superheater in the downtake, the superheater being arranged with by-pass valves and pipes to vary the amount of superheat. A Green's economiser of 144 tubes is arranged in the main flue with by-pass, the economiser scrapers being driven by an electric motor. The boiler feed pumps are by Weir, and are of their direct-acting type, capable of each delivering 2,000 gallons of water per hour against the full boiler pressure of 160lb. per square inch, there being two pumps. The feed pipes are arranged to give a duplicate "feed" to the boilers—one through the feed-water heater and economiser, and the other a "cold feed" direct to the boilers.

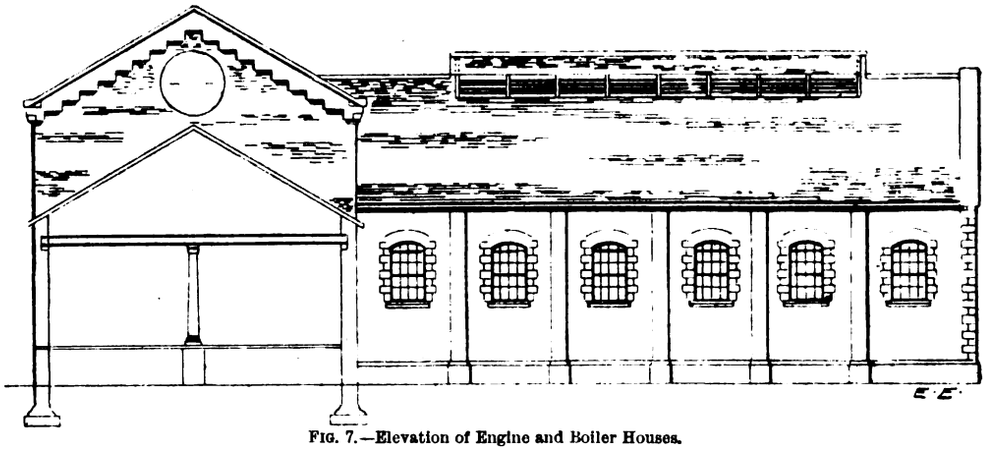

FIG. 7.—Elevation of Engine and Boiler Houses.

Pipe Work.—The steam from the boilers is taken to a 7in. diameter steam-main, from which the branches to the engine spring; and as the working pressure of the pumping engines is but 80lb. per square inch, a reducing valve—Ogden's patent—by Henry Watson and Sons, Newcastle-on-Tyne, is inserted between the above main and the pumping engines. The exhaust from all the engines, including pumping engines, is taken into a common 12in. main, and carried up the chimney to within 6in. of the top. The general arrangement of the piping is shown on the accompanying plan (Fig. 9). The steam-pipes throughout, except those for the pumping engines, are of steel, while the exhaust, feed, and blow-off pipes are of cast iron. All the steam-pipes are drained and trapped, the clear-water drains being taken to the hot-well and the dirty-water drains to the sump.

Generating Sets.—The steam dynamos (Figs. 9 and 10) consist of three two-crank compound non-condensing engines, each capable of developing continuously 175 b.h.p. when running at a speed of 400 revolutions per minute; cylinders, $12\frac{1}{2}$in. by 21in. by 9in. stroke. The engines are by Messrs. Browett, Lindley, and Co.; the dynamos to which they are coupled being of the shunt-wound type, each capable of an output of 118 kw. at an E.M.F. of 230 volts, by Messrs. Thomas Parkers, Limited. The booster for charging the battery is arranged as two separate machines, and is constructed to give an output of 200 amperes at any E.M.F. between 25 and 95 volts.

Switchboard.—The switchboard (Fig. 11) is arranged for three dynamos, one battery, and four feeders. The instruments and apparatus on the dynamo circuits are arranged on the centre panel, those for the battery and booster on the right-hand panel, and those for the feeders on the left-hand panel. In the circuit of each feeder a Ferranti meter is inserted. The ammeters and voltmeters throughout are of the Weston type, and the recording ammeter which registers the full current is of Messrs. Elliott Bros.' make. Fig. 12 shows a section of the switchboard. The exhaust pipe and cable connections between the dynamos and switchboard are carried in the space under the engine-room floor, this floor being of concrete, with a tiled surface, carried on rolled-iron joists. An eight-ton travelling crane is provided in the engine-room, the motions being worked from the ground by cotton ropes.

Battery.—The battery consists of 130 R.L. 23 Chloride cells, arranged in two tiers on iron stands, the capacity of the battery being 1,200 ampere-hours at a nine-hour rate. The belting is capable of discharging up to 1,000 amperes for 15 minutes on an emergency.

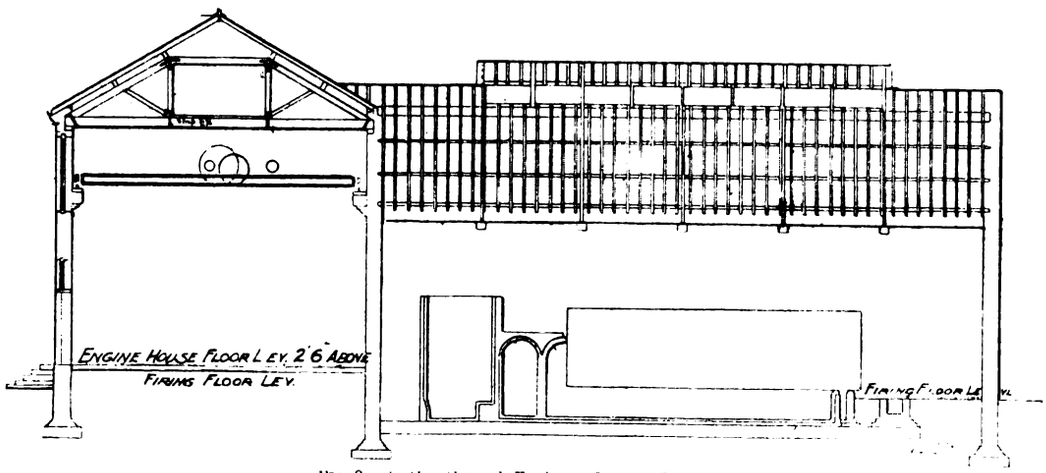

FIG. 8.—Section through Engine and Boiler Houses.

Cables.—The St. Helens Cable Company supplied the cables, which are of their paper-insulated, lead-covered type, laid in earthenware troughs, and run in solid with refined bitumen. The mains from the switchboard in the engine-house to the distributing switchboard in the main building basement, is of ·70 square inch section; from the switchboard in the engine-house to the distributing switchboard in the basement of annexe, of 1·00 square inch section; between the distributing switchboards in the main building and annexe, ·70 square inch section; from the switchboard in engine-room to annexe, farm

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buildings, ·062 square inch section; from engine-house switchboard to workshops and engineer's house, ·062 square inch section; from distributing switchboard in basement of main building to main farm buildings, isolation hospital, and lodges, ·10 and ·062 square inch section. The total length of mains laid is about two miles. The process of laying some of the cable is shown in the illustrations, Figs. 13 and 14.

Wiring.—In wiring the buildings, advantage was taken of the fact of the various wards throughout the asylum forming, as it were, separate houses, to keep the lighting of each ward quite distinct from the others, with the one exception that to prevent a total failure of light in any one ward, the "falling" lights in such ward were fed by a pair of conductors taken from the distributing board in the adjoining ward; and, in addition, an attempt was made to reduce the number of conductors used throughout the buildings to a minimum. In carrying this out the following size cables were used: From the main distributing switch and fuse boards in the basements of both annexe and main buildings $^{19}/_{17}$ S.W.G. conductors were run to the distributing switch and fuse boards in the various wards, and from these secondary distributing boards $^{7}/_{16}$ S.W.G. conductors were run to the fuse boards placed throughout the wards, from which $^{7}/_{22}$ and $^{3}/_{22}$ S.W.G. conductors were run to the lamps or groups of lamps throughout the various rooms in the wards. Flexible cords were used for pendants in all cases, $^{64}/_{38}$, or their equivalent. The main distribution boards in both the main building and annexe were arranged for 23 and 21 circuits respectively. Throughout the asylum buildings the conductors are for the most part run in wood casing, but in the farm buildings, laundries, and kitchens the conductors are run in insulated steel tubing. The total number of lamps connected exceeds 3,520 of 16 c.p., and in addition there are motors for ventilating and refrigerating purposes

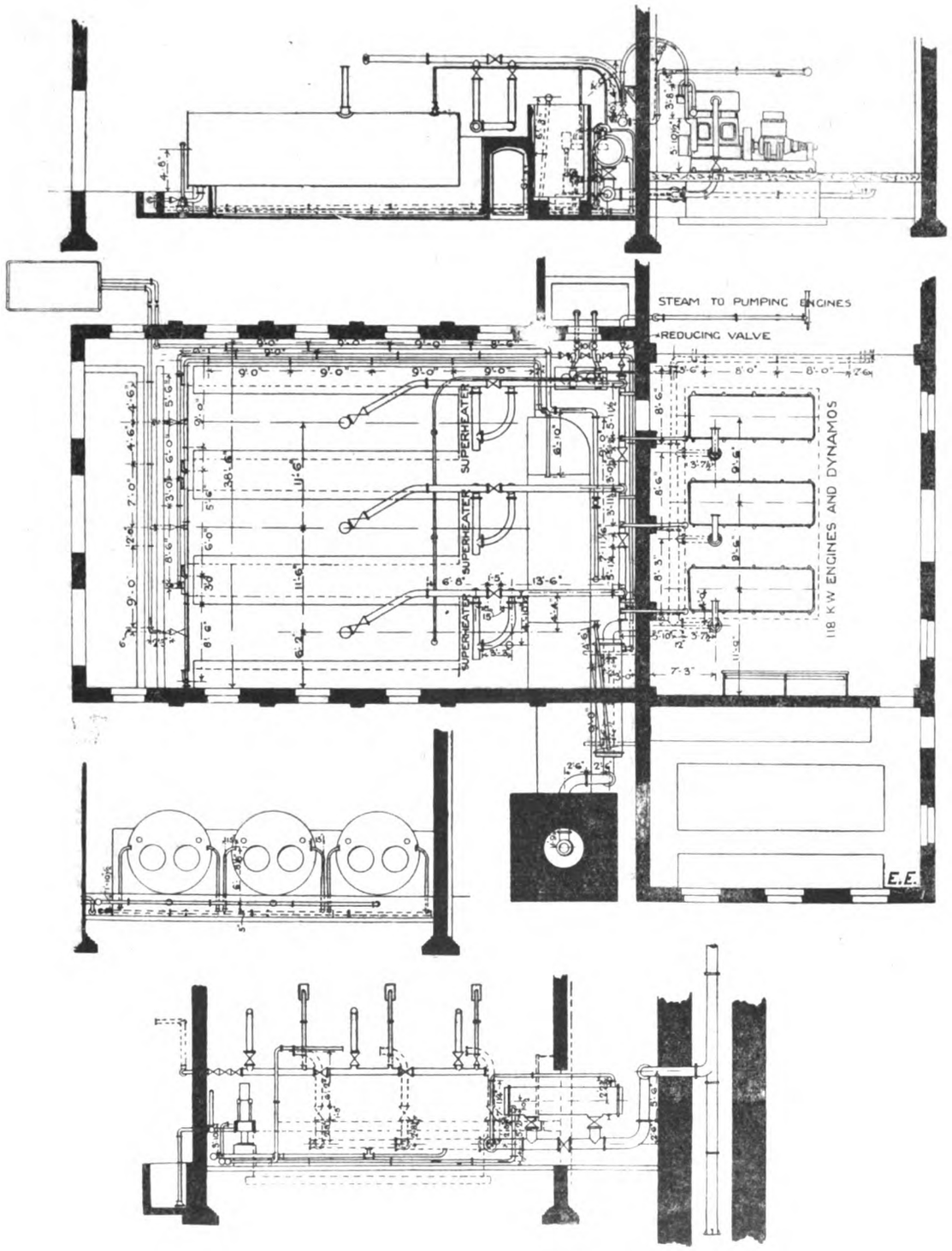

FIG. 9.—General Arrangement of Plant and Piping.

Concluding Remarks.—The whole of the engine-room contract, including steam, exhaust, feed, etc., piping, switch

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board and connections between both battery and switchboard, and dynamos and booster and switchboard, together with the wiring contract, including the supply of all cables from the main distributing boards in the basements, was carried out by Messrs. Lowdon Bros., Dundee. The buildings were constructed by Messrs. Rothwell, of St. Helens, to the designs of Mr. Thomas Wainwright, the resident engineer at the asylum, who also superintended their erection. The resident electrical engineer at the asylum is Mr. E. Fazackerley, late of Messrs. Mather and Platt Limited.

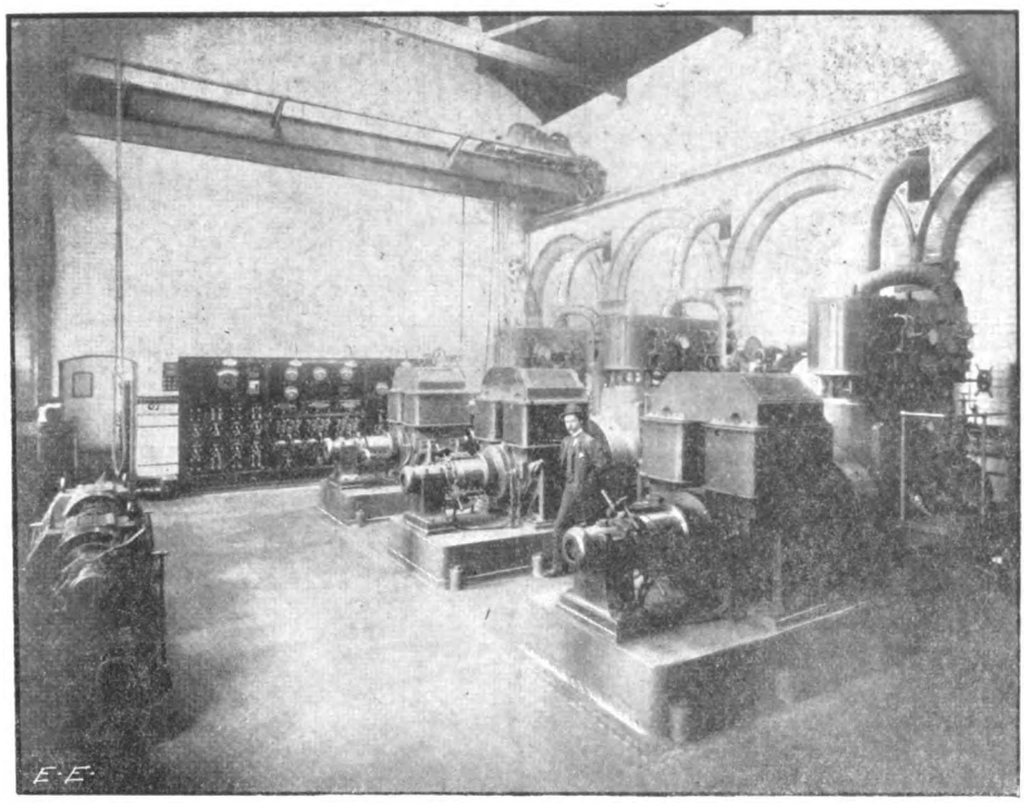

FIG. 10.—Interior of Engine-Room.

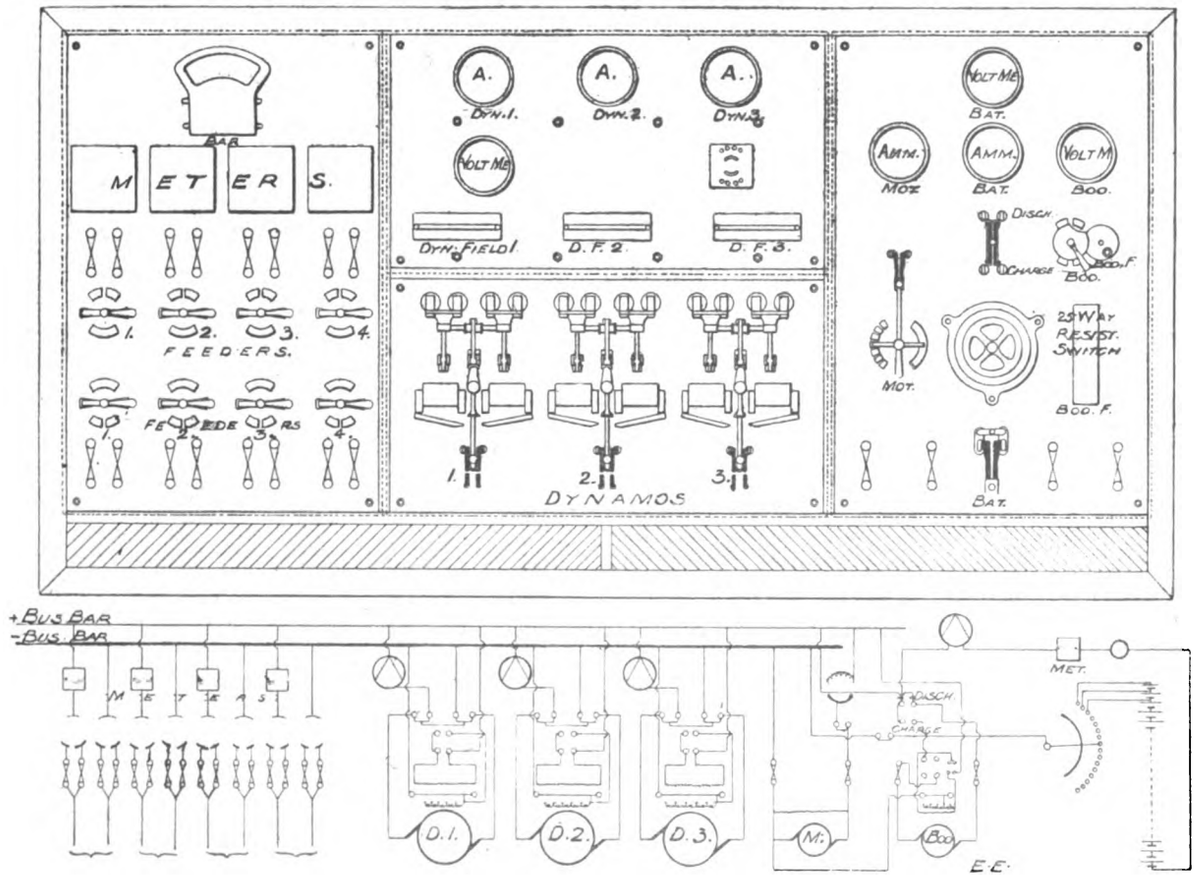

FIG. 11.—Elevation of Switchboard and Diagram of Connections.

We are indebted to the consulting engineer, Mr. Thos. L. Miller, for the above particulars and illustrations of an interesting and carefully designed installation.

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CENTRAL-STATION LIGHTING.

BY J. A. SEAGER, A.I.E.E.

It appears to be an accepted doctrine among those responsible for the management of central stations that units used in station lighting must be kept as low as possible. It is worth while considering that the energy expended in rendering the station visible after dusk is only a small proportion of that energy which must inevitably be wasted in generation and distribution; and that, after all, the power so used is turned to good account, not only in the avoidance of accidents and increase of economical running, but also in producing a good impression among non-technical consumers. The obvious inference from a poorly-lit station is that the manager thinks his energy expensive, and it is not to be expected that the consumer, seeing this, will go in lavishly for extensions in his own wiring system. As a matter of fact, the buildings and offices of a central station may be made a very good standing advertisement to the advantages of electric light by displaying the newest and most effective arrangements for house and factory lighting. It is a wise saying that "The cobbler's wife is always worst shod," otherwise we should expect the electric generating station to be the place where one could gain an

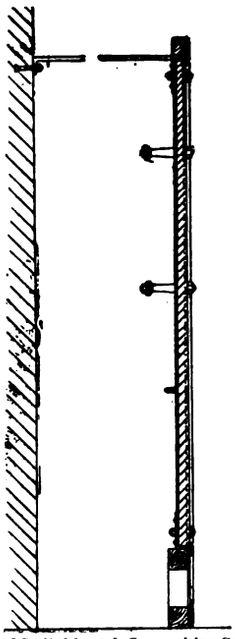

FIG. 12.—Section of Switchboard, Lancashire County Asylum.

object lesson as to the best styles, technically and commercially speaking, of installing electric light. Many gas engineers have grasped this idea, and have established showrooms; electrical engineers, as a rule, have not developed their pushfulness to this extent.

There is another aspect, however, from which the lighting of a central station may be considered—its reliability in time of accident. It is not conducive to an intelligent view of the situation for the switchboard attendant at the time the machines are making hideous noises in the dark, to have to fumble with a box of vestas in order to discover which switches he may with discretion pull out. Various methods have been adopted to reduce the loss of time due to this cause. One of the simplest, and perhaps one of the best, is to have oil lamps with good reflectors hung on the walls of the engine-room and boiler-house so as to throw light on the apparatus most likely to be in use at such times. These would be the switch gear, the stop valves on engines, the balancer-booster or exciter sets if used, and the fronts of boiler drums—particularly pressure and water gauges. It may not be considered necessary to keep these alight as a rule, but if this is not done matches should be kept in a specified place near each lamp.

Another means which has been adopted where a town has both gas and electric light is to keep a supply of coal gas laid on, so as to be available for large flares in the engine-room and boiler-house. This is very effective, but the advantage is gained at the sacrifice of some prestige. The gas manager would be more than human if he did not point out to possible consumers that he supplied gas to the electric light people to help them over their extinctions.

It is not, however, usual for the whole of the station to be disabled at the same time, and the proper employment of change-over switches may possibly enable the station light to be maintained until the normal supply is resumed. For example, in high-tension stations it is common to have the exciter voltage at or near that of the ordinary pressure

FIG. 13.—Laying Cables, Lancashire County Asylum.

supplied to consumers after transformation. When this is the case, a throw-over switch can be arranged on the station lighting circuit so as to change over from alternating to continuous current at the same pressure, in which case the incandescent lighting of the station will again be available. Even if the exciter circuit has failed, it will be possible with this arrangement to get the station light on quickly, in order to see to get machines into parallel again on supply. In low-tension work with battery it is usual to have a maximum cut-out at each end of the cells in order to cut them out in the event of overload. It will readily be perceived that in case the machines fail from any cause, the battery will also come out of action when the load is beyond its capacity, and if the works lighting were taken in the usual way off the network, there would be darkness in the station also. This

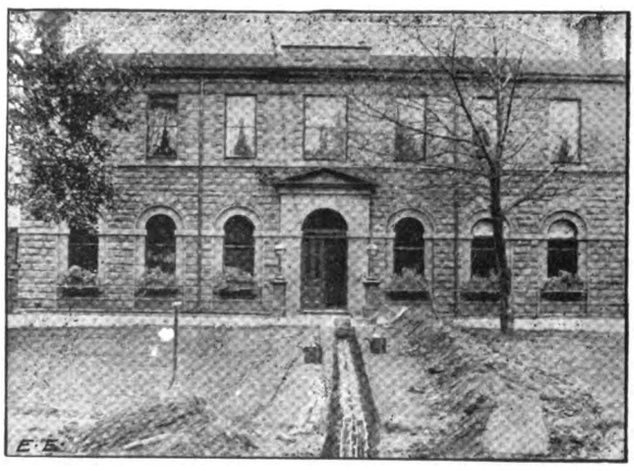

FIG. 14.—Laying Cables, Lancashire County Asylum.

may be obviated by taking the station supply from the battery behind the maximum cut-outs (protecting the battery, of course, by fusing the lighting circuits). In this case, even if the circuit breakers came out, the lighting circuit would be available. Yet another method may be suggested which is applicable both to high and low tension systems where there is a small day load plant kept in order to minimise running expenses during the hours of light load. This plant, being probably shut down or used as a spare in the evening, may be fitted with a pair of leads going to a throw-over switch connected to the station lighting circuit (through a transformer, if necessary). The other branch

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of the throw-over switch is connected to the station 'bus bars. The object of this arrangement is that in the event of an extinction, the station lighting, which before was taken from the main supply, can be thrown over to the day load plant, this being run up on the station lights entirely independently of any of the other sets. It is better to waste steam than to prolong an extinction.

All but one of the precautions mentioned above require the supply of steam. An accident in the boiler-house may, however, cause an extinction which is not so easy to get over quickly. It does not generally happen, however, that a boiler-house mishap extinguishes the lights so suddenly as an engine-room accident, and for this reason there is not so much necessity to provide a speedy means of alternative lighting when the steam fails, beyond having a few oil lamps at hand and in working order.

Passing now from the consideration of the proper source of station lighting to that of its best distribution, we find that not only has the station to be well lit generally, but certain portions in particular require special illumination, the chief of such places being the switchboard. A very common fault on such boards is to arrange the light so as to dazzle the attendant, instead of shining on the instruments. The judicious use of green shades and bent supports will get over the difficulty satisfactorily. If the engines are at all open to inspection—*i.e.*, of the open type, or even of the enclosed type, with glass spy-holes—an incandescent lamp of 8 c.p. or 16 c.p. should be fixed on one of the standards of each engine so as to enable the driver to observe the cranks and connecting rods.

It now seems pretty generally agreed that open-type arc lamps are not very suitable for the general illumination of engine or boiler houses. They require retrimming once every day, or every other day. They flicker badly except when newly adjusted, and the heat of the rooms ascending to the top of the building aids the heat developed by the lamp in stiffening lubricating oil, and generally spoiling the working properties of the lamp's mechanism. A step in the right direction appears to be the use of enclosed arc lamps, as the gymnastic performance on the travelling crane known as recarboning has only to be gone through once in four days or so. The flicker, however, is as pronounced as in the open type, and the tendency to go wrong still remains. The best form of lighting, though requiring more power per unit illumination than arc lighting, is that obtained from incandescent lamps of high candle-power (say, 50 or 100 c.p.), such as the "Sunbeam" variety. The light from these is not painfully blue; it is much steadier, and can be obtained with much less trouble than that of the arc. The cost of renewal of lamps, which has been urged against their use, will not be found to differ unfavourably from the cost of carbons and repairs to arc lamps, even allowing for short life, due to bad regulation of volts.

When auxiliary engines, such as circulating and air pumps, exciters, balancers, boosters, etc., are placed in out-of-the-way situations, care should be taken to have these specially illuminated. In order to meet occasional demands for light in special cases, as, for example, when men are at work behind the board or under machines, wall plugs should be arranged in convenient situations, and a length of flexible cable, armoured with steel wire and provided with the proper connecting plug and lampholder, should be hung on the wall close to the plug. This avoids the necessity for hunting all over the station for a "flex" before starting a piece of work.

In the boiler-house, the remarks concerning deterioration of arc lamps due to the effects of heat apply with increased force, although the flickering of the light is perhaps more tolerable there than in the engine-room. There are various points which require special illumination with incandescent lights, these being the water gauges and pressure gauges on each boiler drum, the backs of the boilers (in order to see the mud-cocks, etc.), and auxiliary plant, which is usually left in semi-darkness This specially applies to economisers where used. It is very rare to find a light installed near the economiser mud-cocks, and the fireman has generally to do his best with a half-melted candle.

The general lighting of the boiler-house should be such that the tops of the boilers can be seen. Where Babcock boilers are used there is a temptation to bring the lights down too near the level of the boiler drums, this, however, being a mistake, as the man in charge of the boilers should be able to make his way quickly along the top of the boilers, to see whether valves are open or shut, and to detect leaks in steam-pipe with the utmost ease. Probably the best way out of the difficulty is to provide the lamps with raising and lowering gear, so that they may be adjusted to the requirements of the fireman.

In every station there is some sort of a workshop, which gives an opportunity of showing what should be done in factory lighting. Each bench and machine (such as lathe, shaper, pipe-screwing machine, emery-wheel, etc.) should have its own incandescent light (preferably protected by a wire guard) adjustable as to height and position, and connected to its own switch. The shop should also be generally illuminated by a strong incandescent or arc light. In the latter case there is an opportunity for exhibiting the effect of an inverted arc shining on a whitewashed ceiling in order to diffuse the light. Almost the same diffusion can, however, be obtained by the use of an opalescent globe, the light being thrown directly down on the shop.

Stores and offices should be well lit. There is nothing so annoying as to rummage in dark corners for stores which are wanted in a hurry. The offices should be fitted up in as many styles as possible in order to show consumers the effect of different modes of lighting. It is conducive to economy to have lights in passages so arranged that they can be switched on at one end of the passage and off at the other by persons walking through the passage in either direction. A simple arrangement of wiring will effect this at the cost of two extra straight runs of wire the length of the passage and two small throw-over switches.

Until comparatively recently the wood-casing system of wiring has been almost universally adopted. This has the advantage of being easily and cheaply applied to almost any position, and most of the standard fittings at present made are applicable principally to this type of wiring. The iron-tube system, however, has undoubted advantages, particularly where leads have to be run near water or oil, as, for example, in a condenser pit, pump-room, on an engine, and in similar places. There is also less risk of fire when this system is used, and a very neat appearance is obtained. Specially-made switches and fittings should be used with this system. If alternating current be in use, it is important to arrange that the "go" lead is enclosed in the same tube as the "return," as otherwise there will be a tremendous voltage drop before the lamp is reached, and the iron casing will become dangerously hot due to induced currents in the iron.

Whatever system is used, it should be adhered to, and no temporary connections should be allowed to remain in use under any consideration.

THE ARMORL SYSTEM OF WIRELESS TELEGRAPHY.

The receiver which the inventors of this so-called system of wireless telegraphy propose to use has been discussed *ad nauseam* in our columns for the last few weeks, but the transmitter and the system of transmitting signals to be received by the receiver have been withheld from us. We understood that the details were reserved for one of the scientific societies, but the English correspondent of the *Scientific American* has prevailed. In a description of the system given by this gentleman in the issue of the *Scientific American* for Jan. 4 an illustration is given of an actual receiver at work, but the description given is still that of the patent specification. We therefore need not refer again to it, but the following paragraphs are worth reproducing in full:

"The complete apparatus comprises this receiver and a small battery of eight volts packed in a case, which is provided upon the outside with two contact screws. Two pointed iron stakes are driven into the ground to a depth of approximately 18in., and about 12ft. apart. To each of

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these a wire is attached connecting the negative and positive poles respectively of the instrument. A small key similar to that usually employed for dispatching Morse code signals is attached, together with a telephone receiver. The current thus set up flows through these wires and stakes into the ground. The operator holds a telephone receiver to his ear with one hand while he transmits the message with the other in the ordinary manner. At the opposite station, where similar iron stakes are placed to receive the impulses, if necessary, the receiver can be connected to a Morse tape printing machine, and the messages printed as they are received."

"The greatest distance over which these inventors have endeavoured to transmit these electric impulses has been 20 miles with an eight-volt battery. The success of the experiments up to this distance, however, has convinced them that this is by no means the maximum distance, but at present they intend to establish this as their limit."

It will be seen from the above statements, so indefinite as to results, that earth conduction currents are to be used much after the way that was first described by Mr. James Bowman Lindsay in 1843. This inventor had not only had a clear idea of what could be done by means of earth conduction currents, but he also had clear views as to the limitations of the method. As we have failed to find any statement as to the exceedingly limited possibilities of purely earth conduction telegraphy in the articles on the Orling system in the daily Press, it may be well to recall them at the present time. In the first place, the success of any such system is dependent on the homogeneity, as far as the electrical conductivity is concerned, of that portion of the earth's surface through which the transmission has to take place. This is one reason why such experiments are most reliable when carried out across a river, or, still better, across a strait of the sea. In our issue of Dec. 20 we gave some particulars of an apparatus for locating deposits of metallic ore from the earth by means of measuring the resistance between various points of the surface. The results then quoted showed that there was a great want of that equal conductivity which is so essential to the success of the Armorl system, but the lack of which enables deposits of metallic ores to be electrically treated. Unfortunately for the system, there is a still graver objection. Thus not only will the presence of metallic pipes in the earth prevent the result which the company hope to obtain with their receiver, but the stray currents from all tramway systems worked by electricity will produce the very effects which the receiver has to record. To sum the matter up, the system has only a chance of being successful in those out-of-the-way country places in which networks of metallic pipes do not exist, and it will be unserviceable within a considerable radius in miles of an electric tramway. We trust that the syndicate will not have to seek financial assistance from the public, as otherwise we shall find it our duty to express strong opinions on the matter.

LONDON TELEPHONES.

On Monday last Mr. A. C. Morton presided over the adjourned conference of the representatives of the 81 local authorities within the London telephone area. The agenda of the last meeting was taken as read, and the clerk of the conference then read letters which had been received from Lord Salisbury, Mr. Arthur Balfour, and Sir Michael Hicks-Beach in reply to those forwarded from the conference. These three letters were purely formal, the task of replying to the resolutions of the conference having been placed in the hands of the Postmaster-General. Lord Londonderry's reply, which was then read in full, is as follows:

Sir,—The Postmaster-General has given careful consideration to the resolutions agreed to at the conference of local authorities in the London telephone area held at the Guildhall on the 23rd ult., and directs me in the first place to express his deep regret that the arrangements which he has recently made on the part of his Majesty's Government for the Post Office telephone service in London have not met with the approval of the local authorities. Dependent as he is on the goodwill of such authorities for the smooth working of the systems in some important respects, he is anxious to do anything in his power to remove the misconceptions which seem to prevail on the subject, and to explain the rather complex position of his department, bound, as it is, to keep in view the interests—not always identical—of (1) the general body of the taxpayers of the United Kingdom, who have to find the money for the London telephone service, in which, for the most part, they are very remotely interested, and (2) the users—present and prospective—of the telephone in the London area. He has already attempted to explain the matter in replying to a deputation from the London County Council on the 6th ult.; and he would be glad if the members of the conference would be so good as to refer to the statement which he made on that occasion, and which was fully reported in the Press on the following day.

With respect to the specific points dealt with in the resolutions of the conference, I am to make the following observations:

The conference begin by referring to the report of the Select Committee on Telephones, dated Aug. 8, 1898, and imply that the scheme recently put forward by the Postmaster-General does not carry out the "promises" made in that report.

The recommendations of the Select Committee cannot, the Postmaster-General thinks, be properly described as "promises." But it was undoubtedly the intention of his Majesty's Government to give substantial effect to those recommendations and to carry out the objects which the committee had in view.

The passage in the report to which the conference calls special attention is as follows: "On reviewing the whole of the evidence, your committee is strongly of opinion that general, immediate, and effective competition by either the Post Office or the local authority is necessary, and consider that a really efficient Post Office service affords the best means of securing such competition."

A good deal of misapprehension appears to the Postmaster-General to have arisen with respect to the use of the word "competition" in this connection. Competition may, of course, be of different kinds and degrees, and in order to understand the meaning which should be attached to the expression, and to see how far the recommendation of the committee has been carried out, it is necessary to consider their report as a whole, and not to deal only with an isolated passage detached from its context. Now, if attention be paid to the general tenour of the report it will be found that the objects which the committee had in view were: (*a*) to extend and popularise the service, by opening it to classes which could not afford to pay the high rates demanded under the company's system of subscription; (*b*) to restrict and regulate the monopoly which, in the absence of competition, the company had been able to establish; (*c*) to prevent the State being forced, on the termination of the company's license, to purchase its plant at a monopoly price. All these objects have been attained through the agreement which is now being discussed. (*a*) The telephone service in London is no longer confined to to those who could afford to pay a high subscription for the exclusive and unlimited use of a wire; (*b*) the company has been brought under regulation—that is to say, its charges are fixed—and it can no longer give favour or preference to one subscriber as compared with another; (*c*) finally, a competitive system is actually in being, which, besides tending to stimulate efficiency, will effectually prevent the company from establishing a monopoly or being able to dictate its own terms when its license comes to an end.

There is nothing in the committee's report to suggest that the competition which they recommend was intended to go beyond this, or to be aimed at the extermination of the company—a course which would, in fact, be disastrous in the public interest, and would involve a use of the taxpayers' money which the Postmaster-General could not justify to Parliament. So long as the company conducts its business on reasonable terms and in an efficient manner it is to the advantage of the public that it should be allowed to do so.

The object, then, which the Postmaster-General conceived he ought to keep in view was, while enabling the company to continue its work, to compel it to provide an efficient service for the public at a reasonable price, and to prevent it establishing a monopoly which would be dangerous to the public interest in the future. This object, he thinks, has been fully secured by the modified form of competition which he has instituted, and could not have been secured without it.

It must further be borne in mind that, in the matter of telephonic communication, a competition which does not include some element of co-operation—to the extent at least of providing means of intercommunication between the competing systems—is distinctly prejudicial to the public interest. Persons connected with one system who wish to communicate with persons on the other must either subscribe to both or submit to be cut off from those connected with the other.

Without intercommunication the Post Office in London would have been able to offer very little inducement to subscribers to join its system. No one will subscribe for a telephone which does not enable him to speak to the persons with whom he wishes to communicate; and without the possibility of intercommunication with the subscribers of the National Company the Post Office would probably have had to wait some years before gaining any large body of subscribers, at all events in districts now served by the company, and would certainly not in any sense have produced "general, immediate, and effective competition" with the company.

The service offered by the Post Office in London will, the Postmaster-General believes, be "really efficient": at any rate, no pains are being spared to make it so. With underground wires, metallic circuits, the exchanges organised on the latest and best principles, the London Post Office telephone service will, it is anticipated, be much, superior in efficiency to anything yet known in this country.

In the next place the conference ask for a revision and reduction of the scale of charges set out in the Postmaster-General's circular.

As regards the charge for an unlimited service, I am to remind you that the Select Committee, whose report is quoted with approval in the resolutions of the conference, reported that the existing rates of the National Telephone Company could not be considered unduly high. The Postmaster-General felt justified in adopting this view,

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but with an important modification in the public interest. Both the Post Office and the company will in future accept subscribers on an agreement for 12 months at a rate which, under the old tariff of the company, was only applicable under an agreement for five years. To many existing subscribers, this must mean an immediate reduction of £3 per annum in the rate.

The message-rate service is, as the Postmaster-General has already explained, an untried experiment in London; and it was necessary to take precautions against loss to the taxpayers by fixing at the outset rates which might in time be reduced, but which it would not in any probable circumstances be necessary to raise.

As the conference is aware, the rates now fixed are open to revision in 1905. Three years will not, in the Postmaster-General's opinion, be too long a time to gain experience of the operation of these rates over the London area. If it then appears that lower rates are possible with due regard to financial considerations, there can be no doubt that reductions in the tariff will be made. The local authorities can, of course, much contribute to this end by facilitating the extension and smooth working of the system in their several districts. Meanwhile, it must not be overlooked that already a telephone with unlimited service over the whole London area can be obtained on a one-year agreement for £17 instead of £20, and that the minimum charge for a telephone has been brought down to £6. 10s. in the county of London and £5. 10s. in other parts of the area, besides the advantages of still lower rates for party-line services.

I am to add that the agreement with the company is not subject to ratification by Parliament. As explained above, the Postmaster-General believes that it carries out the policy recommended by the Select Committee, and embodied in the Act of 1899, and it will no doubt come up for disussion in the approaching session; but it is neither necessary nor customary to submit such agreements for the approval of Parliament before they become operative.

As regards the use by the company of underground wires laid by the Postmaster-General, the provision of such wires will, of course, be regulated strictly by the Acts of Parliament on the subject, and all the existing rights of the road authorities remain intact. There is no reason to think that any greater disturbance of the roads will be necessary for the purpose of laying down wires to be used both by the Post Office and by the company than for wires to be used solely in the Post Office system.

The Postmaster-General is not sure to what the conference allude in their second resolution, where they speak of "the capital charge quoted by Mr. Hanbury in the House of Commons in 1899 for an 'unlimited service.'" In introducing the financial resolution on which the Telephone Bill of that year was based, Mr. Hanbury said: "£40 is the price for which wires can be constructed in London, which is the most expensive place in the world for constructing telephonic communication." This statement was based on a very rough estimate, which would now have to undergo considerable revision in view of the actual cost of laying telephone wires under London streets. Moreover, the annual charge in respect of the initial cost of laying the wires is only one item, and by no means the largest, of the expenditure necessary for carrying on a telephone service.

Other three letters were then read. The first objected to the indemnity clause in the Post Office form of agreement which subscribers are called upon to sign. This clause makes the subscriber responsible for any damage done to the Post Office telephone system in consequence of high-voltage currents getting into the system on his premises. The next letter was from joint owners of a license from the General Post Office, at a rental of £1,600 per annum, of a private telephone connection between London, Birmingham, and Manchester. This service was interrupted on Dec. 12, and had not been repaired for 19 days. In the meanwhile, the firm had both to pay the usual rental and also the cost of obtaining connection over the public wires. The third letter was from Mr. A. Nicholson, of Tunbridge Wells, calling attention to the fact that the Town Council of that town had unanimously agreed to apply for £15,000 additional loans to be used on the telephone undertaking. This would more than double the capital of the undertaking, and showed how successful immediate and effective competition with the Telephone Company had been.

Mr. A. C. MORTON, before calling upon anyone to move the first resolution, made a few critical remarks on Lord Londonderry's letter. Thus, while that gentleman now recognised the important influence which local authorities would exert on the success of the telephone undertaking, he had not explained why he had not consulted these local authorities before making an agreement, but had only consulted a large trading company. While the recommendations of a Select Committee were not promises, he (Mr. Morton) was sure that effective competition would have been secured if the chairman of that committee had had the carrying out of these recommendations. They had in the city of London a good example of the two kinds of competition. They had recently suffered great inconvenience and loss through the traffic in the streets being disorganised by the laying of wires by the Postmaster-General and by the Charing Cross and Strand Company. They had put up with this inconvenience because of the benefit they expected to arise in consequence of competition. They now found, however, that the competition in the telephone system would not give any reduction in price, whereas the competition in electric lighting had reduced the charge by nearly one-half. He was sure that no reform would be obtained from the Post Office unless it was forced on them, as had been the case with the 6d. telegram, etc. He blamed for the obstruction the permanent officials of the Post Office, and not Lord Londonderry.

The following resolutions were then moved, seconded, and passed. It is interesting to note that only two speakers opposed the general opinions of those present, and only these two voted against the first resolution. The first of these speakers urged that any loss made on the telephone undertaking would fall unduly on the working classes, who do not use the telephone, while the second speaker urged those present not to continue throwing obstacles in the way of the telephone system of the Post Office just as they had for years opposed the National Telephone Company. The resolutions were:

"A. That the Right Honourable the Lord Mayor, M.P., be asked to bring the question of the agreements with the National Telephone Company and the proposed Post Office scale of charges before the House of Commons on the address in reply to the King's Speech, so that the same may be referred to a Select Committee, with a view to obtain for London 'by real and active competition' an efficient telephone service at a reasonable charge."

"B. That the members of Parliament representing constituencies in the London telephone area be requested to support the Lord Mayor in the House of Commons, and otherwise to use their influence to carry into effect the resolutions adopted at the conference held on Dec. 23 last."

"C. That in view of the importance of the matter to telephone users, and more or less to the public generally, the several authorities represented at this conference be asked forthwith to communicate respectively with their representatives in Parliament, urging them to support in the House of Commons the resolutions passed by this conference."

"D. That the clerk be requested to at once forward a copy of the foregoing resolutions to the members of Parliament and the councils within the London telephone area and to each of the delegates."

Also it was decided to send a reply to the Postmaster-General to the effect that the conference urged a reconsideration of the matter. The conference, which was largely attended, then adjourned till after the matter has been discussed in Parliament. The Chairman explained that the object of this adjournment was that the result of this discussion, if unfavourable in their opinion, might be commented on.

NEW COMPANIES REGISTERED.

Ito Syndicate, Limited.—Capital, £45,250. Objects: to acqui. the benefit of divers Acts of Parliament and provisional orders, and o. applications to be made for other provisional orders, and to promote any Act of Parliament, or to make applications to the Light Railway Commissioners and the Board of Trade or other public bodies or authorities for any orders, etc., for the construction of tramways, light railways, etc.; to equip the same, etc.

Schaffer and Budenberg, Limited.—Capital, £50,000. Objects to acquire and carry on the business of engineers, makers of pressure gauges, engine and boiler fittings, indicators and measuring instruments, brass finishers, general hardware merchants, etc., now carried on under the style of Schaffer and Budenberg at Whitworth-street Manchester, 77A, Queen Victoria-street, E.C., and 5, Wellington-street, Glasgow, and to carry on the general business of mechanical, electrical, consulting, and general engineers, etc.

Industrial Undertakings, Limited.—Capital, £20,000. Object: to acquire and carry on industrial, commercial, manufacturing, and financial business generally, to establish and maintain railways, tramways, electric light, gas, water, and hydraulic works, electric cables, telegraphs, telephone systems, warehouses, wharves, docks, harbours, canals, and other works, and to adopt an agreement with Dorington and Co.

European Construction Syndicate, Limited.—Capital, £45,000] Object: to adopt an agreement with J. Millen, to construct, maintain improve, manage, control, and superintend railways, roadways tramways, electric works, etc.

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SOME PRINCIPLES UNDERLYING THE PROFITABLE SALE OF ELECTRICITY.*

BY ARTHUR WRIGHT, ASSOCIATE MEMBER.

DISCUSSION.

The **President**, in inviting discussion on the above paper, said the difficulties attending the wiring of small houses, while they often prevented those who desired it from having the electric light, also interfered with the extension of supply into the most profitable quarters. The small houses made use of the electric light much more regularly, having regard to the number of lamps, than the larger residences, and were, therefore, the more profitable consumers.

Mr. R. A. Dawbarn, referring to Diagram 10 in the paper, which showed how the present consumption of electricity at Brighton was divided among different classes of consumers, etc., thought it proved unquestionably that this very intricate method of charging (the demand indicator system) was not perfect, and did not really satisfy all the conditions that were to be met with. Mr. Wright did not go quite far enough to tell them how he would deal with those extreme cases which represented quite the profitable portion of the consumers. The speaker went on to criticise the author's statement that the general load factor had only to be increased by unity for the extra profit, thereby made to more than cover the increased annual expenditure the use of demand indicators might involve. He could not quite understand this, his view being that the introduction of an additional non-productive instrument, as the demand indicator was, would not get over the difficulties referred to, and the community as a whole would suffer from its use. It seemed to him that as time went on, the demand indicator system would become less and less important. Taking a case where there was no other artificial illuminant than the electric light, he would ask the author how under those conditions he would argue that he had increased his load factor or derived any benefit corresponding to the increased total cost of running such an installation?

Mr. Wright: You are assuming an impossible case. I do not know of any place where the electric light is the only artificial illuminant available. There are always candles and paraffin.

Mr. Dawbarn said the point he had arrived at was whether there was any safe way of meeting the worst features of a uniform tariff. He had shown that the demand indicator system did not really perfectly meet the conditions as indicated in Mr. Wright's Diagram No. 10. It appeared to him that it was only in the extreme cases where very long-hour consumers were concerned that it was necessary to adopt this system, and he thought that, in order to catch the final 10 per cent. of these exceptional users, it was not advisable to introduce this special instrument into other houses. The system of charging which his firm was proposing to use at Foots Cray to meet the case of residential houses was: (*a*) for any amount up to 20 units, 13s. 4d. per quarter, and for each unit over 20 units 8d.; (*b*) or, at his option, the consumer may elect to be charged for any amount up to an average of 4½ units per lamp fixed, 3s., and for each unit consumed beyond an average of 4½ units per lamp 4d. The flat rate as well as the extent of the reduction of tariff after the 4½ units per lamp per quarter would, of course, be adjusted to each individual case according to the corresponding works costs and the price of gas. The speaker explained that the object of the proposal was to avoid putting a demand indicator on every consumer's premises, when there were probably not more than 5 per cent. of the consumers who really required such special treatment. So far as lighting and motor loads were concerned, he felt that the use of the demand indicator, although he did not call in question the principle of the system, should be restricted to special cases.

Mr. J. S. Highfield was of opinion that Mr. Wright's contention was correct, that the business of central-station engineers was to obtain every possible class of load, and to do that it was necessary to adopt some differential tariff. In his own station, at St. Helens, he did not use the demand indicator system for charging for lighting, because when he first went there the practice was to charge 6d. per unit. At a small Midland town with which he was previously connected, they used the demand indicator system, and the great difficulty experienced there was to explain the theory of the system to the consumer. The ordinary consumer was not able to appreciate the difference between his load which did not get a reduction and his neighbour's load which did. In this town the opposition was so strong that an average rate of 5d. per unit was given as an alternative for 7d. for the first hour and 3d. for extra units. Although 25 or 30 per cent. of the consumers were paying considerably less than an average of 5d. per unit on the demand indicator system, all except two preferred to adopt the alternative rate and take current at a flat rate of 5d. per unit. Another point was that the demand indicator system operated against the early-closing shop load. No doubt in a town like Brighton, where the shops were large, there was no difficulty with the demand indicator system, but for small shops it was impossible to charge 7d. per unit for the first hour. Therefore, if it were possible, he should rather have a lower price for the first two hours. In a poor class of town he thought there would be less trouble with the consumers if this were adopted. As Mr. Wright stated in his paper, the use of batteries might result in reducing the initial price per unit of current. In a town like St. Helens a very great part of the load was for motor purposes, especially in summer time, and there was also a tramway load. The first effect of such a load was that the total of the consumers' maximum demand would be large in comparison with the maximum capacity of the station, and that would enable the initial price to be reduced. In St. Helens they charged a fixed rate of 4½d. per unit for lighting, and he could see no chance of adopting the demand indicator system. His chief object was to encourage the motor load, and he was now using the demand indicator system for that. He had found that for essentially motor work about 2d. per unit was absolutely the maximum price he could charge consumers averaging an hour or two a day. As soon as they got to any load which lasted for over two hours a day, then electricity had no chance in competition with gas for motor purposes, and it was necessary to reduce the price to 1d. The demand indicator system for motor power purposes then came in very well, and the consumers at St. Helens readily fell in with the arrangement. At the rate of 1d. per unit, they could easily compete with gas at 2s. per 1,000ft., except under particular conditions. In order for station engineers to go ahead, it was very desirable to obtain the greatest diversity of load possible, and for this object the motor load was exceedingly valuable. In the initial stages of any electric supply undertaking, the early-closing shop consumers came on with great readiness. It seemed to him that these shops, although their load was a poor one, were an excellent advertisement, and should, therefore, have some amount of consideration. They were the means often of inducing the local authority to go in for improved street-lighting. If any station engineer were able to tell the early-closing shop consumers that they were unprofitable, he was in a very lucky position; but in the first years of an undertaking this was not possible.

Mr. W. H. Patchell thought that Mr. Wright's system was an ideal one, but he must confess that he (the speaker) had not yet reached that ideal. Experience had shown that in large towns they could not dictate terms to the consumer; what the consumer wanted to know was what he was actually going to pay for the electric light. If it was explained to him, for example, that he was first to pay 8d. per unit and then 2d., he was not nearly so happy as if he were told the actual price. The flate rate was always accepted by consumers without objection. The aim of the engineer was to keep up the load factor at the station, and the speaker gave figures to show that in Charing Cross, for the half-year from January to June, 1900, they had as high a load factor as 28½, and this without the use of demand indicators. His point was that they could do without this system and still maintain a high load factor. In one part of his paper Mr. Wright stated that it must be obvious that all the peak of a curve should be supplied from plant put down, having in view rather the lowness of capital costs, of standing-by coal, and the small amount of labour required, consistent with thorough reliability of service, than economy in coal on production account. He quite agreed with this, and it was proving correct at Lambeth. At this station they were now running at 75 per cent. of the load condensing.

Mr. W. M. Mordey stated that many people were mentally incapable of following a number of the arguments in this paper. It was undoubtedly a very great defect in the application of this system that it was difficult to get an ordinary person to understand it, and even persons skilled in figures often found trouble in following the argument. But were they sure that the basis of this system was sound? Taking the case of churches, for instance, the idea had been put forward that as these were exceptional consumers they should pay exceptional prices. But was this so? He thought it was probable that when people went to church they usually turned off two or three lights at home, so that it was quite possible that the demand on the station at that time was really less, or not greater, than when the churches were not lighted up. The same idea applied in the case of halls, and other places of occasional entertainment. He should very much like to have figures giving the results in such cases. In a further criticism of the demand indicator system, he referred to Mr. Wright's figures showing a gradual increase in the load factor at Brighton, which the author put down to the use of this system. But was it not the fact that the load factor in most cases all over the country had grown, and that in Brighton it would have increased to some considerable extent even if the people had been supplied on the improved flat rate? One objection to the system seemed to him to be that it must tend to prevent the installation of lights in places in a residence which were not much used, such as spare bedrooms. After all, the object of the system was to get at an average, and if so, then they might as well charge a flat rate straight away. The whole of the customers in a town ought not to be penalised because a small portion required special rates of charge. Simplicity of apparatus and method of charging was what they should aim at, and he did not agree with putting in a non-productive apparatus, the cost of which would swallow up a great part of the profits.

Mr. J. R. Dick said that great interest was being shown in this question in all countries at the present time, and the charges were now being based on the principle Mr. Wright had laid down in his paper. In this connection England occupied the primary position. Rapid progress had been made in this country in the cheapening of electricity, and their achievements were freely acknowledged abroad. He was surprised to find that so many eminent engineers were sceptical as to the doctrines set out in Mr. Wright's paper. He thought that all those who had given deep consideration to the question had arrived at a conclusion favourable to the demand indicator principle, not only in this country, but in America and on the Continent. The question to consider was in what way the load curve of each consumer could be measured in order to ascertain what proportion it bore to the demand at the station. The best way of doing this was to use the demand indicator system. One of the most appropriate names for the demand indicator was the "investment meter," because it more nearly than any other instrument gave the proportion of the investment charges which each consumer had to bear. A very important point was that with Mr. Wright's system all customers were charged fairly, and that none were discouraged. He did not agree quite with the use of batteries at times of peak. Obviously, they were not convenient in an alternating-current station. Mr. Dick went on to refer to the tariff usually adopted in the North of Italy in water power installations. Consumers were, as a rule, charged at so much per kilowatt demanded in these cases. He thought that a system of this kind would be more

* Paper read before the Institution of Electrical Engineers, Dec. 12, 1901.

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acceptable for power distribution charges than a flat rate. Too much stress had, in his opinion, been laid on the objection of the consumer to be charged on the demand indicator system. All the consumer wanted was to get his light as cheap as he possibly could.

Mr. H. L. P. Boot said the town he represented had had nearly all the present systems of charging in use. The flat rate proved a failure, and finally the demand indicator system was adopted because he was advised that it was the best system at present. The disadvantages of the system, however, about which Mr. Wright had said nothing, were very serious, and required much consideration on the part of the engineer. So far as the consumer was concerned he received a great benefit from the system, but his advice to the engineer was to leave it alone so far as his own comfort was concerned. The author mentioned that the system should be properly explained to each consumer. Mr. Wright was fortunate in having a great number of able assistants, and probably he found that their time was well occupied in this matter. Although he might criticise the system, it was simply with the object of ultimately getting some other system of charging which would have all the advantages of the demand indicator and none of its disadvantages. One objection to the demand indicator was that it did not take account of the time of maximum demand. What they wanted, he thought, was a meter which would read on the basis of, say, one hour a day, that hour only to be counted at the maximum rate, and at other times the meter should register at the lower rate. He was told that there was an idea of putting such a system into practice. It was clear that what they wanted to do was to encourage consumers at any other time than peak. On the whole, it must be admitted that the author had made out a very strong case for adopting the demand indicator system. He rather thought, however, that some of the figures given in the paper were too high, and should be cut down somewhat. In conclusion, he pointed out that the present system of charging for free wiring was a failure so far as inducing consumers to come on to the mains was concerned. Placing a charge on this work undoubtedly stopped consumers from putting in lamps or consuming electricity. It was far better to charge as the author suggested.

In reply to a query from Mr. Boot with reference to Diagram 10, **Mr. Wright** said the number of consumers given at 550 was the number of each class, so that every one of the consumers on the Brighton mains was taken into account in this calculation.

Mr. L. J. Aron thought the author had not laid sufficient stress, in dealing with the five or six light consumers, on the fact that these were practically all long-hour lamps. It was very obvious that in London such small installations could be made profitable. It might be interesting to the meeting to hear that in London the gas companies collected 240 tons of coppers in one quarter from the prepayment meters. He thought these coppers should go to the electrical engineer rather than to the gas engineer. The system spoken of by the author of charging by the hour or by the lamp had been tried in Germany and other countries on the Continent with success. In Germany they used a time-meter electrically driven, and they adopted the prepayment system. By this system the consumer put in an amount before the end of the quarter to correspond with the rent of 7s. per lamp. According to Mr. Wright's calculation, the consumer on the prepayment system got 30 hours of light from each lamp. One great advantage of this system was that they had no bad debts. Referring to other classes of consumers, the speaker thought there was not very much purpose in permanently installing the demand indicator system. One reason for this was that as a rule the average consumer did not increase his maximum demand, but maintained it fairly evenly. He also disagreed with the suggestion made by the author to cut out the demand indicator during hours of peak, and thought that what was known as the two-rate system might be substituted for this.

Mr. L. Andrews spoke of the use of the system at Hastings. It was introduced there some six years ago, and they were still in favour of it. But they did not believe in carrying it too far. It was a mistake to use demand indicators for all consumers. He did not think they ought to discriminate between customers using light one hour a day and those using it two hours a day. If the demand indicators were only used for long-hour consumers, the expense of having a very large number of such instruments was avoided. He also thought they should not force the system on consumers. Having called attention to the irregularity of the Brighton accounts, the speaker went on to show the effect of the system on the account of an actual consumer at Hastings. Taking first the September quarter, the consumer got about half the units consumed at the high price and the remainder at the reduced rate, and his bill for that quarter was £165. In the December quarter, when he consumed more units—about 10,000—he was supplied at the low rate, and the bill only came to £65. Then, again, for the March quarter, using only 9,000 units, the consumer had to pay £170. This was the experience at Hastings, where the system had been in use for about nine months, and the consumers absolutely refused to pay their bills. He admitted, however, that there were a great many advantages in the system, and it was still being used in that town. What they were anxious to do was to charge each consumer his proportion of the capital investment on the plant. The stand-by price at Hastings was 10s. per 8-c.p. lamp per annum, and the practice now was to announce that the price for current was 6d. a unit, but if any consumer liked to pay the stand-by charge he could get his supply for 1½d. per unit. He had experienced no difficulty in making the consumers understand the demand indicator system.

Mr. W. L. Madgen gave some figures showing the variations of the load factors from year to year at different stations in the country, and he said they were sufficient to satisfy him and those with whom he was associated in making the extracts that the maximum demand basis of charging was the true and correct one, and they certainly meant to adopt it. He first gave two instances in provincial towns. In Portsmouth they had charged from the commencement a uniform price of 4½d. per unit. The load factor in this station for the second year of the undertaking—*i.e.*, 1896-97—was 14·51 per cent. This figure steadily decreased each year, and in the year 1900-01 it was down to 12·01 per cent., a diminution of 2½ per cent. In South Shields, also a shipping town, they had steadily adhered to the maximum demand system. In the year 1897-98 the load factor was 11·31 per cent., and this gradually increased each year until for the period ending March last it was 12·24 per cent. He then gave two examples from London, the first being the case of Islington. At this place the maximum demand system was adopted at the opening of the station, and as a result the load factor had always shown an increase. Thus in the year 1896-97 it was 9·82 per cent., and at the end of March last it was 15·31, an increase of about 6 per cent. The other example he gave was that of St. Pancras, which started with a flat rate in 1893. In that year the load factor was 19·74 per cent., and by the year 1896-97 it had decreased to 11·94. At this time the maximum demand system was adopted, with the result that the load factor of the station was now 15·09. This state of things was pretty uniform all over the country, and the conclusion was that the demand indicator was the only sound commercial system at present. Experience showed that the short-hour consumer actually cost 7d. per unit to supply, and if he was supplied at 4½d. per unit the result was that they got an accession of the worst class of consumers. In the end they came to what he called a "tariff dead lock," which would ultimately lead to a "financial deadlock." These short-hour consumers coming on in such numbers, they could never put in enough plant to supply them profitably. He felt that in fixing a tariff one must have strict regard to commercial interests. He preferred to fix his tariff on that principle than give way to the ignorance and prejudice of the consumer.

Mr. C. P. Sparks was of opinion that the differences between the two parties—the one for and the other against this particular system—were due to a consideration of the system as applied to different areas. If they considered a system supplying every class of consumer in one town, then he thought it was possible to supply short-hour consumers at a flat rate, because the class of long-hour consumers counteracted the deficiency of the other class. Examining the load factors in some of the large cities on the flat rate, he found no indication of their having adopted a wrong tariff. On the other hand, taking the case of London, which was separated up into districts, one company might supply residences, another offices, and another shops, and in these circumstances no doubt some such system as Mr. Wright had put before them was essential. Of course, the great aim of all station engineers was to get as great a diversity factor as possible, and at the first start of a system in many towns where the electrical business was in the hands of the corporation it was at once found that the best consumers were the public lamps. These had a very marked influence on the accounts. In the case of Brighton they supplied no less than 18 per cent. of the total output for public purposes with a magnificent load factor. Another concern, near London, supplying over two million units a year for lighting purposes, had 49 per cent. of the total output used in the public lamps.

Mr. T. H. Minshall said there was no doubt whatever that the demand indicator system was exceedingly unpopular with the consumers. They started at Croydon with a flat rate of 6d., and, as a result, they were steadily losing all the long-hour consumers they had got. They then went in for the maximum demand system, and at the present time the consumers were charged 7d. and 2d. a unit without any option. The consumers strongly objected to be charged on this basis. He, therefore, issued a form of account which showed the average price the consumers were actually paying for their light, and the complaints immediately fell from about 200 to 15 or 20. With the adoption of the new system the load factor in the station improved. Referring to the question raised in the paper about the installation of economical plant, he thought that the author had clearly shown how they could calculate when it would pay them to put in superheaters, economisers, etc., and when not.

Mr. H. R. Beeton said it occurred to him that, perhaps, electrical engineers did not devote sufficient attention to the commercial aspects of electric lighting. To use Mr. Wright's expression, it was very much more important that engineers should devote their attention to the efficiency of capital than of plant. He thought that Mr. Wright's system was best calculated to promote the success of an electric lighting undertaking for the reason that it ensured that no consumer was supplied at a loss, and all consumers at a reasonable profit on the cost of production. That was the only basis from which profit could result. He pointed out that the object in view, as it had been stated by a previous speaker, was to encourage consumers to take a supply during the light load. But to offer a man electric light in brilliant sunshine was a mistake, and he who proposed to sell the consumers what they did not want would do a very poor business. It appeared to him that if proper consideration were given to the particular commercial aspects of this tariff, which was based on a plain but thoroughly sound principle, it would emerge from amongst all others as the one best calculated to increase the consumption and lower the price.

Mr. Percy Still, while agreeing with the instrument, considered that the principle of the system could be carried too far. As an example, he referred to the case of the early-closing shops in the West-end of London. Practically speaking, these shops only got the advantage of the lower price during six months of the year. Against these consumers there were in the same district residential houses which only commenced to use the supply to any extent after the shops had closed for the day. The principle of this system was that every consumer should pay his proportion of the capital charges before he obtained the units at the lower price. But in the circumstances he had mentioned these capital charges were obtained twice over, and this was one case in which the system could be carried too far. At Chelsea the Wright demand indicator system had been introduced with success. He saw no reason why those consumers who had been

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termed bad consumers could not be supplied except at a prohibitive price. Mr. Wright complained that he was unable to charge 8d. per unit for a supply. In the speaker's case, the statutory price was 10d., but it had never yet been enforced.

Other members who had intimated their desire to take part in the discussion were asked to send in their remarks for publication in the *Journal*, and the meeting was adjourned.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution on Jan. 9, the following were the candidates balloted for:

Members.—C. S. V. Brown, 13, Mosley-street, Newcastle-on-Tyne; S. W. Cuttriss, Prudential Buildings, Park-row, Leeds; D. Macdonald, 20, Rue de l'Arcade, Paris.

Associate Members.—W. H. Alabaster, 29, Edmund-street, Langworthy-road, Seedley, near Manchester; J. L. Cateaux, 10, Kingdon-road, West Hampstead, N.W.; H. F. Clayton, 49, Middle Abbey-street, Dublin; R. C. Cliff, Cape Government Railways, Cape Town; J. S. Colquhoun, 11, Oliver-street, Rugby; C. Day, Grove House, New Moston, Manchester; G. Edwards, Charing Cross and City Electric Company, Trunk Mains Department, 86, Fenchurch-street, E.C.; J. E. Ellis, care of Messrs. J. Fowler and Co., Leeds; A. H. C. Gibson, 14, Temple-street, Birmingham; C. C. Gibson, Hampden House, Phœnix-street, N.W.; F. Golding, Chief Electrician's Branch, G.P.O., Sydney, N.S.W.; G. H. J. Hooghwinkel, 34, Manchester-street, W.; W. Inglis, Electric Light Station, Port Adelaide, Australia; A. D. Jones, St. Aubyns, The Vale, Hampstead, N.W.; A. F. Lord, Westwell-street, Plymouth; T. McEwan, 56, Frederick-street, Edinburgh; W. McLellan, 1, Moseley-street, Newcastle-on-Tyne; R. H. Paus, 27, Heaton-grove, Bradford; F. G. Poulton, Shaftesbury House, Whitecross-road, Hereford; E. G. Pulford, 108, Whitechapel, Liverpool; L. Rottenburg, Belmont, Elderslie; E. Sayer, 6, Sarre-road, West Hampstead, N.W.; J. E. Sayers, 189, St. Vincent-street, Glasgow; W. A. Scott, 8, Working-street, Cardiff; J. H. Seccombe, 19, Portland-road, Holland Park, W.; W. Shaw, 10, Colmore-row, Birmingham; P. G. Timms, 21, Chelverton-road, Putney, S.W.; H. W. Umney, 19, Sylvan-road, Upper Norwood, S.E.; D. Wilson, 15, Whiteley-road, Upper Norwood, S.E.; H. E. Wimperis, 20, Granard-road, Wandsworth Common, S.W.; A. E. Woodhouse, Darnley, Tomes-road, Papanui, Christchurch, N.Z.

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FORTHCOMING EVENTS.

FRIDAY, JANUARY 17.

Institution of Civil Engineers (Students' Section).—At 8 p.m.: Lecture on "The Theory of Heat-Engines," by Capt. H. Sankey, R.E.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. Paper: "Modern Machine Methods," by Mr. H. F. L. Orcutt.

Royal Institution.—At 9 p.m., the Right Hon. Lord Rayleigh on "Interference of Sound."

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "Manchester and Liverpool High-Speed Electrical Railway," by Mr. F. B. Behr.

MONDAY, JANUARY 20.

University College, London.—Prof. C. A. Carus Wilson on "Electric Motors, with Special Reference to Tramways and Railways."

London Electrical Contractors' Association.—At 3 p.m., meeting at Anderton's Hotel, Fleet-street, E.C., to discuss the formation of an association of electrical manufacturers.

Society of Arts.—At 8 p.m., Mr. Samuel Rideal, D.Sc., on "The Purification and Sterilisation of Water" (Lecture II).

Institution of Marine Engineers.—At 8 p.m., 58, Romford-road, Stratford, E. Subject for Discussion: "Combustion of Fuel, Continued Experiments."

TUESDAY, JAN. 21.

Royal Institution.—At 3 p.m., Mr. Allan MacFadyen on "The Cell: Its Means of Offence and Defence" (Lecture II.).

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be further discussed: "American Workshop Methods in Steel Construction," by Mr. H. B. Molesworth.

WEDNESDAY, JAN. 22.

London School of Economics.—At 6.30 p.m., Mr. W. M. Acworth on "The Economics of Railway Administration."

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "Scientific Observations at High Altitudes," by Rev. J. M. Bacon.

Institution of Electrical Engineers (Birmingham Section).—At 7.30 p.m., ordinary meeting. Paper: "Surface-Contact Systems of Electric Traction," by Mr. W. Kingsland.

Institution of Civil Engineers (Students' Section).—At 2.30 p.m., visit to the testing works of Messrs. David Kirkaldy and Son Southwark-street.

THURSDAY, JAN. 23.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Paper: "Earth Currents Derived from Distributing Systems," by Mr. E. B. Wedmore. (Dublin Section): At 7.30 p.m. Paper: "Notes on Inductive Circuits," by Mr. W. Brew.

FRIDAY, JAN. 24.

Royal Institution.—At 9 p.m., Mr. H. G. Wells, B.Sc., on "The Discovery of the Future."

Physical Society.—At 5 p.m., ordinary meeting. Papers: "The Factors of Heat" (Part I.), by Mr. James Swinburne; "Exhibition of some Twinned Crystals of Selenite," by Mr. Eustace Large.

North-East Coast Institution of Engineers and Shipbuilders.—General meeting at Newcastle-upon-Tyne.

SATURDAY, JAN. 25.

Institution of Junior Engineers.—At 7 p.m., seventh anniversary dinner, Hotel Cecil.

Manchester Association of Engineers.—Annual dinner at Manchester.

Institution of Electrical Engineers.—(Students' Section): At 10 a.m., visit to the works of the Silvertown Company.

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "Large Storage Batteries and their Application to Central-Station Supply," by Mr. Henry MacEwen.

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THE
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THE TELEPHONE CONFERENCE.

The representatives of the eighty-one local authorities within the London telephone area have twice met in conference on the telephone question in the Council-chamber of the city of London. We made no editorial comment on the proceedings of the first conference, held just before Christmas, but now that an answer has been received from the Postmaster General to the resolutions then passed, the whole matter may be advantageously reviewed. The various resolutions passed at the first conference, and the great majority of the speeches on both occasions, clearly show that the London local authorities as a whole are conscious of three distinct grievances. We think we shall not be doing them an injustice if we place these grievances in the following order of importance from the local authorities' point of view. They are, therefore, (*a*) that the Postmaster-General signed and sealed an agreement with the National Telephone Company without first obtaining the approval of the eighty-one authorities to the terms of the same; (*b*) that the rates to be charged in common by both the Post Office and the National Telephone Company are too high; and (*c*) that the Postmaster has agreed to work to a certain extent in co-operation with the National Telephone Company instead of instituting a "general, immediate, and effective competition" with the company's system. We have in a previous leader expressed our opinion on this last grievance, to the effect that the Postmaster-General is to be greatly complimented for the action he has taken in avoiding the very form of competition which these local authorities desire. This competition, with its rate cutting and duplication of the telephone equipments in all large business houses, would involve the user in increased expense, and at the same time give him a much more inconvenient telephone service. Lord Londonderry's reply to both the London County Council deputation and to the resolutions passed at the first meeting of the above-mentioned conference most clearly explained this, and bring forward the additional objection that the general taxpayers' money would be squandered as well. It is on the second grievance, however, that we have the most fault to find with the speakers at the conference. They have almost unanimously declared that the Postmaster-General has not reduced the telephone rates. Even the chairman of the conference, Mr. A. C. Morton, emphatically stated this at the last meeting. When complaining of the great inconvenience and loss resulting from the breaking up of the streets in the City, he stated that the citizens had put up with this inconvenience because they expected great reductions in the cost of electrical energy and telephony. In the case of the electric light competition, Mr. Morton claimed the charges had been reduced thereby to practically one-half, but he declared that the rates for telephone service had not been reduced. This is only true to a certain extent of the charges made for unlimited service, as the new terms for message-rate subscribers give a very large reduction to subscribers who make but few calls. In this way many who do not now use the telephone should be induced to take it, as the trial need not cost them more than £6. 10s. per annum. At the Institution of Electrical Engineers last week the question of the telephone rates in Berlin was discussed. In view of the remarks from one speaker, that the telephone was much more used in that city than in London, Mr. J. Gavey explained that whereas the unlimited users in Berlin made on the average sixteen calls per day, those using the telephone on the message-rate system made only two calls per day, which brought the general average throughout the system down to twelve and a half calls per subscriber per day. This, Mr.

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Gavey said, is practically the same as obtains on the London system of the National Telephone Company. We believe, however, that the London figure at the present time is nearly fourteen calls per day per subscriber. It is true that the unlimited user in Berlin gets his instrument for some £9 or £10 per annum, but he has not the privilege of speaking over such a large area as the subscriber in London. On the message-rate system the Berlin subscriber has to pay about £6. 10s. per annum for four hundred calls, while in London we shall pay the same amount for three hundred and sixty calls. Assuming that the London subscriber uses his instrument for calling twice a day, as is found to be the case in Berlin, he will pay now £8. 13s. per annum for what previously he could not have obtained under £20, or for £17 by signing a five years' agreement. The above calculation is based on the assumption that one-fifth of the calls are made to subscribers outside the London County Council area. It remains to be seen how far the statements made in the conference is true—that the present price of a telephone to an unlimited user handicaps the London business man. It would not be fair to make the comparison of the average cost per call to the large business houses making often one hundred calls per day, so we will take Mr. Gavey's figures of the average user, who calls up other subscribers twelve and a half times per day. This at £17 per annum works out at ·85d. per call. For this sum he not only gives his message to the person called, but also gets that person's answer. The same operation performed by the penny post would cost £38 per annum, or by two sixpenny telegrams £228 per annum. Beyond the consideration of cost, however, the telephone message receives a more prompt reply, and the opportunity of personal converse such as cannot be compared with the postal or telegraph messages. In fact, no unbiassed person looking into the matter can fail to endorse the opinion expressed by Mr. Hanbury's Telephone Committee that the present charges for unlimited number of calls are reasonable. Lord Londonderry has accordingly given all the reductions he considers possible to the small user, and by so doing he will secure a greatly increased use of the telephone, which will be so advantageous to the whole community. There is only one grievance of the local authorities left to be considered, and this grievance no one can mitigate or explain away. The London authorities were not consulted by the Postmaster-General before concluding the new telephone agreement, and from the speeches made by the delegates at the London telephone conference it is not difficult to see the reason why. It is that these authorities have shown both by their previous obstructive policy towards all telephone improvements, and by their resolutions in conference, that they are not competent to deal with the points at issue. Assuming that it were possible, we know of nothing which would so retard the progress of telephony in London as the granting to the London County Council the power to conduct the competition it desires. The result would be disastrous to all in London connected with telephony, and then, when too late, the delegates at the present conference might learn the essential difference between a constructive and a purely destructive policy.

GAS v. ELECTRICITY.

It is not often nowadays that the cudgels are taken up in a thoughtful manner by an experienced engineer to combat the view that gas is and will be superior to electricity. However, the well-reasoned paper of Mr. John Laycock, the gas manager at Keighley, before the Keighley Engineers' Association, causes one to turn and see if electricity is keeping pace in improvements with its competitor, gas. There is still company-mongering *ad nauseam* in electrical work, but that is not progress, nor conducive to progress; and we believe that if municipalities had not taken up electric lighting, progress in improvement would have been practically an unknown quantity. Companies are often not promoted for work, only for pelf; their desire is to plank down a standardised plant in any and every conceivable position, no matter how much the surrounding conditions differ. They point to America as the source of their inspirations, never for a moment acknowledging that the conditions holding on one side the Atlantic are and were absolutely distinct from those obtaining on the other side. In America standardising and scrapping possessed enormous advantages. Here the whole case was different; not that we are opposed to standardising or scrapping when it is done under favourable conditions. Electrical engineers are too often prone to tell only a part of the truth because certain wire-pullers have influence, and may use that influence detrimentally towards anyone who expresses an opinion at variance with that of the interested party. There exists a considerable lack of backbone, otherwise gas engineers would find it advisable to introduce comparisons that might have some reality rather than comparisons which are altogether misleading. Take as an example the tabular statement made by Mr. Laycock in his paper. He took the cost of electricity at 5d. per unit, each unit being, according to the Board of Trade basis, equal to 280 candles, and the cost of gas at 2s. 6d. per 1,000ft. He gave the following statistics:

Burners.	Gas (1,000ft. costing 2s. 6d.). Candle-power.		Units.	Electricity at 5d. per unit). Cost.
Iron burners.....	1,500	equal to	5½	2 2¾
Bray's old	1,700	,, ...	6	2 6
Bray's special	2,600	,, ...	9½	3 11½
Christiania	2,900	,, ...	10½	4 4½
Argand	3,400	,, ...	12	5 0
Welsbach "C" ...	15,000	,, ...	54	22 6
Welsbach "Kern".	24,000	,, ...	86	35 10

Now, so far as any report of this paper is concerned, we cannot find that the comparison was made between different methods of utilising electric energy for light, but rather the various gas burners seem to have been compared with the least efficient electric burner. Is such a comparison honest? It may go down and obtain applause from an interested or an ignorant audience, but as soon as it is exposed people begin to look askance upon those who endeavour to support their cause by such means. The candle-power efficiency for a given expenditure of energy between incandescent and arc lamps is just as great as is the efficiency between an old iron gas burner and a "Kern." It is not because of the ease with which such statements can be controverted that we call attention to them, but because electrical engineers assume that incandescent and arc lamps are perfect, and so neglect attempts at improvement in directions that are clearly open, if the blind would only see. Gas has been rendered in some ways more efficient, and invention goes on, while the same rate of improvement has not been carried on during the same period as regards the use for lighting by electrical energy.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suit-

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able question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

447. A shunt motor of 7½ b.h.p., wound for 230 volts terminal pressure, according to makers' plate runs at 825 revolutions. It is connected to the supply mains of the three-wire system of 230 and 460 volts. I believe that during the day the supply is obtained from the batteries of the station. It is necessary that the speed should be constant for the class of machines driven, but I find that this varies greatly. On the motor is an 8in. pulley; on the driven shaft is a 47in. At 7 a.m. the speed of the shaft is 142 revolutions, of which the motor must give 834·25 revolutions. At 10.30 a.m. the speed rises to 146 revolutions. The motor must then give 857·75 revolutions; and at 3.30 p.m. the shaft makes 158 revolutions—the motor must then make 928·25 revolutions. What is the cause or causes of such rises in the speed? What would be the remedy? Would a 460-volt motor be of more advantage for the work?—J. D.

448. What in practice are found to be the chief advantages and the chief disadvantages of (1) the moving grate and (2) the sprinkler types of mechanical stoker?—S. G. P.

ANSWERS

Question No. 441.—How is it that strengthening the field in the Elihu Thomson wattmeter increases the speed of the armature, seeing that strengthening the field of a shunt motor at constant pressure decreases the speed of armature?

Answer to No. 441 (*awarded* 7*s.* 6*d.*).—If E be the constant E.M.F. applied to the terminals of a shunt-wound motor, R the resistance of the armature, C the current through it, and e the counter E.M.F. developed in the armature, then

$$E = e + C R \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

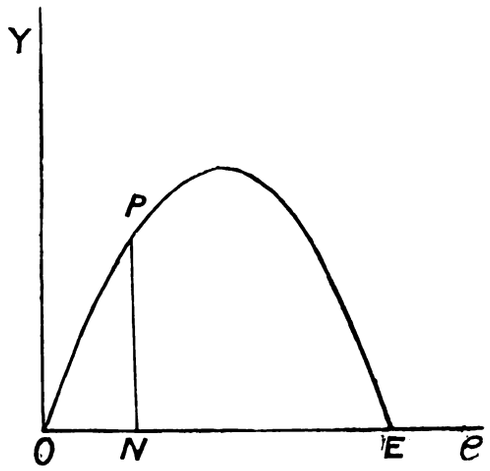
If T be the torque on the armature shaft in foot-pounds, and n the number of revolutions per second, then

$$T = 0{\cdot}1174 \frac{C e}{n}.$$

By means of (1) this may be written in the form

$$T = 0{\cdot}1174 \frac{e (E - e)}{n R} \quad . \quad . \quad . \quad . \quad (2)$$

Now, if we plot out a curve so that $P N = \frac{e (E - e)}{R}$, and $O N = e$, we get the parabola, O P E, in the figure where



O E = E. This figure shows us at once that if e is less than ½ E, $\frac{e (E - e)}{R}$ increases as e increases. If, on the other hand, e is greater than ½ E, $\frac{e (E - e)}{R}$ diminishes as e increases.

In a shunt-wound motor running normally, e is considerably greater than ½ E. If we strengthen the field, e is increased, and, therefore, $\frac{e (E - e)}{R}$ is diminished; and, hence, if the torque is to remain constant, we see from (2) that n must diminish. In general, strengthening the field of a shunt-wound motor makes it run slower if e be greater than ½ E, and, by similar reasoning, strengthening the field will make it run faster if e is less than ½ E.

Now, in an Elihu-Thomson watt-hour meter we have a very high non-inductive resistance in series with the drum-wound armature. In this case the term C R in equation (1) is at least 1,000 times greater than e at full load, as the maximum speed is only about one revolution per second, and at smaller loads there is a much greater difference between e and C R. Hence e is very much less than ½ E, and, therefore, strengthening the field will make the armature rotate faster. As this motor only works at the beginning of the curve in the figure, which is nearly a straight line, we see that the increase of speed is almost exactly proportional to the increase of the current. Also, since the retarding torque caused by the eddy currents in the large copper disc fixed on the spindle is proportional to the speed, it follows that the speed is proportional to the watts in the external circuit.

We conclude that if a shunt-wound motor were to run very slowly, strengthening the field would make it accelerate, whilst if the armature of an Elihu Thomson watt-hour meter were to rotate fast enough, then increasing the field would make it go slower.—J. C. R.

Answer to No. 441 (*awarded* 7*s.* 6*d.*).—The explanation rests on the following: (1) In the Elihu Thomson wattmeter, the strength of the field being small and the speed low, the ratio of the back E.M.F. to the terminal E.M.F. of the armature circuit is nearly, though always greater than, zero. In a shunt motor, the strength of the field being great and the speed high, the ratio is nearly, though always less than, unity. (2) In the meter the resistance of the armature circuit is high and in the motor low.

The driving torque of the meter armature varies as the field and as the armature current. The armature current is constant for all speeds, because of the low back E.M.F., and thus the meter will go faster the stronger the field.

In the case of the motor, the driving torque also varies as the field and as the armature current, but the latter is not constant for different speeds. The difference between the terminal and back E.M.F.'s is the effective current producing E.M.F. on the armature circuit, and this difference is small since the resistance of the armature is very low. Accordingly, the speed of the armature must be that which gives a back E.M.F. approximately equal to the terminal E.M.F., which is constant. Now, the back E.M.F. varies as the speed and as the strength of the field; thus the product of the speed into the field is approximately a constant. Therefore the stronger is the field the less the speed.

Let i = armature current in C.G.S. units;
N = flux through armature in C.G.S. units;
E = terminal E.M.F. in C.G.S. units;
e = back E.M.F. in C.G.S. units;
r = resistance of armature circuit in C.G.S. units;
n = speed of armature in revolutions per second;
C = number of armature conductors;
T = torque in dyne-centimetres.

Then $$e = n C N,$$

$$i = \frac{E - e}{r} = \frac{E - n C N}{r},$$

and the work per second in ergs is

$$2 \pi n T = e i.$$

Therefore $$T = \frac{e i}{2 \pi n} = \frac{C}{2 \pi} N i;$$

and therefore the torque (of the meter or motor armatures) varies as the field and as the armature current. Substituting the value for i,

$$T = \frac{C N}{2 \pi} \cdot \frac{E - n C N}{r}.$$

In the case of the meter the resisting torque due to the

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copper disc and brake magnets is proportional to the speed and, therefore (k being a constant),

$$T = k\,n = \frac{C\,N}{2\pi} \cdot \frac{E - n\,C\,N}{r}.$$

In the meter, n, N, and n C N are small and r large; for example, if E = 100 volts, n C N would be less than 1 volt, and r about 4,000 ohms. Therefore we may write as a close approximation

$$k\,n = \frac{C}{2\,\pi\,r}\,N\,.\,E.$$

The speed is thus proportional to the field and the terminal E.M.F., and since the field is proportional to the main current, the speed varies as the main current and as the volts.

From this result we see the greater the field, the higher the speed.

In the case of the motor, from

$$T = \frac{C\,N}{2\pi} \cdot \frac{E - n\,C\,N}{r},$$

we get

$$n = \frac{1}{C\,N}\left(E - \frac{2\,\pi\,T\,r}{C\,N}\right).$$

Now N is large and r small, so we can neglect the last term, and as a close approximation

$$n = \frac{E}{C\,N};$$

i.e.,

$$E = c,$$

from which we see that the speed varies inversely as the field, and thus the stronger the field the less the speed.

Example.—A shunt motor has terminal E.M.F. = 100 volts, back E.M.F. = 95 volts, armature resistance = ·1 ohm.

$$\frac{2\,\pi\,T\,2}{C\,N} = 100 - 95 = 5,$$

which may be neglected in comparison with E = 100 for a rough approximation.

$$\text{Armature current} = \frac{100 - 95}{\cdot 1} = 50 \text{ amperes.}$$

—W. H.

Answer to No. 441 (*awarded* 5*s.*).—The reason why an increase of field strength causes a Thomson meter to increase in speed whilst a shunt motor decreases in speed for the same cause may be seen as follows: the speed in either case will depend upon the torque, which latter is proportional to (armature current × field strength). The question is, therefore, what decides the value of the armature current?

In the Thomson meter it depends almost solely (for a given voltage) on the resistance of the armature circuit, for the counter E.M.F. produced by the armature is so small as to be negligible compared with the voltage of the circuit, and hence the speed and field strength have practically no effect upon the value of the armature current. It is evident, therefore, that the torque is proportional to the field strength—*i.e.*, the field current—so that increasing the latter increases the speed until the opposing torque produced by the braking magnets balances that due to the armature.

But with an ordinary shunt motor the case is different. Though, as above, the torque is proportional to (armature current × field strength), the current is dependent upon the difference between applied and counter E.M.F.'s. The latter E.M.F. is proportional to (speed × field strength), and is nearly equal to the applied E.M.F. Now, an increase of field strength tends to increase the counter E.M.F., but a very small increase of the latter diminishes the armature current greatly, and the torque, therefore, falls off, causing the motor to slow down.

To take a numerical example Suppose a shunt motor is running on a brake load—*i.e.*, a load requiring constant torque independent of speed. Let there be 100 volts across the brushes, and let the counter E.M.F. be 96 volts. Then the armature current will be equal to

$$\frac{100 - 96}{R} = \frac{4}{R} \text{ amperes,}$$

where R is the armature resistance. The torque will be proportional to $\left(\frac{4}{R} \times F\right)$, where F = field strength. Suppose, now, F to be increased by 5 per cent.; as the torque must remain the same, the current must now be equal to $\left(\frac{4}{R} - 5\,\%\right) = \frac{3{\cdot}81}{R}$ amperes. The C R drop is, therefore, 3·81 volts, and the counter E.M.F. = 100 − 3·8 = 96·2. The new speed must, therefore, be equal to

$$\frac{96{\cdot}2}{96} \times \frac{100}{105} = 95{\cdot}4\,\%$$

of its original value.

In fact, the Thomson meter is a separately-excited motor with a very large resistance in its armature circuit. For if a shunt motor be taken, and a high resistance be put in series with the armature, it will be found that increasing the field strength increases also the speed. If the resistance be reduced, it is interesting to note that a certain value of it will be found where speed is nearly independent of field strength over a certain range. With less resistance an increase of speed will be caused by diminished field. The value of the resistance for this condition will be such that the counter E.M.F. is equal to the C R drop in the armature circuit.—R. C.

Question No. 442.—In a central station are three 300-kw. Allis-Corliss cross-compound surface-condensing engines with cylinders 16in. and 32in. by 3ft. stroke; steam 160lb. per square inch. At times the low-pressure pistons make a terrific grunting noise, accompanied by great vibration, and occasionally by squeaking of exhaust valves. This is immediately stopped by reducing the vacuum. Can any reader explain this?

Best Answer to No. 442 (*awarded* 10*s.*).—There is always considerable difficulty in locating, much more so in determining, the cause of a noise proceeding from the cylinders of an engine, and the information conveyed in the question is rather too limited to fully diagnose the case. As a general rule, the true cause can only be obtained by making tentative experiments based on practical considerations until one is successful in eliminating the knock. The framer of the question has given us two observed effects directly or indirectly connected with each other, and it would have been of further considerable help in elucidating them to have had indicator cards showing the distribution of the steam in the cylinders. If an engine of only moderate speed is to run smoothly and quietly, it is essential that there should be a fair amount of compression of the steam at the ends of the exhaust stroke, and the amount depends upon the speed and the size of engine.

It appears to the writer from the data given that the engine in question is deficient in this respect, as the following personal experience illustrates: Some time ago he was called in to stop a knock occurring in a small compound engine, and by trial and error it was discovered that when the indicator cocks on the low-pressure cylinder were opened the knock disappeared at once. On taking indicator diagrams from this cylinder it was found that there was a fair amount of compression, but as it was considered, for the reasons given below, that the disappearance of the knock pointed to insufficient compression, it was increased, and subsequent results justified the alteration, as the knock was then permanently eliminated.

The case in question presents features of a similar character, as opening the indicator cocks in the instance cited by the writer vitiated the vacuum, because air was being drawn in during practically the whole of the stroke, arising from the fact that the low-pressure cylinder was doing very little work, and only for a short period of the stroke was there any pressure above the atmosphere. The reduction in the vacuum in the question under consideration results in a higher absolute pressure in the low-pressure cylinder, and since the point of compression is fixed, the final compression pressure is higher with the inferior vacuum, or, in other words, there is more compression. This, then, probably accounts for the smoother running with the inferior vacuum. The course, therefore, to adopt here is to increase the com-

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pression temporarily, if possible, by altering the eccentrics, even though this may be detrimental to other points of the distribution, and, if the result justifies the increase of compression, the eccentrics should be put back, and the valves permanently altered, or new ones fitted, to give the required amount of compression to produce smooth running.—E. Y. T.

Answer to No. 442 (*awarded* 5*s.*).—The question at issue opens up a much wider scope than is at first apparent, there being several "factors" which could be conducive to the piston's vibration with its natural accompanying noises. Firstly, want of oil would cause the trouble, or it may be that the oil used is of inferior quality and lacking in *body*; if so, the remedy in this case is obvious. Secondly, the reason may be that the piston—which in this class of engine is unusually heavy—being entirely unsupported by a "tailrod," is too heavy for the springs inside the "spring-ring" (which is only 1in. wide) to bear its weight, and consequently rides on the cylinder bottom, and this being the case the only remedy which would prove permanently effective is the addition of a "tailrod" and slipper block, which could easily be fitted, and at no great expense. When a heavy piston like the one in this case is running unsupported from both sides, there must be a tendency of the cross-head momentarily to bear on the top instead of bottom guide at the extreme back stroke, owing to the piston's enormous weight making a lever of the piston rod and using the neck ring as fulcrum. Finally, the primary cause of the trouble is undoubtedly imperfect lubrication, and when the vacuum is reduced the low-pressure cylinder naturally does less work, causing a corresponding effort on the part of the governors to make up this deficiency by admitting more steam, and steam being a magnificent "lubricant," the trouble ceases.—E. Rudland Wood.

Answer to No. 442 (*awarded* 5*s.*).—Water is probably the cause of the trouble alluded to by "Baron." With a high reading on the vacuum gauge, which means a low pressure in the condenser and cylinder, we have, other things being equal, a lower temperature in the cylinder and condenser than when the vacuum is not so good. By "other things being equal," I mean that it is possible, with a faulty air-pump, to have a low temperature in the condenser and yet a poor vacuum. This low temperature will give rise to increased condensation on the walls of the cylinder, as the cylinder will be correspondingly cooler. This condensed water will prevent the proper action of lubricants, because the cleaned surface of cylinder being wetted with water, the oil, owing to its inability to remove the water and take its place, cannot perform its duty. The result is rubbing and grinding between the moving parts, and consequently greatly increased wear and tear. Drain cocks should be looked to, and some alteration made in the method of lubrication.—M. M.

THE STRETFORD REGULATIONS AS TO THE SUPPLY OF ELECTRICAL ENERGY.

DRAFTED BY C. H. WORDINGHAM, M.I.E.E.

1. *Area of Supply.*—The Stretford District Council are prepared to furnish electrical energy for lighting, motive power, heating, and other purposes in the streets enumerated in Schedule 1 attached to these regulations, and to all premises situated within 50 yards of the electric mains laid in those streets.

2. *Mode of Application for Supply.*—(*a*) Application for a supply of electrical energy must be made on Form A for lighting or Form B for motive power. Full particulars as to the consumer's proposed installation must be entered in the blanks provided, and the forms must be signed by the consumer himself. When application is made for motors the capacity of which exceeds 2½ kw., Form C must be filled up and signed, in addition to the ordinary application forms. After signature, the forms must be forwarded to the Clerk of the Council, District Council Offices, Old Trafford. (*b*) A new tenant entering upon premises previously supplied with electrical energy must make application on the ordinary forms, and must not use the supply until he is advised by the Council that he may do so. (*c*) If it be desired to extend the use of the supply, application must be made upon the same forms for the additional lamps, motors, etc. In no case may the maximum demand covered by the consumer's accepted applications be exceeded without permission from the Council.

3. *Deposit.*—(*a*) Before giving a supply, the Council will require a deposit to be made of such an amount as will be sufficient to cover their estimate of the amount of the account for a winter quarter's supply of energy to the consumer, and the consumer will be advised of the amount required after his application has been received. (*b*) The Council may dispense with the payment of a deposit if they think fit, but so doing does not destroy their right to subsequently enforce it if they consider it expedient to do so. (*c*) The Council will pay interest at the rate of 4 per cent. per annum on each deposit for every complete period of six months during which it is retained by them.

4. *Period of Supply.*—(*a*) Applications will not ordinarily be accepted for a shorter period than one year. (*b*) If a temporary supply be required, application must be made on Form D, and special terms will be quoted. (*c*) No installation will be connected until it is fully complete, except under very special circumstances, and then only when the sanction of the Council has been previously obtained in writing.

5. *Change of Tenancy.*—In the case of consumers vacating their premises, they must fill up Form E, giving not less than 48 hours' notice of their intention to discontinue taking the supply. If such notice be not given, the consumer will be held responsible for the whole of the energy registered by his meter or meters until the supply is cut off.

6. *Charges for Electrical Energy.*—The following are the charges made by the Council for the supply of electrical energy: (*a*) A charge of £2 per quarter per kilowatt capacity of consuming devices installed irrespective of the quantity of energy consumed, and in addition a charge of 1½d. per Board of Trade unit of electrical energy supplied as shown by the meter or meters. (An illustration of the foregoing charges for different numbers of hours of consumption is shown in the table set forth in Schedule 2.) (*b*) At the end of every four complete quarters the average price paid will be ascertained, and if this exceeds 6d. per unit for lighting, or 3d. per unit for motive power, heating, or charging of accumulators, the difference between the amount actually paid during the period over which the average is taken and the amount that would have been paid at 6d. per unit for lighting, and 3d. per unit for motive power, heating, or charging accumulators, will be credited to the consumer in the ensuing quarter's account. (*c*) When electrical energy is used for motive power under such conditions that the motor or motors must be kept running for not less than 48 hours per week the fixed charge is remitted, and only 1½d. per Board of Trade unit of electrical energy is charged.

7. *Accounts.*—All charges accrue day by day, but as a rule they will be collected quarterly. Payment is due on demand.

8. *Non-Payment of Accounts.*—In the case of non-payment of accounts, the supply will be cut off without notice.

9. *Nature of Supply.*—Continuous current at constant pressure is supplied for all purposes.

10. *Pressure of Supply.*—The pressure of supply for lighting and heating is 220 volts; for motors not absorbing more than 2½ kw. each, 220 volts; for motors above this capacity, 440 volts.

11. *Service Mains.*—(*a*) Service mains are provided and laid free by the Council when the building in which the supply is to be taken abuts on a public street and is not more than 50 yards from the main, but the Council reserve the right to determine the point of entry of the main to the premises, due regard being had to the reasonable convenience of the consumer. (*b*) Where a building does not abut on a public street, but a garden, yard, or other private property intervenes, the consumer must pay the cost price of so much of the main as is laid on his premises, including the cost of laying, and must sign Form F. On his ceasing to take the supply, the portion of main for which he has paid becomes his property. (*c*) The hole through the wall necessary to admit the service main must be cut by the consumer. (*d*) The service main for all installations, whether for lighting or power, in which the demand does not exceed 2½ kw., will consist of two conductors. Where the demand is greater than 2½ kw., the main will consist of three conductors. In the latter case the installation *must* be wired with two independent circuits, kept separated from one another throughout the building, and the consuming devices must be divided between the two circuits approximately equally. When 440-volt motors are included in the demand, they will be supplied from the outer conductors of the three-wire main, and a distinct circuit must be run for them. (*e*) Where permission has to be obtained from owners of property to allow a service main to be carried through such property, it rests with the consumer to obtain this permission. (*f*) When a building occupied by several tenants is supplied, one service main only will be run, consisting of two or three conductors, according to the demand. The supply to the individual consumers in the building may then be taken to them in one of three ways at the option of the landlord and at his or the consumer's expense—viz.: (i.) Each tenant's installation may be independently connected to the service main. (ii.) Main wires may be run by the landlord from the service main to convenient points in the building, and at their termination distribution boxes must be fixed, which will be sealed by the Council. In this case the landlord must sign Form G. (iii.) The building may be wired as if for one tenant, in which case the individual tenants will not be recognised as consumers, the landlord being responsible to the Council for the whole consumption in the building, and recovering from the individual tenants himself.

12. *Main Fuses.*—The Council will provide and fix free of charge main fuses at the termination of their service conductors. These fuses will be placed as near as practicable to the point of entry of the service main to the building.

13. *Main Switches.*—The Council will provide and fix free of charge one main switch in close proximity to their main fuses for each pair of service terminals. Note. This position is not always that most convenient to the consumer, but it is imperative that the main switches should be so placed as in case of need to cut off the supply from the whole of the wiring in the installation. If, therefore, main switches are required by the consumer at some other point, they must be provided by himself.

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14. *Meters.*—(*a*) The Council will provide and fix free of charge one meter for each pair of service terminals used for lighting, and one for each pair used for motive power, and the meter will be fixed in close proximity to the main switch. The consumer must provide wires for each circuit of sufficient length to reach, one to the meter, the other to the main switch, and must case them in efficiently after connection has been made by the official of the Council. (*b*) In the case of a building with several tenants, one meter will be supplied free for each consumer if the wiring be done in accordance with Regulation 11 (*f*, i.), or Regulation 11 (*f*, ii.), but if it be done in accordance with Regulation 11 (*f*, iii.) only one meter for each pair of service terminals will be provided free. (*c*) If consumers require additional meters beyond those supplied free, the Council will supply them on hire at a fixed rental, which will include the services of their meter reader for taking their indications at the same time as he reads the ordinary meters. The terms for the hire of these meters can be obtained on application at the District Council Offices, Old Trafford.

15. *Interference with Council's Mains and Apparatus.*—Official seals will be placed by the Council on the main fuses, main switches, and meters, and no person may interfere with any of this apparatus nor with the service mains. Any person making an unauthorised connection so as to abstract electrical energy without registration by the meter will be proceeded against under Section 23 of the Electric Lighting Act, 1882.

16. *Inspection of Consumers' Installations.*—Inasmuch as the supply to the whole body of consumers may be disturbed by faulty apparatus or wiring in any one installation connected to the supply mains, it is necessary that all installations should be inspected on behalf of the Council in order to ascertain that proper precautions to avoid interference with the supply have been taken by the consumer. It must be distinctly understood that the Council's requirements have this object only in view, and that the inspection and tests made by their officials are solely to see that they are conformed to. The passing of an installation for connection to the Council's mains does not in any sense imply that it has been carried out in the best possible manner, or that the consumer may be satisfied with it, but only that it is not calculated to disturb the supply to other consumers. The Council take no responsibility whatever for any wiring, fittings, or other work on the consumer's side of the Council's main switch.

17. *All Work to be Inspected.*—(*a*) No work, whether new, altered, or repaired, may be connected until it has been inspected and passed by the Council's duly authorised official, and then only under his direction. (*b*) It is strictly forbidden to make even momentary connection before inspection for trying apparatus or any other purpose.

18. *Prevention of Disturbance of Supply by Leakage.*—(*a*) Installations will be tested before connection, and afterwards from time to time, to ascertain their insulation resistance from earth, and at all times it must be not less than the following: (i.) Circuits of incandescent lamps: 50 megohms divided by the number of lamps fixed irrespective of their power up to 50 candles, that is to say for installations of

25	lamps	the insulation resistance	must be	2,000,000 ohms
50	,,	,,	,,	1,000,000 ,,
75	,,	,,	,,	666.000 ,,
100	,,	,,	,,	500,000 ,,
200	,,	,,	,,	250,000 ,,
300	,,	,,	,,	167,000 ,,
400	,,	,,	,,	125,000 ,,

When lamps of higher candle-power are fixed, their equivalent in 50-c.p. lamps will be taken as the number of lamps for the purposes of this test. (ii.) Circuits of arc lamps: five megohms divided by the number of lamps fixed for lamps taking current up to 15 amperes; for larger sizes their equivalent in 15-ampere lamps will be taken for the purposes of this test. (iii.) Mixed circuits of incandescent and arc lamps: one arc lamp will be reckoned as equivalent to 10 incandescent lamps. (iv.) Motors: One megohm between earth and any part carrying current, together with all leads, sliding contacts, and metal work connected to the circuit of the motor, when the magnets, framework, and shaft of the motor are connected to earth. (*b*) All arc lamps must be insulated as a whole from earth, and must be so fixed that it is impossible for them to swing into contact with any metal work connected to earth. When fixed in positions exposed to the weather, the terminals must be effectually protected from rain and snow. (*c*) The brush rockers on motors must be arranged in such a manner that they cannot be moved so as to bring either conductor into contact with the framework of the motor. (*d*) The terminals of all motors must be so guarded that it is impossible for them to be accidentally touched or short-circuited. (*e*) Gas fittings adapted to electric lamps, if the gas connection is retained, must be insulated at the point of suspension from the gas-pipe, and the fitting as a whole must have an insulation resistance from the gas-pipe of not less than one megohm.

19. *Prevention of Disturbance by Sudden Changes of Load.*—(*a*) Motors in which the current passing through them can momentarily exceed 12½ amperes when the motor is connected directly with the mains must be provided with a switch and starting resistance to be approved by the Council, and to be such that in no case can the current through the motor when the switch is on the first contact exceed 12½ amperes, or increase by greater steps than 12½ amperes at a time as the starting resistance is cut out. This starting switch must be so arranged that the current can only be increased gradually. (*b*) In the case of very large motors, where the above regulation would not apply, special arrangements will be made, but it will in all cases be required that the current shall increase gradually. (*c*) The supply to every motor must be controlled by means of an efficient double-pole cut-off switch, placed in such a position as to be easily handled by the person in charge of the motor, and connected so that by its means all pressure can be cut off from the motor itself and from any regulating switch, resistance, or other device in connection therewith, and it must be so arranged that it interlocks with the starting switch in such a manner that the double-pole switch can be taken off when the starting switch is in any position, but cannot be put on again until the starting switch is in the position which leaves all resistance in circuit. (*d*) Arc lamps, normally taking 15 amperes or less, must be so constructed that the current flowing at the instant they are switched on does not exceed a current 80 per cent. in excess of the normal working current. (*e*) Where an arc lamp, when burning under normal conditions, takes more than 15 amperes, and in the case of all hand regulated arc lamps, a starting resistance must be provided so arranged that the current cannot exceed 15 amperes at starting, nor increase by greater steps than 12½ amperes at a time as the resistance is cut out. The resistance must be so arranged that it can only be cut out gradually. (*f*) In those cases in which the Council's supply is used as a stand-by to the consumer's own generating plant, the lamps must be divided up into circuits not exceeding 2½ kw. capacity each, and each circuit must be provided with a separate throw-over switch, so that it shall be impossible for more than 2½ kw. to be thrown over to the Council's mains at one instant.

20. *Prevention of Shock.*—(*a*) No work of any kind may be done to any portion of an installation while the pressure is on it. (*b*) The covers of all fuses, switches, and plugs must be of porcelain or other non-conducting material, or of rigid metal lined with vitreous enamel or similar insulating incombustible material. The use of asbestos for this purpose is allowed, but is not recommended. If it be used, the asbestos must be not less than ⅛in. thick. All metal parts whatever liable to be touched by the hand must be effectually insulated from the electrical circuit. In the case of large switchboards, the covers of the individual switches may be dispensed with if the whole switchboard is contained within an incombustible casing, or is placed in a chamber accessible only to some responsible person. If the cover of a fuse or switch be lost or broken, it must be immediately replaced. (*c*) The magnets, frame, and shaft of every motor must be permanently connected to earth by a copper conductor having a sectional area equal to that of either of the two main conductors leading to the motor. Where these conductors exceed 10 square millimetres in sectional area, the area of the earth conductor shall be not less than 10 square millimetres, but need not be more. The earth connection must be strongly and efficiently made. Gas-pipes must on no account be used as an earth connection.

21. *Wiring Regulations.*—All installations must be wired strictly in accordance with the recommendations of the Institution of Electrical Engineers, which so far as they apply to installations supplied from an outside source shall be read as forming part of these regulations.

22. *Consumer's Main Fuses.*—Each installation must be provided with a main fuse on each conductor of every circuit so constructed and proportioned that it will effectually and safely break the circuit when the steady current maintained through it is 50 per cent. in excess of the normal maximum proper to the circuit, and also when the terminals from which the circuit is supplied are instantaneously short-circuited through the fuse. These fuses must be provided by the consumer in addition to the main fuses provided by the Council. Note.—All circuits must be wired on the two-wire system and balanced at the service as provided in Regulation 11 (*d*), no three-wire wiring of the installation itself being allowed.

23. *Special Regulations for 440-Volt Motors.*—The following requirements in the case of motors supplied at a pressure of 440 volts are in addition to those relating to ordinary motors: (*a*) All wiring in connection with 440-volt motors must be completely enclosed in strong metal casing efficiently connected with earth. Such casing shall be electrically continuous throughout its length. (*b*) All resistances for starting and regulation of 440-volt motors must be completely enclosed by metallic casing efficiently connected to earth, and the insulation resistance between the material forming the resistance and the casing must be not less than one megohm. (*c*) The fuses or other automatic cut-outs employed to protect the branch circuit of each motor must be so constructed that they will break the circuit when two conductors, between which a pressure of 440 volts is maintained, are short-circuited through them, the fuse wire or setting corresponding to the current for which the cut-outs are rated being employed. It is recommended that a magnetic blow-out or some equivalent device for extinguishing the arc be provided. (*d*) A plate supplied by the Council displaying the notice required by the Board of Trade must be fixed by the consumer to every 440-volt motor and cut-off switch connected with it in such a position as to be conspicuous.

SCHEDULE 2.

Table showing average price for different numbers of hours of consumption per annum when the price is £8 per annum per kilowatt, and 1½d per Board of Trade unit:

Number of hours maximum demand is used per annum.	Average price per Board of Trade unit.	Number of hours maximum demand is used per annum.	Average price per Board of Trade unit.
426	6·0d.	3,000	2·14d.
500	5·3d.	3,500	2·05d.
600	4·7d.	4,000	1·98d.
700	4·2d.	4,500	1·93d.
800	3·9d.	5,000	1·88d.
900	3·6d.	5,500	1·85d.
1,000	3·4d.	6,000	1·82d.
1,200	3·1d.	6,500	1·79d.
1,400	2·8d.	7,000	1·77d.
1.600	2·7d.	7,500	1·76d.
1,800	2·6d.	8,000	1·74d.
2,000	2·46d.	8,500	1·73d.
2,500	2·27d.	8,760	1·72d.

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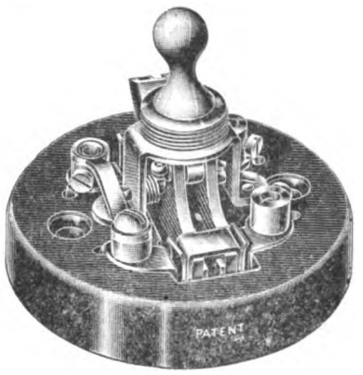
TRADE NOTICES AND NOVELTIES.

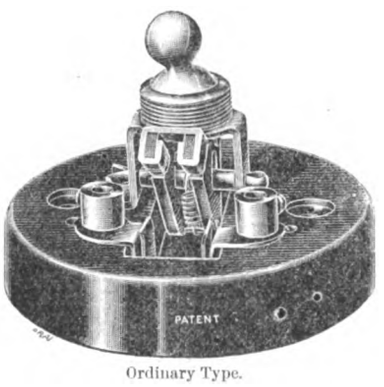
The "Century" Tumbler Switch.

We have received from Mr. A. P Lundberg, Pioneer Electrical Works, 477-487, Liverpool-road, Islington, N., samples and a descriptive circular of his new "Century" single and two-way tumbler switches. It is claimed that the "Century" switch embodies several points of novelty. The accompanying illustrations will assist in giving some idea of its construction. A spiral controlling spring



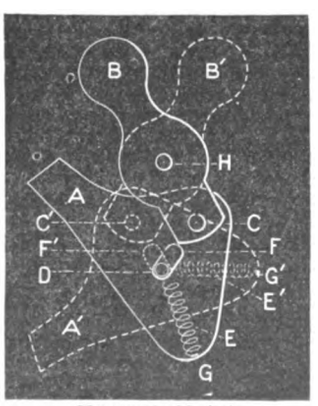
Two-way Type.

has been adopted, as this form of spring produces a quick movement with a very easy and agreeable action. The spring is attached within the moving contact bar, and moves with it in its motion from the off to on position, and *vice versa*. By means of metal-bushed slots in the contact bar, what may be termed a variable sliding lever action over the fixed fulcrum pin is obtained, and this produces a peculiar movement of the contact arm, the result being a very short dead centre to be overcome. The movement possesses definite action into both on and off positions, with an



Ordinary Type.

appreciable locking action into the former. The controlling spring is only slightly in tension in both off and on positions, being in full tension only when passing the dead centre. The two-way type is of similar construction. Referring to the accompanying diagram, which illustrates the movement of the switch, A, A′ is the contact arm ; B, B′. the actuating knob ; C, C′, the pin attaching contact arm to knob ; D, the fixed fulcrum pin on which contact arm rocks ; E, E′, the spiral controlling spring ; F, F′, the slot in contact arm, giving variable leverage over fixed fulcrum pin ; G, G′. the pin



Movement of Switch.

supporting one end of controlling pin ; and H, the fulcrum pin on which the actuating knob rocks. In moving contact arm, A, from off to on, or *vice versa*, by means of the knob, B, the slot, F, by its sliding action over fixed pin, D, allows movable pin, C, to pass between fixed pins, D and H. The lower end of slot, F, is kept up to the pin, D, by means of the actuating spiral spring, E, and the top end of F only touches D when contact arm is midway. In conclusion, it may be said that the samples of the switch submitted to us are of excellent finish, while their action seems thoroughly efficient.

Illumination Lamps.

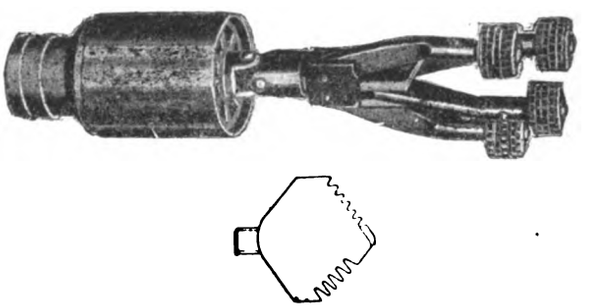
The General Electric Company, Limited, have long made a speciality of electric lamps for illumination purposes, and in view of the approaching Coronation ceremonies, remind us of the fact by issuing a sheet on the front of which is represented a crown device studded with electric incandescent lamps, while on the reverse side several illumination sprays are shown. The latter consist of 5ft. lengths of green leaves with three roses, coloured red, yellow, and pink respectively, and fitted with lampholders carrying 8-c.p. lamps. The sprays are wired complete for attaching to the source of supply, or for joining to each other to form a long length. Robertson lamps are used, and can be supplied in any colour and for all voltages and candle-powers, special quotations being given for quantities.

Traction Telephones.

A circular recently issued by the General Electric Company, Limited, Queen Victoria-street, London, E.C., deals with telephones especially designed for electric traction systems. These telephones are adapted for use in the feeder pillars of such systems. Many developments, we are told, have taken place since this class of work was first specialised by the firm, being mainly the outcome of suggestions made by traction engineers. The special construction adopted is claimed to render the telephones now offered fully capable of successfully withstanding the severe conditions to which they are subjected in feeder pillars. Any number of instruments may be connected to one pair of wires on any one route, while the same pair of wires that allows communication to be made from the feeder pillars may also be used for connecting a sub-station or depôt to the power-house. A portable telephone for connecting to the plug boxes fitted in the feeder pillars is illustrated in the circular, also a pole-fitting plug box and street telephone posts, etc. The modifications of the system to suit it to different conditions are also described, and a long list of towns given in which this special form of apparatus is in use.

Turbine Tube Cleaner.

We herewith illustrate a turbine tube cleaner designed to facilitate the cleaning of boiler tubes, and to allow of the operation being carried out more economically and quickly than can be done in the ordinary way by hand. The machine consists of a turbine, which



works in ball bearings, and to which is attached four arms, as shown, having steel cutter-wheels at their extremities. Water power or compressed air may be used for operating the tool. The former is mostly used, and may be obtained from the town water service, where this has sufficient pressure, or, as is more usual, from a connection with the feed pump. The water which operates and passes through the turbine serves also the beneficial purpose of washing out the tubes. The water is conducted to the turbine through a strong hose-pipe connected with a valve on a branch of the feed pipe or direct with the feed pump. A speed of about 2,000 revolutions per minute is imparted to the cutter heads, which cut away the deposit. When the incrustation is very thick, the flat single cutter shown is passed through the tube first. Full directions for operating the cleaner are contained in a circular just issued by Messrs. Babcock and Wilcox, Limited, who, we understand, have acquired the sole right to sell the machine in all countries, with the exception of the United States.

Enclosed Ventilated Motors.

We have received from Messrs. P. R. Jackson and Co., Limited, engineers, Salford Rolling Mills, Manchester, a new price-list of their enclosed ventilated motors, in the preface of which the firm claim that these machines fully uphold the reputation they have borne for upwards of 60 years for high-class work, and that they are essentially British in every way.

APPOINTMENTS VACANT.

Electrical and Tramway Engineer, Blackpool Corporation, Jan. 27. Full particulars in our advertisement columns.

Works Manager, must be efficient in the design and construction of modern machine tools, and have a good knowledge of electrical manufactures generally. Full particulars in our advertisement columns.

Draughtsman accustomed to overhead travelling and general electric crane work. Full particulars in our advertisement columns.

Assistant in switchboard designing department of large works in the provinces. Full particulars in our advertisement columns.

Electrical Engineer, Bray Urban District Council, £150 per annum, and proportion of apprentices' premiums. Jan. 23.

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LEGAL INTELLIGENCE.

ELECTRICITY SUPPLY IN THE CITY.

On Monday, at the Guildhall, City, **Mr. Alderman Crosby** gave judgment in the case against the Charing Cross and Strand Electricity Supply Corporation, Limited, for beginning certain works without having served a notice upon Mr. Edmund Woodthorpe, the district surveyor for the northern division of the City. As reported in last issue, the complaint was that the defendant company had neglected to give notice to the surveyor in respect of a street box they were constructing underground at the corner of Bishopsgate-street Within and Wormwood-street.

The Alderman now held that the company had not given notice in accordance with the 145th Section of the Building Act. He decided that the street box was a building or work within the meaning of the Act, and he was unable to distinguish it from the Whitechapel case, which was quoted at the outset. Therefore a conviction must follow. He would impose a fine of 40s. and 42s. costs.

An application to state a special case for the opinion of the High Court was refused.

ELECTRICAL SERVICES.

In the City of London Court, on Tuesday, before Judge Rentoul, K.C., M.P., an action was brought by Alexander R. Leask, consulting electrical engineer, 91, Minories, E.C., to recover the sum of £20. 5s. for services rendered between April and September last year to the defendants, the Crown Electrical Heating Syndicate, Limited, 15, Bury-street, St. Mary-axe.

Mr. Holloway, plaintiff's counsel, said that his client was an inventor of an electrical heater. He took out a patent for it, and he transferred it to the defendant company. At the time of the transfer he was requested to render certain services to the company in starting their factory, where they manufactured the apparatus in question. On 108 days the plaintiff attended at the defendants' business premises, and he gave in all 160 hours, for which he now claimed to be paid.

The **Plaintiff**, in his evidence, said that in manufacturing the electrical heaters skilled supervision was required, and that he gave. When the company purchased his patent his payment took the form of shares only, as he was so satisfied with it. He had done all in his power to promote the prosperity of the company. It was not true to suggest that he had worked voluntarily.

Mr. Horace Marshall, the defendants' counsel, said the plaintiff was considerably interested in the success of the company, and one of the terms under which he sold his patent to the company was that he should render certain services from time to time in getting over little difficulties which might arise. Whatever definite work the plaintiff was asked to perform he was paid for.

The learned **Judge** said he was satisfied that judgment ought to pass for the plaintiff for the sum claimed, with costs.

Judgment accordingly.

CLAIM FOR ELECTRICAL WORK.

In the Westminster County Court, on Wednesday, his Honour Judge Woodfall tried the case of Bayley *v.* Cattle, in which the plaintiff, Mr. Arthur Bayley, electrical engineer, Westminster, sued the defendant to recover the sum of £7. 10s. for electrical work carried out to his order.

The defence was that the plaintiff's father was the person to whom the money was due, and also that the work was not efficiently completed.

The **Plaintiff**, in evidence, stated that at the time when this work was completed he was working for his father, who was also an electrical engineer, and who had since assigned this debt to him in respect of wages.

His Honour said there was no evidence that the work was not properly done, and he was satisfied that the debt was assigned to the present plaintiff by his father. Judgment would therefore go in plaintiff's favour for the amount claimed, with costs.

A COLLISION CASE.

At the Brompton County Court last Friday, before Judge Stonor, William Eaton, a carman, brought an action against the London United Tramways, Limited, claiming £50 damages in respect of personal injuries sustained and alleged to have resulted from the negligent driving of an electric tramcar by one of the defendant company's servants. It appeared that on Aug. 25 last he was driving a large forage van, drawn by three horses, along the Uxbridge-road, Ealing, when one of his horses slipped down near the tramlines. An electric car coming behind "bashed" into the van and pitched him from his seat into the roadway. By the fall his hip was injured.

On the conclusion of the evidence the learned **Judge** said he came to the conclusion that the cause of the accident was the falling of the plaintiff's horse, rather than negligence on the part of the tramcar driver, although it was possible that the latter might have stopped the car a little sooner than he did. On the whole, however, his Honour considered that the occurrence was a pure accident. There would accordingly be judgment for the defendant company, with costs.

CLAIM FOR INJURY.

On the 10th inst., before his Honour Judge O'Connor, in the West Hartlepool County Court, John George Brown sued the Hartlepools Electric Tramway Company for damage to a horse alleged to have been sustained in consequence of the breaking of an overhead trolley wire. The evidence was to the effect that on Oct. 12 last a wire was torn down in Church-street by the trolley arm of a tramcar. The wire struck plaintiff's horse, which fell on to its knees. When it got up the wire touched it again, and it bolted. Plaintiff said he paid 30 guineas for the horse, and had to sell it for £12 after the accident. He claimed £26. 12s. 4d.

In the result judgment was given in plaintiff's favour for £15.

ELECTRICAL FITTINGS.

On Wednesday, in the Westminster City Court, before Judge Woodfall, the case of Smyth *v.* Harrison was tried. It was an action by the plaintiff, a dealer in electrical appliances carrying on business at Charing Cross-road, to recover the sum of £4. 15s. in respect of goods supplied to the defendant.

The **Plaintiff** was called and said the order for the goods was given by the defendant's manager.

The **Defendant**, on the other hand, contended that he had never given authority to anyone to give orders in his name.

After hearing evidence, **His Honour** said he was satisfied the defendant was liable, and he gave judgment for the plaintiff for the amount claimed, with costs.

COMPANIES' MEETINGS AND REPORTS.

MANCHESTER-LIVERPOOL MONO-RAILWAY.

The annual general meeting of the syndicate which is promoting the electric railway between Manchester and Liverpool was held on Tuesday.

Mr. J. H. Macmillan, who took the chair, informed the meeting that the requirements of Parliament with reference to the submission of full plans for the approval of the Board of Trade had been complied with, and that he hoped this approval would be obtained now very shortly. When this was done no time would be lost in proceeding with the preliminary work necessary before the commencement of the construction of the line. He pointed out that the year's delay, which had been caused through the very bitter opposition of the railways, had not been altogether a loss. It had enabled the projected line to be improved in certain respects, and, more important than that, the prolonged and most minute examination of the Parliamentary Committees had established beyond reasonable question not only the engineering feasibility but the commercial practicability of the scheme.

TYPEWRITING TELEGRAPH CORPORATION.

At the adjourned general meeting of this Company, held on the 10th inst. at Winchester House, to receive the report of the committee appointed on the 12th ult. to enquire into the affairs of the Corporation, Sir James Ferguson, M.P., occupied the chair.

The report stated that the committee found the past administration and management of the Corporation had been marked by a total want of appreciation of the interests of a special trade like theirs together with a lack of business capacity. The Board—and their late manager—had all along insisted that the want of progress of the business was not due to any fault of theirs, but to the fact that the Postmaster-General had not sealed the pattern of the Corporation's instrument, and that it would be unwise to try and open up private business until the pattern had been sealed, which was eventually done on June 6 last. Nevertheless, the late manager was authorised to order 530 receivers in August, 1900. The committee considered that the policy of the Board to sell the foreign patents outright for cash was most unwise. No foreign patent had yet been sold, and, considering the terms suggested, the shareholders might be congratulated that this shortsighted policy could yet be reversed. On the question of the newly-made arrangement with the manager of the Phonophore Company, it had been stated that the Corporation's instruments would not work with the ordinary telephone, but that they worked well with the phonophore. This statement was absolutely unwarranted, and was contradicted by reference to the prospectus, in which it was set out that their instruments would work on the telephone. The report concluded by recommending, *inter alia*, that a business manager should be appointed, whose salary should be largely dependent on results; that as to the legal questions raised by the covenants contained in the agreements with the Exchange Telegraph Company, these should be sent back to the committee in order to obtain counsel's opinion thereon in reference to the rights of the Corporation; and that the Board should be asked to resign.

Mr. A. J. Parker moved the adoption of the report, which was seconded by **Mr. A. Knight.**

The joint reply of the Board to the report was then read by the **Chairman,** who said that an attack was only effective when established by facts, and in the present case this had not been done. It was not correct that the directors had attributed the Corporation's want of success so far only to the delay which took place in completing the agreements with the Post Office and the National Telephone Company. They also attributed it to the declining health and fatal illness of the late general manager, and to inability to obtain a sufficient number of instruments when the Post Office were satisfied with the alterations desired by them. The order given for 530 instruments in the latter part of 1900 was not placed in ignorance of the requirements of the Post Office, as alleged by the committee. The Board did not agree that the policy of offering to sell the foreign patents for cash was unwise. It was calculated to procure an immediate return, and relieve

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the Corporation from constant and heavy expenditure for agencies. In the majority of cases the terms proposed were for cash and shares, and in the three cases in which cash only was asked it was at the particular request of Mr. Liebmann, who held the options. With regard to the arrangement with the Phonophore Company, he maintained that an agent pushing the sale of the phonophore would have no inducement to neglect the Stelje instrument. From their report it was evident that the committee's investigation was directed rather to proving their charges than to placing before the shareholders an impartial statement as to the past management and the prospects of the Corporation. This was borne out by the committee making no reference to the difficulties inherited from the Recording Telegraphs, Limited, or to the long illness of the manager. If, by a *bona fide* majority, the shareholders expressed their want of confidence in the directors, who had had to face so many unforeseen difficulties in prosecuting the business, they were prepared to hand over their duties to any gentlemen better fitted than themselves to manage the affairs of the Corporation.

Mr. Wilfrid King next explained the connection between the Exchange Telegraph Company and this Corporation. He stated that the former would not submit to any alterations in the articles affecting their rights, and if anything of the sort were attempted it must mean a legal fight. The motion for the adoption of the committee's report was carried by a large majority.

A poll was demanded, and in order that absent shareholders might be afforded the opportunity of reading the directors' defence, the **Chairman** directed that the poll should be taken on the 23rd inst. at Winchester House. A motion to the effect that the report and accounts to Sept. 30 last should not be adopted was agreed to, and the proceedings closed.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ghent.—The Municipality require tenders for the electric lighting of the town. Tenders must be posted before March 1, 1902.

Madrid.—The Municipality invite tenders for the supply of material, maintenance, etc., of the electric lighting of the corn market. Tenders by 12 noon on Feb. 4.

Hull.—The Corporation invite tenders for the extension of the electric light works, Sculcoates-lane. Full particulars may be obtained from Mr. A. E. White, city engineer, Town Hall, Hull. Tenders by Jan. 23.

Ilford.—The Urban District Council invite tenders for copper rail bonds (fixed), and stoneware cable conduits (laid and jointed), drawboxes, etc. Tenders by Jan. 27. Details in our advertisement columns.

Barking (Essex).—The Urban District Council invite tenders for supply and erection of additional generating plant. Full particulars may be had from the Engineer, Electricity Works, East-street, Barking. Tenders by Jan. 24.

Llanelly.—The Harbour and Burry Navigation Commissioners invite tenders for the supply and erection of an electric lighting plant for their new dock at Llanelly. Tenders by Jan. 20. Full details in our advertisement columns.

Middleton (Lancs.).—The Corporation invite tenders for the supply of electricity meters. Specifications, etc., can be obtained from Messrs. Lacey, Clirehugh, and Sillar, 78, King-street, Manchester. Tenders by Jan. 21.

Brussels.—The Belgian Government Railways invite tenders for the plant, etc., for an electric lighting station at Marchienne au Pont. The estimate is 4,027,282fr. A deposit of 3,600fr. is required. Tenders by noon on Jan. 20, 1902.

Fulham.—The Establishment Committee of the Borough Council invite tenders for the supply of transformers (20 of 50 kw. each), and mains, conduits, lamp-posts, and street boxes. Tenders by Jan. 27. Details in our advertisement columns.

Blackburn.—The Corporation invite tenders for the various oils and greases required by the electricity and tramway departments for a period of one year ending March 31, 1903. Tenders by Jan. 27. Details in our advertisement columns.

Blackburn.—The Corporation are prepared to receive tenders for the various engineering stores required by the electricity and tramways departments for a period of one year ending March 31, 1903. Tenders by Jan. 27. Details in our advertisement columns.

Bootle (Lancs.).—The Corporation invite tenders for the wiring of the baths, library, etc., in Marsh-lane, for the purpose of electric lighting. Specification, etc., may be obtained at the Borough Electricity Works, Pine-grove. Tenders by Jan. 21.

Rochdale.—The Corporation invite tenders for the supply, delivery, and erection of all the additional panels, instruments, and switchgear, and connections for the extensions to the lighting switchboard. Tenders by Feb. 2. Details in our advertisement columns.

Cardiff.—The Tramways Committee invite tenders for the supply, delivery, and erection of two vertical compound condensing engines of 1,600 i.h.p., each direct coupled to two 900-kw. generators. Tenders by Jan. 22. Details in our advertisement columns.

Ilford.—The Ilford Urban District Council invite tenders for copper rail bonds, fixed, and stoneware cable conduits, laid and jointed, drawboxes, etc. Specification, etc., may be obtained at the offices of Mr. John W. Benton, Council Offices, Ilford. Tenders by Jan. 27

Hunslet (Leeds).—The Guardians invite tenders for the electrical equipment of their new workhouse and infirmary at Rothwell Haigh, near Leeds. Specifications, etc., may be obtained from Messrs. Shepherd and Watney, consulting engineers, Greek-street-chambers, Leeds. Tenders by Jan. 21.

Madrid.—The Department of Agriculture invite tenders for the construction of an electric tramway from Linares to the mines of San Roque and Torilla, in the Province of Jaen. Tenders by Feb. 24. This is the extension of the tender advertised for Nov. 17, but the conditions have been modified.

Louvain (Belgium).—The period within which proposals will be received for lighting the city of Louvain by gas or electricity, or by a combination of the two systems, has been extended from 31st inst. to Feb. 19, 1902. Proposals, marked "Lighting Contract," to be addressed the Burgomaster, Louvain, Belgium.

West Bromwich.—The Council invite tenders for the supply, delivery, and erection in their electricity works of boilers, feed pump and piping, steam dynamos and condenser, boosters, traction switchboard, and extension of lighting switchboard. Tenders by Jan. 29. Details in our advertisement columns.

Grimsby.—The Corporation invite tenders for the extension of the plant at the electricity works, as follows: steam dynamos, extension of switchboard, accumulators, condenser plant and pipework, and water-tube boiler. Specification, etc., can be obtained from the borough electrical engineer, Mr. W. A. Vignoles. Tenders by Jan. 20.

Liverpool.—The Directors of the South Lancashire Electric Traction and Power Company, Limited, Liverpool, invite tenders for three-phase high-tension motor-generators, positive and negative boosters, battery-charging boosters, etc., and batteries of accumulators with accessories. Tenders by Jan. 29. Details in our advertisement columns.

Shipley (Yorks).—The Urban District Council invite tenders for the construction of new tramways and for the reconstruction of existing tramways (about 1½ miles double line). Specifications, etc., may be obtained on application to Mr. W. H. Dawson, surveyor to the Council, or to Mr. R. C. Quin, M.I.E.E., consulting electrical engineer, Electricity Works, Blackpool. Tenders by Jan. 27.

Madrid.—The Public Works Department invite tenders for an electric tramway from San Sebastion to Toloso, with power to work same for a maximum of 60 years, after which the undertaking becomes Government property without compensation. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m. Tenders by Jan. 27.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Stuart-street generating station of (a) main high-tension three-phase switchboards at generating station, (b) exciter and auxiliary switchboards at generating station, (c) high-tension three-phase switchboards at 10 sub-stations, (d) low-tension switchboards at 10 sub-stations. Tenders by Jan. 21. Details in our advertisement columns.

Hartlepool.—The Corporation invite tenders for the erection of a generating station and the supply and erection of plant—viz., erection of buildings, boilers (two of marine type), engines and dynamos, steam, feed, and exhaust pipes, valves, and other apparatus, storage battery, switchboard, arc lamps, feeder mains, arc light leads, etc., arc lamp columns and brackets, and overhead travelling crane. Specification, etc., may be obtained from the borough accountant (Mr. C. Robson). Tenders by Jan. 25.

Middlesbrough.—The Electric Lighting Committee invite tenders for the supply and erection of—engine-house plant: one 300-kw. high-speed steam dynamo and accessories; switchboard panels: panels and instruments for dealing with the above plant, and three new feeders; condensing apparatus and pipework: ejector condenser for dealing with 8,100lb. of steam per hour, and steam, exhaust, and feed pipes; feed pump and economiser: one feed pump and extension to existing economiser. Tenders by Jan. 21. Details in our advertisement columns.

Leytonstone.—The West Ham Board of Guardians invite tenders for the supply, delivery, and fixing at their new infirmary, Forest House, Leytonstone, N.E., of three direct-coupled engines and dynamos and one motor-booster, one battery of accumulators; all engine and battery room accessories; the whole of the feeders, distribution mains, junction boxes, main and sub-distribution boards; and all wiring, fittings, lamps, &c., for about 1,756 lamps. Specification, etc., may be inspected on and after Jan. 6 at the Clerk's Office at the Workhouse between 10 and 4. Tenders by Jan. 22.

London.—The London County Council invite tenders for the supply of about (a) 3,250 tons of track rails; (b) 1,850 tons of slot rails; (c) 670 tons of conductor tee rails; together with (d) the fishplates bolts, nuts, etc., required in connection with the reconstruction of the London County Council tramways for electrical traction. Alternative tenders must be submitted for the supply of smaller quantities as follows of the articles above specified: (a) 2,280 tons; (b) 1,300 tons; and (c) 475 tons, with the necessary accessories. Specifications and other particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by Jan. 28.

Rockhampton (Queensland).—The Municipality invite applications from companies desirous of undertaking the construction and working a system of electric tramways under the Queensland Tramways Act of 1882 and the Amendment Act of 1890, within the municipality of Rockhampton aforesaid. Rockhampton, with a population of 15,461 is a rising town, and is situated on the Fitzroy River, about 40 miles from the sea coast, and is the second largest town in Queensland. Particulars of construction, maintenance, and working of tramways are contained in the Queensland Tramways Act of 1882 and the Amendment Act of 1890, copies of which may be seen at the office of this paper. Applications to be forwarded to Mr. H. W. Johnson, mayor, Municipal Chambers, Rockhampton, Queensland, Australia, by March 31.

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RESULTS OF TENDERS.

Warrington.—The Town Council have accepted the tender of J. A. Ewart for the construction of the permanent way for car-sheds at £1,155.

Bury (Lancs.).—The Town Council have accepted the tender of the British Westinghouse Electric Traction Company for supply of 28 electric tramcars at £18,077.

Cardiff.—The Town Council have accepted the tender of Messrs. Musgrave, London, for supply of three boilers at £657 each, and three superheaters at £139. 10s. each.

Pemberton.—The District Council have accepted the following tenders: British Electric Meter Company, meters, £2. 12s. each; British Insulated Wire Company, Prescot, cables and service boxes, £145. 9s. 6d.

National Telephone Company.—The National Telephone Company have accepted the tender of R. Carr and Co., 6 and 8, Lime-street-square, E.C., for the supply of insulating compound for the next six months.

Reading.—The Corporation have accepted the tender of A. Faulks, Loughborough, at £21,541, for the works comprised in specification for Contract No. 3 (construction of buildings in connection with the generating station).

Swindon.—The Town Council have accepted the following tenders: J. Carter and Sons, Stalybridge, three Lancashire boilers, £6,667. 4s. 6d.; Couper, Swarz, and Co., Liverpool, water cooler, £535; Carrick and Ritchie, Edinburgh, travelling crane, £235.

Ayr.—The Town Council have accepted the tender of Messrs. Lowdon Bros., Dundee, at £1,828, for the supply of overhead equipment for the extension to Alloway, to be completed before March 31. They have decided to order the cars for the above extension from Messrs. Hurst, Nelson, and Co.

Chorlton (Manchester).—The Hart Accumulator Company have recently secured the contract from the Chorlton Guardians for renewing battery of 110 cells installed at Styal Cottage Homes, and have also been successful in obtaining the order for the 110-cell battery required at Salford Cottage Homes.

Dewsbury.—The Corporation have received the following tenders for two 100-kw. dynamos:

		Spare armature.
Siemens Bros. and Co., Limited (accepted)	£625	£132
T. W. Broadbent	658	146
Union Electric Company	667	140
Lancashire Dynamo Company	715	156
British Schuckert Company	760	175
International Electric Company	770	170
Royce, Limited	760	210
Johnson-Lundell Company	793	193
Thames Ironworks Company	798	210
Crompton and Co., Limited	846	180
Mather and Platt	850	178
B. Thomas	871	158
A. Hirst and Son, Limited	850	180
Greenwood and Batley	908	125
Electric Construction Company	894	140
Lahmeyer Electrical Company	845	205
Brush Electrical Engineering Company	880	174
Bruce Peebles and Co.	900	175
Sunderland Forge Company	986	130
T. Parker, Limited	919	198
Johnson and Phillips, Limited	1,010	210
Electro-Motor and Dynamo Company	1,040	180
Clayton Engineering Company	1,042	195
Phœnix Dynamo Company	1,120	210

BUSINESS NOTES.

TRACTION.

Hertford.—The official enquiry into the light railways scheme is fixed for the 23rd inst.

Sheffield.—The electric cars are now being fitted with an improved type of lifeguard after the fashion of the American "cow-catcher."

Southport.—The Tramways Committee are considering a reduction of the fare to High Park. It is proposed to charge 1d. "all the way."

Halifax.—The Town Council have rejected a recommendation asking that tenders for advertisements on the tramcars should be invited.

St. Leonards.—A meeting of the Public Interests Association has passed a resolution condemning Mr. Murphy's front-line scheme of tramways.

Chesterton.—The Parish Council are in communication with the tramway company with reference to an extension of their system to Audley and Talke.

Edmonton.—The District Council have resolved to lodge a petition against the Middlesex County Council's Bill with respect to the proposed light railways.

New Malden.—The District Council have decided to formally dissent from the proposals of the London United Tramway Company concerning their district.

Wigan.—The Town Council have confirmed the committee's decision to purchase the Wigan End District Tramways Company's undertaking for £45,000.

Whitworth.—Negotiations are proceeding between the District Council and a London firm of engineers with reference to the introduction of tramways in the district.

Glasgow.—Arrangements have been completed for the erection of red lamps at ½d. tramcar stopping places, and green lamps at the places where the cars stop by request.

Sowerby Bridge.—The District Council have adopted a resolution accepting the offer of the Halifax Corporation to bring the tramways through Pye Nest to Sowerby Bridge.

Barnet.—The Urban District Council have agreed to support the light railway scheme for the district at the enquiry before the Light Railway Commissioners next Thursday.

Swindon.—The Town Council have decided to make application forthwith to the Board of Trade for the necessary borrowing powers in connection with the proposed tramways.

Benwell.—An agreement has been concluded between the District Council and the Newcastle Town Council with reference to the extension of the tramways into Benwell.

Appointment.—Mr. I. Bulfin has been appointed resident engineer under the Bournemouth Corporation to superintend the construction of the tramways at a salary of £250 a year.

Pemberton.—The District Council have resolved to make application to the Board of Trade for sanction to borrow £8,217 for the purchase of the tramways in Ormskirk-road.

Wimbledon.—The District Council have sealed a memorial against the London United Tramway Bill in Parliament, complaining that the standing orders have not been complied with.

New York.—The first train on the Manhattan Elevated Railway of New York has been run over the Second-avenue line. It is reported to have made much better time than a steam train.

Stockton.—Complaints having been made in regard to the speed of the tramcars through the streets the Town Council have decided to write to the company calling attention to the matter.

Portslade.—At the meeting of the Urban District Council on Tuesday, it was decided to strongly oppose the Bill for empowering the promoting company to construct electric tramways.

Newcastle.—On Saturday last the electric cars commenced to run between the Central Station and Scotswood-road, the Board of Trade inspector having reported favourably on the new route.

London-Brighton Electric Railway.—A parliamentary deposit of £375,000 was made on Tuesday at the Bank of England on account of this scheme, the estimated cost of which is £7,338,403.

Wrexham.—The Urban District Council have been asked for their consent to the proposed extensions of the electric tramways and the construction of new lines in the parish of Rhosllanerchrugog.

Ayr.—A start has been made with the extension of the Corporation tramways from St. Leonard's Church to Burns's Monument. It is stipulated that the extension shall be ready for traffic by April 1.

West Bromwich.—Application will be made shortly on behalf of the Town Council for sanction to borrow £8,500 to extend the plant and buildings at the electricity works required to meet the tramway load.

Drighlington.—The Urban Council have been informed by the British Electric Traction Company that it is their intention to commence the construction of the projected light railway through the district.

Gosforth.—The Urban District Council have decided to dissent from the Newcastle Corporation tramway scheme as it affects their district, and to support that proposed by the Tyneside Tramways Company.

Acton.—It has been agreed by the District Council to formally oppose the Tramways Bills which the tramways company and the Middlesex County Council are promoting in the present session of Parliament.

Gloucester.—It is estimated that the cost of converting the existing horse tramways to electric traction, including the sum of £26,000 to be paid by the Corporation for the company's undertaking, will be about £120,000.

Sunderland.—The Tramways Committee have decided to order 10 double-deck and four single-deck cars, which will make 64 in all. The engineer has also been instructed to prepare plans for a siding down Athenæum-street.

Colne.—With reference to the Colne and Trawden light railway scheme the Town Council will suggest to the company that they construct a double line from the town hall to the railway station, in lieu of the proposed single line.

Shardlow.—With regard to the proposed Derbyshire light railway, which is intended to open up the populous districts about Long Eaton and Stapleford, the Shardlow District Council have determined to remain neutral to the scheme.

Farnworth.—Major Druitt, of the Board of Trade, having inspected the tramway which has recently been completed at this place, the regular service is now in full swing, and in a few weeks the cars will run into Kearsley.

Houghton-le-Spring.—The United Kingdom Tramways Company are asking for a prolongation of time for commencing with the Houghton and district tramways. The time required is 12 months before commencement and 12 months to complete.

West London Tramways.—Good progress has been made with the construction of the tramway from Isleworth to Twickenham. This route will eventually reach to Kingston, *viâ* Teddington and Hampton

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Wick, and we learn that the contractors are now engaged in pegging out the new line, starting from the Kingston end.

Wallsend.—The Town Council have decided in favour of private enterprise in regard to tramways. They have agreed to support the scheme of the Tyneside Company and to oppose that of the Newcastle Corporation for constructing tramways to Wallsend.

Perth.—The Special Tramways Committee recommend the Town Council to confer full powers on them in carrying out the resolution of the Council to acquire the tramways by arbitration or otherwise, including the power to engage a consulting engineer.

Lexden and Winstree.—With reference to the proposed light railway from Marks Tey to Southend *viâ* Colchester and West Mersea, the Rural District Council have decided to make formal objection on account of the positions of some of the level crossings.

Edinburgh.—The dispute with reference to the payment of arrears of rent by the Edinburgh Tramways Company to the Corporation is to be settled in the Court of Session on condition that £20,000 is consigned in the court and a guarantee found for £18,000.

Burnley.—Major Druitt, of the Board of Trade, will visit this place next Tuesday for the purpose of inspecting the Padiham section of the new tramways. The Tramways Committee have agreed to run two or three cars in the afternoons from Cheapside to Burnley for the use of miners inside and outside.

Reading.—The Corporation have now placed their third contract for work in connection with the reconstruction of the tramways for electric traction. The full list of the firms tendering will be found in another column, the successful tender being that of Mr. A. Faulks, of Loughborough, for £21,541.

Bury.—The borough engineer and Mr. Lacey (the consulting engineer) have been instructed to prepare a detailed estimate of the cost of the permanent way of the proposed tramways. A sub-committee is now making investigations as to conditions and price of premises to be acquired for tramway purposes.

Yarmouth.—About one-third of the length of rails for the new electric tramways has now been laid. The Town Council have approved the plan of additional buildings, and have decided to invite tenders for 14 cars. They have further authorised the expenditure of any necessary portion of the amount raised by loan for the paving of the roads.

Hove.—At the last meeting of the Town Council it was decided by a large majority to take steps as soon as possible to promote a Bill in Parliament empowering the Corporation to provide tramways in the borough, and, if thought desirable on further consideration, to acquire the tramways now working and running to Shoreham, and to work the same.

Swinton and Pendlebury.—The District Council have decided to oppose the Tramways Bills promoted by the Corporations of Manchester and Salford, with a view to getting clauses inserted to compel those bodies to appoint a joint Tramway Board with representatives of the local authorities in which there are tramways worked by either of the two Corporations.

The "Tube" Railway.—At the inquest on the man Reader, who committed suicide by jumping before a train on the Central London Railway at Shepherd's Bush Station on Friday last, it was stated on behalf of the railway company that during the past year they had conveyed 40,000,000 passengers without a single accident. The coroner congratulated the company.

Plymouth.—Several memorials have been presented to the Town Council against the proposal to make the Market-square the tramway centre for the town. The Tramways Committee will shortly discuss a suggestion as to utilising the Houndiscombe-road line to North-road and extending it to the Octagon, thereby serving a large district and commanding considerable traffic.

Leeds.—The substitution of electric traction on the Wortley and Oldfield-lane tram routes has proved most successful, the receipts being almost doubled. The laying of the lines in West-street has now been commenced. It is proposed to run a number of electric cars from Kirkstall along West-street, round by City-square, returning to the Abbey along Wellington-street.

Aston.—By a unanimous vote the District Council have adopted the minutes of the Tramways Committee recommending an application to the Local Government Board for powers to borrow £65,000 for the erection of a generating station and cables for electric lighting and tramway purposes. The other recommendations of the committee noted in last week's issue have been also adopted.

Darlington.—Prof. Kennedy, consulting engineer to the Corporation, has been asked to report on the overhead trolley system and the conduit system of electric traction, more particularly as to the cost. It is practically decided that double-deck cars shall be adopted for nearly all the routes, and that the gauge shall be 3ft. 6in. The length of the proposed route is a little over five miles.

Branksome.—With reference to the application of the Poole and District Electric Traction Company for an order authorising the extension of the tramway along the Parkstone-road, the District Council are willing to give their consent if an assurance be given that a service of not less than six cars per hour each way would always be maintained along the Ashley-road route from Bournemouth to Poole.

Bradford.—The Town Council have decided to reduce the fares on most of the tramway routes on and after February. The committee have invited the two tramway companies to tender for the hire of the rolling-stock to work the lines on the revised fares until they can be converted to electrical working. It is probable that the Manchester-road and Sunbridge-road lines will be completed and ready for electric traction by Feb. 1.

Twickenham.—The Highways Committee recommend the District Council that, subject to the company agreeing to terminate the double line of tramway opposite Park-road, and giving a written undertaking with regard to the various matters referred to in the committee's report, the surveyor be authorised to approve the plans and drawings submitted in respect of the works in the district authorised by the London United Tramways Act, 1900.

Private Bills.—As many as 29 memorials alleging non-compliance with the standing orders have been deposited in the Private Bill Office of the House of Commons. The memorials affect 15 Bills, seven being against the London and Brighton Electric Railway, six against the London United Tramways and the London County Council (Tramways and Improvements), and four against the Croydon and District Electric Tramways and the London United Electric Railway.

Nelson.—At the last meeting of the Tramways Committee it was resolved that it was desirable that the construction of the light railway between Nelson and Barrowford should be proceeded with, provided satisfactory terms for working the same could be arranged with the Barrowford Urban District Council. It was further decided that the electrical engineer be instructed to proceed with the preparation of the estimates, specifications, and plans of the scheme.

Exeter.—Particulars of various systems of electric tramway traction have been considered by the Electric Traction Committee, who have decided that it is desirable that information be obtained as to the practicability and suitability of introducing motor 'buses, electric road cars, and other means of passenger transit in the city. A sub-committee, as a deputation, has accordingly been appointed to visit towns where any or either of these systems are in operation and to report.

Scarborough.—The Corporation have agreed to insert special clauses in the Tramway Bill providing for the extension of the tramways from the junction of Falsgrave-road and Seamer-road to the new athletic ground on Seamer-road. The estimated cost of the extension is about £10,000. At a meeting of property owners and occupiers on Wednesday, it was unanimously resolved to oppose the laying down of a double set of tramway lines between Bar-street and Vernon-place in Westborough.

Accident at Liverpool.—On Wednesday, at Liverpool, a temporary stoppage of the tramcar traffic occurred on the Dale-street and North John-street section owing to the snapping of one of the overhead conductors. The accident was due to the falling of an iron girder which was being hoisted by a crane into position on a new building. The girder fell a distance of 50ft. right on to the wire. Dale-street was crowded with pedestrian and vehicular traffic at the time, but fortunately no one was injured.

Chester.—The Tramways Committee recommend that the city surveyor and Mr. Thursfield be requested to prepare the necessary specifications, plans, etc., for obtaining tenders for converting and equipping the tramways for electric traction in sections—viz.: (*a*) the section from the fountain in Bridge-street to Saltney, sanctioned by the Council; (*b*) (in anticipation) the remainder of the existing tramways. It is also proposed to extend the electric system to the railway station. A rough estimate puts the cost at £57,000.

Crewe.—For some little time the Electric Tramway Committee have had under consideration the new order about to be applied for to authorise the construction of an electric tramway within the borough, and in order to avoid any opposition and to expedite the scheme, they have confined themselves to a route lying from Crewe Station to the Merrill's Bridge, running through the heart of the town. When the proposals have been approved by the Town Council, application will be made to the Board of Trade to hold an enquiry.

Clacton and St. Osyth Light Railway.—A meeting of owners and ratepayers at Clacton have resolved to request the Urban District Council to support the above scheme, provided the undertakers consent to the requirements mentioned in the Council's reports, and to the insertion of a provision that the powers of the order cease if the railway be not commenced within two years instead of five, and that the period when the Council shall have power to purchase be at the end of 10 years instead of 14; otherwise that the Council be requested to oppose the order.

Hammersmith.—The Law and Parliamentary Committee report having received from the Board of Trade a revised print of the regulations proposed to be made by them in regard to the use of electrical power on the overhead trolley system on the London United tramways and light railways, and they find that the Board have adopted the suggestions which the Council on July 3, 1901, made upon the original draft regulations, suggesting that the speed at which the tramcars should run in portions of King-street, Uxbridge-road, and Goldhawk-road should not exceed six miles an hour.

"Tube" Competition.—The directors of the East London Railway in their report for the half-year ended 31st ult., attribute the diminution in the passenger traffic mainly to the falling off in through bookings from the Metropolitan and Metropolitan District systems to and *viâ* the East London consequent on the competition of the Central London Railway. The parliamentary notices for the ensuing session of the Metropolitan and District Companies, by which they seek power, *inter alia*, to adopt this railway for working their traffic by electrical power, are receiving the directors' careful attention.

Aberdeen.—Last Friday a conference between the County Council Road Board and the District Committee was held to deal with the question of the proposed suburban tramways to Culter and Bankhead. After discussion, it was resolved to recommend the County Council to give their consent to the construction of the tramways upon certain conditions, which are to be embodied in a minute of agreement between the County Council and the promoters, and scheduled to the provisional order. In the meantime, it was resolved to lodge a formal petition against the order to allow time for the adjustment of the agreement.

Greenock.—A special meeting of the Law and Finance Committee has unanimously agreed to recommend the Corporation to oppose the

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new provisional order to be sought for by the Greenock and Port-Glasgow Tramways Company. The tramway company seek power to extend the line, to run motorcars and omnibuses, to increase their capital, and to dispense with certain protections for the working of the line, such as the fitting up of speed indicators on the cars. The committee regarded certain points in the new order as likely to prejudice the interests of the Corporation if at any time they should take over the tramways.

City and South London Railway Co.—The accounts for the half-year ended Dec. 31, 1901, show a balance, after providing for the debenture stock interest, transfer to the renewal fund of £2,000, and the full dividend of 5 per cent. per annum on the preference stocks, sufficient to allow the payment of a dividend on the consolidated ordinary stock for the half-year and on the ordinary shares from Nov. 17 last at the rate of 2¼ per cent. per annum, carrying forward a balance of £1,424. The dividend for the corresponding period last year was at the rate of 1¼ per cent. per annum, carrying forward a balance of £1,228.

South Shields.—The question of the municipalisation of the tramways at this place has been the subject of a poll of the ratepayers. Under their Bill the Corporation seek powers to work the trams themselves or to let them to a private company. Hitherto the tramways have been worked by a private company, who ran horse cars on the Corporation's lines, but it is proposed to introduce electric traction. At the same time, the British Electric Traction Company are seeking running powers over the Corporation lines. The result of the poll as announced is as follows: against the Bill, 5,942; for the Bill, 5,716—majority against, 226.

Motor-Wagon Service in Lancashire.—It is reported that a regular service of motor goods wagons is to be established between Liverpool and the more important inland Lancashire towns. The cars will be suitable for carrying loads of five or six tons, and it is intended to carry goods direct from the quayside to St. Helens, Bolton, Chorley, Ormskirk, Wigan, and other centres of industrial activity within a radius of about 25 miles of Liverpool. It is expected that a good deal of freight will be obtained for the return journey in the shape of agricultural produce, and that the motor-wagons will be able successfully to compete with the railways over short distances.

Cardiff.—The umpire has fixed the price of the cars, horses, harness, stores, and equipment of the tramways company at £15,643, which sum has to be paid by the Corporation over and above the £50,000 for the permanent way. The total claim of the company for depôts, lands, buildings, etc., is £30,839. The power station at Roath is now practically completed. Mr. Ellis, the electrical engineer, reports that his part of the work of reconstruction is proceeding satisfactorily. It was stated at the meeting of the Town Council on Monday that a scheme for the proposed extension of the tramway system was being prepared, and would be put forward as soon as possible.

Smoke Nuisance.—The Public Health Committee of the metropolitan borough of Hammersmith report that further summonses against the Central London Railway Company for permitting black smoke to issue from the chimney shafts of their premises in Wood-lane in such quantities as to be a nuisance were heard at the West London Police Court on the 20th ult., when the magistrate, Mr. Rose, fined the company £5 on each of 12 summonses, with £8. 8s. costs, making a total of £68. 8s. From observations made by one of the Council's inspectors upon the company's chimney shafts, the committee recommend that further summonses be taken out against them for a similar nuisance.

Southend.—The Tramways Committee in their latest report to the Town Council expressed grave dissatisfaction with the slow progress in the completion of the works in connection with the tramways undertaking. At the last meeting of the Council the committee reported having considered the reference back of the terms of the appointment of the Tramways and Electric Lighting Sub-Committees, and it was resolved that the duties of the first-named should be to supervise the management of the traffic of the tramways and to periodically report thereon for confirmation to the committee; and the duties of the latter should be to supervise the management of the electric lighting undertaking upon the same basis.

Tramways in Northumberland.—The Northumberland Electric Tramways Bill, which is being promoted by the Northern Counties Electric Supply Company, Limited, seeks powers to construct tramways and tramroads from Morpeth to Bedlington, Bebside to Blyth, and Ashington to Newbiggin, and to make certain street widenings. The first of these lines is 7¾ miles in length, the second 3½ miles, and the third 4¾ miles. The company is to take its electrical supply from the local authorities, where they are able to provide such a supply, but as a sort of penalty for this concession there is a clause providing that the local authorities shall not have power to buy out the company under 42 years. Considerable opposition is developing to the proposals of the company.

Liverpool.—Statistics of the tramway traffic which have been laid before the committee show that in 1897, the last year during which the tramways were managed by a company, and in which the haulage was by horse power, the mileage run was six millions, the passengers were 38,400,000, and the receipts were £291,000. In 1901, with electric tramways, the mileage was just under 11 millions, the passengers were 101,109,000, and the receipts £468,383, with a surplus on the year's working of nearly £70,000. Compared with 1897, the increase in passengers was fully 163 per cent., in mileage 82 per cent., and in receipts 61 per cent., and as against 1900 the increases were: passengers, 22 per cent.; mileage, 20 per cent.; and receipts, 12 per cent.

Clapham-Islington "Tube" Blocked.—On Wednesday morning about nine o'clock there was a temporary block on the electric railway which connects Clapham Common with the Angel at Islington. It lasted for about 15 or 20 minutes, and resulted in nothing more serious than a brief detention of the passengers. Enquiry at the offices of the company elicited the fact that in passing the cross-over near the Elephant Station the motors failed to receive the current, and the train was thus brought to a standstill. Later reports state that as the result of the accident one of the carriages caught fire. The train was backed into the station and, with the aid of the fire appliances, the outbreak was overcome. Eventually the carriage was shunted into the nearest siding, and the regular traffic resumed.

Brighton.—The work of fitting the trams with the patent brake, which prevents the cars from running back if the current momentarily fails when they are mounting the hills, has been so far completed that 20 out of the 30 cars required for the full service have now been provided with them. Colonel Von Donop, the inspector who conducted the previous inspections of the routes on behalf of the Board of Trade, visited Brighton on Tuesday to see a car fitted with the new brake tried over the hilly districts of Ditchling-road and Elm-grove, and as soon as the formal certificate has been received from the Board of Trade the full service will be put in operation by the addition of about 10 cars on the Ditchling-road and Beaconsfield-road routes, four on the Elm-grove route, and two on the Queen's Park-road section.

"Tube" Railways in London.—There has been some talk of late with reference to the possibility of injury to the trees and shrubs of Hyde Park, St. James's Park, and Green Park as the result of the construction of the three projected tube railways, the Bills for which will be introduced in the coming session. It is pointed out that if parliamentary powers are granted as sought, eight distinct tunnels may be constructed beneath various portions of Hyde Park and four beneath Green Park, while St. James's Park would also be affected near the Mall. One of the companies proposes to tunnel within a short distance of the northern corner of Buckingham Palace, and another scheme will possibly interfere with the Albert Memorial, Hyde Park, as the promoters in this case seek to tunnel under the outer steps of the structure. The tunnels would be 70ft. to 100ft. below the surface of the parks.

Huddersfield.—A tramcar collision occurred here on Saturday night owing, it is said, to the failure of the brakes to act on greasy metals. As a car was standing in the Colne Valley to pick up passengers, another car, the driver of which was unable to make the brakes act on the slippery rails, dashed into it, damaging both vehicles considerably. A number of passengers were cut by the glass, and Hayes, the driver of the runaway car, had his leg badly crushed, to which he afterwards succumbed. During the reconstruction the Fartown, Waterloo and Almondbury, Lockwood and Berry Brow, and Bradley sections, the service of cars on these routes will be suspended. For the nine months ended Dec. 31 last, the receipts on the electric section of the Corporation tramways amounted to £21.307—11·04d. per mile—and the expenditure to £23,968, inclusive of £8.585 devoted to the interest and sinking fund. The loss on this section was therefore 1·37d. per mile.

Durban (Natal).—We learn that the total length of track laid up to the present for the new electric tramways is 10·17 miles. The progress made at the power station is still slow, although during the past month delay in the erection of the power station has been a matter which could not well be controlled, and the shortness of labour is as acute as ever. The weather has also been a factor in the delay in the works, 24 wet days having been recorded out of 30 during November. The regrettable serious illness of Mr. Roberts, the borough electrical engineer, is also another factor which must be taken into consideration, and, in addition to the difficulties in the matter of rapidly completing the tramway system, the ever-increasing demand for more electrical current for lighting purposes has to be faced and met. During the past month one of the large new sets—a 600-h.p. Willans engine—has been erected at the Point, and is now in use, and the erection of a second one has just been commenced at the new power station. The erection of the large engine at the Point referred to, including foundations and engine-house, was completed in three weeks.

Salford.—The new tramway route to Kersal is now open, and electric cars are running over that portion of Great Clowes-street, between Great Cheetham-street and Bella Vista. With regard to the laying of other electric lines, attention is now being devoted exclusively to Regent-road, but in the course of a few days Lower Broughton-road, where it is intended to lay a double set of rails, will be commenced. Nearly the whole of the route from Eccles along Eccles New-road and Regent-road is completed, and the erection of the poles and the trolley wires is making progress. The overhead equipment at the Cross-lane and Regent-road junction, which is rather of a complicated character, is proceeding apace. An interesting experiment which is being tried is the placing of electric arc lamps at the top of the poles, along Blackfriars-road, Chapel-street, and Broad-street. The lamps are being placed in position with all speed, and as a result the thoroughfares in question will be brilliantly illuminated. Should the result be as successful and effective as is anticipated, the same method of lighting will be adopted in other districts through which the electric cars pass.

East Lancashire Schemes.—Representatives of the promoters of the Rossendale Valley Tramways Bill and the Accrington and Burnley light railways order have had an interview with the Parliamentary Sub-Committee of the Burnley Corporation with reference to the schemes. The deputations were informed that the sub-committee favourably regarded both projects, but they preferred that the Burnley Corporation should construct the necessary length of line in each case within the Burnley borough boundaries, rather than have the roads taken up by the companies promoting the two projects. Clauses to this end will accordingly be drafted and submitted to the promoters of the two undertakings with a view to their accepting the same, in which case Burnley will offer no opposition to the two schemes. It is intended that the gauge in each case shall be 4ft., similar to that at Burnley. The Rossendale scheme proposes to bring cars from the

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Rossendale Valley to Burnley by way of Clow Bridge and Dunnockshaw. By the Accrington scheme it is proposed to run cars from Accrington to Burnley, through Huncoat and Hapton, and join up with the new Burnley electric tramways.

Light Railway Orders Confirmed.—The Board of Trade have confirmed the following light railway orders: Jarrow and South Shields Light Railways Order, 1901, authorising the construction of light railways in the boroughs of Jarrow and South Shields, in the county of Durham: Worcester and District Light Railways Order, 1901, authorising the construction of light railways in the city of Worcester and in the rural districts of Pershore and Upton-on-Severn, in the county of Worcester; County of Middlesex Light Railways Order, 1901, authorising the construction of light railways in the parishes of Edgware, Finchley, Friern Barnet, Hendon, Hornsey, Kingsbury, Little Stanmore, Southgate, Tottenham, Wembley, Willesden, and Wood Green, in the county of Middlesex; East Sussex Light Railway Order, 1901, authorising the construction of light railways in the county of Sussex, between Northiam and Rye; Barton-upon-Irwell Light Railway Order, 1901, authorising the construction of a light railway in the parish of Clifton, in the rural district of Barton-upon-Irwell, in the county palatine of Lancaster; Loughborough and District Light Railways Order, 1901, authorising the construction of light railways in the county of Leicester, from Loughborough to Mountsorrel, and in the borough of Loughborough.

Proposed City-to-Wimbledon "Tube."—A Bill promoted for the purpose of incorporating a company with powers to construct an underground electric railway from the City to Wimbledon has been deposited for the ensuing session of Parliament. The proposed line will commence near Cannon-street Station, and will pass under the Thames to Southwark, whence it will proceed *via* Lambeth and Wandsworth-road to Clapham Junction. From this district it will run *via* St. John's-hill to Wandsworth, and thence to its termination at Hartfield-road, Wimbledon. The railway will be constructed in two tunnels, with an internal diameter of 12ft. 6in., and similar in other respects to the existing tube railways. The generating station will be erected on lands on the boundary line between Wandsworth and Wimbledon, and abutting on the Wimbledon and Fulham line of the London and South-Western Railway. The company seek power to appropriate the subsoil under any building, premises, or hereditaments without being required to purchase any such property or any easement or right to the use of the subsoils, provided that the crown of the tunnel does not come within 30ft. of the lowest floor of any property affected by this clause. The total capital required for this scheme is £8,000,000, and the period required within which to complete the railway is five years.

Tyneside.—There has just been deposited in the Private Bill Office of the House of Commons the Bill of the Tyneside Tramways and Tramroads Company, to confer further powers on the company for the construction of tramways and tramroads. There are 12 sections of new lines proposed under the Bill, in all over 13 miles in length. There are also 15 widenings, and a new road to be made, the company's proposals affecting Wallsend, Long Benton, Tynemouth, Gosforth, Blythe, Cowpen, and Bedlingtonshire. An important part of the Bill is that under which it is proposed to alter the Tramways Act of 1870, so far as it applies to the company, by providing that the company shall not be required to sell any part of the tramways unless each of the legal authorities in whose district the tramways are situate, shall pass a resolution as provided by the said section. The period of 25 years shall be substituted for the period of 21 years mentioned in the said section. The terms upon which the company may be required to sell the company's property, or any part thereof, shall be the terms of paying the fair market value thereof as a going concern, but without any allowance for compulsory purchase on any sale to local authorities. Such arrangements as may be approved by the Board of Trade shall be made for vesting in each local authority a portion of the tramway situate in their district, and for a scheme or schemes for future maintenance, management, and working of the tramways; and the sale shall not take effect until an instrument has been properly executed in a form approved by the Board of Trade for carrying into effect such arrangements.

Wolverhampton.—A satisfactory settlement has been arrived at between the Town Council and the British Electric Traction Company with reference to the inter-communication with the outlying districts. The company have withdrawn their appeal as to the claim for running powers in the borough, and the Corporation agree to grant the company such powers and also to supply electricity for the purpose. A number of minor matters and costs will be referred to the Board of Trade. The arrangement arrived at dispels the long isolation of the borough from the neighbouring towns. With regard to the construction of the electric lines, good progress is being made. A start has now been made at the junction of Tettenhall-road and New Hampton-road West. At the meeting of the Town Council on Monday a resolution was adopted that, subject to the consent of the Lorain Steel Company being obtained, the Tramways Committee be empowered to give notice to the company, as provided by Clause 8 of the contract between the Corporation and the company, to proceed with the equipment of the whole of the remainder of the route mentioned in the said clause, as soon as the Board of Trade's approval of the system, notwithstanding that the period mentioned in the said clause may not have expired. A proposal is before the committee to appoint a general traffic manager of the new electric tramways, at a salary of £250 per annum. Colonel Yorke made an official inspection of the track of the Sedgley tramway on Tuesday. It was stated at the committee meeting which followed that the inspector had expressed a guarded approval of what he had seen, but stated that he should be willing to issue a provisional license for the track for the 30 days' test, so that that could be proceeded with at once. The proposal will be carried out as soon as possible.

LIGHTING AND GENERAL.

Brierfield.—The electric lighting question is to be discussed at a special meeting on Jan. 20.

Melbourne.—Large tenders for telegraph insulators will be required shortly by the Government.

Accident.—A pavement explosion took place at South Shields on Tuesday owing to leakage of gas-mains.

Brierfield.—Plans of the proposed electricity works have been approved by the Urban District Council.

Globe Telegraph and Trust Co.—The directors announce a quarterly interim dividend of 1s. 9d. per share.

Morecambe.—The Urban District Council have decided to allow the electrical engineer to engage a premium apprentice.

Paris.—A miniature of the Niagara electricity works has been installed at Poses, on the River Seine, where there is a dam.

Southampton.—Application is to be made for sanction to a loan of £337 for laying a main in Adelaide-road for the supply of electric light.

Lighthouse Board.—The estimate of the Northern Lighthouse Commissioners' expenditure for the year ended March, 1901, is £64,578.

Ryton.—The District Council are asking the Stella Coal Company for terms under which they would supply the Greenside district with electric light.

Brechin.—Lectures on electric light, with special reference to its uses for domestic purposes, are being held under the auspices of the Town Council.

Ambleside.—The agreement between the Urban District Council and the Windermere and District Electricity Supply Company has been completed.

Whitehaven.—At the last Council meeting it was stated that the electricity department of the Corporation was now working in a very satisfactory way.

Southend.—Mr. W. E. J. Heenan, of Northampton, has been appointed electrical engineer to the Southend Corporation, at a salary of £350 per annum.

Rochdale.—The Guardians have decided to obtain estimates for an electric light installation at the Townhead premises. The municipal telephone question has been adjourned for 12 months.

Coseley.—At the last meeting of the Council it was suggested that the clerk should obtain the necessary information in regard to the possibility of getting the district lighted by electricity.

Northfleet.—The District Council will send delegates to a meeting of the municipal authorities of the county to discuss the terms of the Kent Electric Power Company's Bill with a view to opposition.

Doncaster.—Colonel Hepper has held an enquiry into the application of the Corporation for sanction to borrow a further sum of £16,487 for the purpose of carrying out their electric lighting scheme.

Kettering.—The estimates for the Urban District Council's electric light installation have been reduced from £43,450 to £43,275, and those for the provision of a refuse destructor increased from £4,200 to £5,000.

Scarborough.—The Corporate Property Committee of the Corporation on Monday afternoon considered a report from the Telephone Sub-Committee, and decided to engage Mr. Bennett to give advice on the subject.

Derby.—An extension of the mains to supply the works of Messrs. Handyside and Co., Limited, with current for power purposes, at a cost of about £60, has been ordered on certain conditions embodied in an agreement.

Edmundsons' Electricity Corporation.—The directors have declared an interim dividend on ordinary shares of 5 per cent. per annum for the half-year ending Sept. 30, 1901, and dividends will be paid on the 17th inst.

"Sheffield Daily Telegraph."—The new offices of this enterprising paper in Fleet-street are connected with the Sheffield offices by an exclusive private wire, in connection with which nine tape printing instruments will be used.

Abertillery.—The District Council are asking the South Wales Electrical Power Distribution Company to amend a clause in the Bill they are promoting which is calculated to give the company a footing in this and other districts.

Prison Lighting.—It is stated that the Home Office authorities are quite satisfied with their experiments of the electric light, which have been carried out recently with a view of testing its suitability for general adoption in H.M. prisons.

Rio de Janeiro.—It is proposed to erect a generating station for the supply of current and power in 1903. Plans have been approved by the Town Council, and the power is to be taken from a waterfall which exists about 43 miles inland.

Boston.—On Tuesday the Town Council, after considering Mr. Adrian Collins's report on the electric lighting of the town, decided to invite one or two public companies to give estimates of a scheme of electric lighting, with traction power.

Tidal Power.—A suggestion has been made for utilising the tide by means of an extensive inland lake for generating electricity for driving the tramcars and lighting Southend, and the adjacent towns of Rochford, Shoeburyness, and Wakering.

Wireless Telegraphy.—A committee of Spanish engineer officers has been engaged for the last three months in experimenting with wireless telegraphy between Tarifa and Ceuta. They used Commander Pereira's apparatus. The trials were a complete success.

Morley.—Mr. H. Drewett, the electrical engineer, in his last report states that the output from the electricity works for the four weeks

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ending Dec. 14 was 12,653 units, against 10,066 units for the same period last year, being an increase of 25·7 per cent.

Football.—The annual football match between the "Robertson" Lampmakers and the General Electric Company Football Club took place on Saturday, the 11th inst., at Wormholt Farm. After a most exciting game the lampmakers proved the winners by three goals to none.

Eccles.—An adjourned meeting of owners and ratepayers was held in the town hall on Wednesday to consider the proposal of the Town Council to join the proposed joint Telephone Board. Pending the action of Manchester and Salford a further adjournment was made to Feb. 19.

Copper Prices.—Copper keeps on the downward grade. From Jan. 8 to Jan. 14 the London prices decreased from £47. 10s. per ton to £45. 10s. per ton for cash, and from £47. 17s. 6d. to £45. 17s. 6d. for three months' delivery. In America Lake ingots declined from 12⅛ to 11⅛ cents per pound.

Heywood.—The Town Council have resolved that a testimonial under the corporate common seal be granted to Mr. W. P. Adams, consulting engineer, expressing the high opinion of the way in which Mr. Adams has performed his duties during the construction of the electric supply station.

Sale of Plant.—The Electric Lighting Committee of the Dewsbury Corporation are prepared to receive offers for two 100-kw. four-pole dynamos, made by Crompton and Co. in 1894, 250 volts, 400 amperes, with spare armature and outer bearing. Full particulars appear in our advertisement columns.

Farnham.—The Urban District Council have decided to proceed with their electric provisional order, and to enquire of Messrs. Preece and Cardew upon what terms they will advise the Council as to carrying out of the new works up to the completion of the same and the installation of the scheme.

Birkenhead.—Mr. M. K. North has held an enquiry into an application of the Corporation for sanction to borrow £40,000 for the provision of additional plant at the Central and South-end generating stations, distributing mains in Rock Ferry and other districts, and 42 arc lamps for street-lighting.

West Hartlepool.—The Electrical Engineer in his last report states that during the five weeks ending Dec. 31 52,857 units were generated, and that the income by meter only approximated £660, and the works cost £216. The number of 8-c.p. lamps or their equivalent connected to date was 20,545.

Burton.—The last report of the Gas and Electric Light Committee states that the quantity of electric light sold in December was 53,030 units, an increase of 8,277 units on the corresponding month of last year. The committee are considering the question of lighting the proposed tramway route with electricity.

Direct United States Cable Co.—The Board have resolved upon an interim dividend of 3s. per share, free of income tax, being at the rate of 3 per cent. per annum, for the quarter ended Dec. 31, 1901, payable on the 31st inst., setting aside £10,000 to reserve fund account, and carrying forward a balance of about £3,350

Willing's Press Guide.—We have great pleasure in noting that the twenty-ninth annual issue of "Willing's Press Guide," which has just appeared, corresponds in every particular with the handy volumes which preceded the same. The book is easy for reference, and is published at the remarkably cheap price of 1s.

Islington.—The following estimates have been approved for electric lighting: provision and laying of length of low-tension distributing main from 284, St. Paul's-road to north corner of Highbury New-park, £330; and provision and laying of lengths of low-tension distributing mains in Southgate-road and Sherborne-street, £1,160.

Rhos.—The Parish Council are about to approach the Urban and District Electric Tramways Company, Limited, with a view of obtaining from them a supply of current for the street lamps. They have asked the company upon what terms they would undertake the laying of the mains and make all the necessary connections, etc.

Market Drayton.—A letter from the Market Drayton Electric Lighting Power Company, stating that it was the intention of the company to apply to the Board of Trade for a license authorising them to supply electricity for public and private purposes in the parish of Drayton-in-Hales, will be considered at the next meeting of the Guardians.

London Gazette.—A composition dividend of 7s. 6d. per pound has been declared in the estate of W. R. Beckton, electrical and general engineer, 35, Stradella-road, Herne Hill, Surrey, and 13, Brownlow-street, Holborn, London. Payable any day (except Saturday) between 11 and 2, at offices of official receiver, Bankruptcy-buildings, Carey-street, W.C.

Standish.—The District Council have granted the local electrical company permission to lay an iron pipe, ½in. diameter, which was to contain an electric cable from the company's works to the property across the highway, subject to no precedent rights being created, and also to disconnection when the Council were in a position to supply electricity themselves.

National Electrical Contractors' Association.—A general meeting is to be held at Anderton's Hotel, Fleet-street, E.C., on the 20th inst., at seven o'clock, when reports will be submitted and questions of trade interest discussed. We are asked to state that electrical contractors in London and the provinces are urgently requested to attend this meeting.

Bury.—Mr. F. Keiffer has been appointed as junior assistant. The electrical engineer having estimated the cost of supplying electricity to the workhouse, the Electric Lighting Committee will now consider any scheme which would bring in an annual revenue of £300. The consideration of the electrical engineer's report with reference to the extension of plant required for tramway purposes, has again been adjourned for one month.

Grimsby.—Mr. A. S. Channon, of Barrow-in-Furness, has been appointed to the position of chief assistant engineer to the Corporation electricity department. One hundred and seven applications were received for the position, Mr. Channon being selected from these. The other two selected candidates were Mr. G. Stamp Taylor, of Leeds, and Mr. G. S. Shankster, of Grimsby.

Hebburn.—The Northern Counties Electricity Supply Company, Limited, state that the whole of the plant and machinery for lighting the district is ready for delivery. Objection has been taken to the County of Durham Electrical Power and Distribution Company, Limited, laying down distribution mains in the streets leading from the Shields highway to the riverside.

Electric Construction Co.—On Saturday evening, in the Drill Hall, Wolverhampton, a complimentary dinner was given by Sir Daniel Cooper, Bart., G.C.M.G., chairman of the board of directors of the Electric Construction Company, Bushbury, to those employés who had been in the service of the company for seven years and upwards. The after proceedings were presided over by Mr. James W. Barclay.

Stretford.—At a special meeting of the District Council on Tuesday a resolution was adopted approving of the Bill to establish a joint scheme of telephonic communication in the Manchester exchange area; whilst with regard to the tramways schemes of the Manchester and Salford Corporations it was agreed that the policy of opposition, which had been previously agreed upon, should be persisted in.

Ealing.—The Highways Committee reported to the Town Council last week that a report in connection with the lighting of the district was under consideration, and the committee recommended that an additional sum of £50 be spent in providing Kern burners, with new lanterns, where necessary, in various roads. The consideration of the recommendation from the Electric Lighting Committee was adjourned till the next meeting.

Cardiff.—The electricity department's consumers have during the past 12 months increased by 160—viz., from 364 at the end of 1900 to 524. They also increased their lamps 50 per cent., from 10,127 to 15,250. The question as to the expediency or otherwise of taking proceedings to institute a corporate telephone exchange at Cardiff has been referred to the Parliamentary Committee, with power to make the necessary enquiries.

Salford.—At the last meeting of the Town Council enquiries were made with regard to a preferential rate granted to the Co-operative Wholesale Society at Broughton. It was stated that this course had to be pursued upon the undertaking to take a large quantity of current during the day, when the committee were able to sell it cheaply. The same rate would be given to any consumer who would take the same quantity of current and use it in the daytime.

Aldershot.—The Electric Lighting Committee recently deputed the chairman, with Mr. Calvert, to visit Walthamstow for the purpose of ascertaining details of their scheme of deferred payment recently approved by the Local Government Board. The chairman has reported that they had visited Walthamstow, and they had found the powers granted by the order had been stopped. The Council will now endeavour to obtain an interview with the Local Government Board in the matter.

Finchley.—Mr. Calvert, the resident electrical engineer, has been empowered to engage the services of a competent draughtsman at a salary not exceeding £2 a week. Upon the presentation of the Tramways and Electric Lighting Committee's report last week, the Chairman said he would like the ratepayers to know that whatever happened to the Finchley Improvement Bill the Council were going on with the electrical installation in Finchley on their own account, and not through the medium of a company.

Inverness.—The Electric Lighting Committee—comprising all the members of the Town Council—have been discussing the question of introducing the electric light. Messrs. Crompton have offered to purchase the Council's provisional order. Mr. James Fraser in a former report suggested that water power might be obtained from the Caledonian Canal. It has now been agreed to retain the provisional order for the present, and to make enquiries as to the securing of a water power from the Caledonian Canal.

Helensburgh.—The Town Council has decided to remonstrate with the Post Office, who propose to erect an overhead trunk wire from King-street to the post office. It is regarded as a retrograde movement, as the existing trunk line is underground, and there appears to have been an understanding that there would be no more overhead wires. Two years ago there was a complete collapse of the system owing to climatic conditions, and Helensburgh was shut out from communication with the outside world for 10 days.

Blackburn.—The summons recently issued on behalf of the sanitary inspector against the Corporation for allowing black smoke to issue from the chimney of the town's electricity works has been adjourned for two months. The Electric Lighting Committee have recommended application to the Local Government Board for sanction to borrow an additional amount of £14,650 for electric lighting purposes, £10,900 of the first loan having been charged to electric lighting account. This does not represent an increase in the amount to be borrowed.

Northumberland Electric Power Co.—This Company's Bill provides for the erection of generating stations at North Seaton and Cowpen. The capital is £500,000, and the dividend payable by the Company is restricted to a standard rate of 8 per cent., but, subject to a sliding scale, this dividend will be increased or decreased according to the price charged for electricity, which for dividend purposes is fixed at a standard price of 2d. per unit. The Company's area practically comprises the whole of Northumberland, with the excep-

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tion of Newcastle and Gateshead, and several of the other principal centres.

Huddersfield.—At the meeting of the Town Council on Wednesday the Electricity Committee submitted the following resolution: "That the Council be recommended to establish a municipal telephone system forthwith, and that the borough electrical engineer be instructed to secure a suitable site for an exchange." An amendment, however, was carried providing for the appointment of a small committee to wait on the National Telephone Company with the view of ascertaining the best terms that they were prepared to offer in reference to telephones.

Brighton.—We are informed that Mr. F. E. Sharpe, of Newcastle, has been appointed to the post of draughtsman to the Corporation, recently advertised in our columns. There was an item on the agenda for the last meeting of the Town Council as to agreeing on a memorial to the Local Government Board for their approval to a loan of £45.000 to defray the cost of the construction of a system of telephones in the Brighton telephone area, but the Town Clerk advised that such memorial would not be necessary, and the matter was accordingly withdrawn.

Stockton.—Mr. R. H. Bicknell has held an enquiry into the application of the Town Council for permission to borrow £27,500 for electric light purposes. The sum includes £6,500 which has been expended in excess of the loans previously sanctioned by the Local Government Board. It is not proposed to expend the remainder all at once, but already the Council have had to put in extra machinery, as at the end of December the demand nearly reached the maximum quantity they were able to supply without any margin in case of a breakdown in the machinery.

Stock Exchange.—The Stock Exchange Committee have appointed Jan. 22 special settling day for Calcutta Electric Supply Corporation's further issue of 10,000 shares of £5 each (issued at £1 per share premium), £2 paid (£1 capital and £1 premium), Nos. 30,001 to 40,000; and Central Electric Supply Company's £250,000 4 per cent. guaranteed debenture stock. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to, the Commercial Cable Company's further issue of £100,180 sterling 500-year 4 per cent. debenture stock (redeemable).

South Wales Electrical Power Distribution Company.—This company, whose offices are at 1, Royal-chambers, Cardiff, have increased their staff, and Mr. E. L. Hill has been appointed resident manager. The managing director of the company, Mr. G. L. Addenbroke, is negotiating with various local authorities and proprietors of large works for the supply of energy both for power and lighting. The building of the generating station at Treforest has been commenced by the contractors, Messrs. Holloway Bros., of London, and powers are now being sought to alter the site of the eastern station.

France.—That it pays electrical undertakings to open branches abroad is shown by the fact that in connection with the celebrations on the recent visit of M. Waldeck Rousseau to St. Etienne the French representatives of Electric Lighting Boards, Limited, received from the Government the order for the electrical illuminations, the extent of the contract being for £1,250, and including as many as 4,000 lamps. They also obtained a further contract from the Paris Illumination Company, no less than 30,000ft. of flexible cable, 1,000 superficial feet of boards, and 15,000 lamps having to be provided.

London Electrical Contractors' Association.—Various points affecting the prosperity of the trade will be discussed at a meeting to be held on the 20th inst., at 3 p.m., at Anderton's Hotel, Fleet-street, E.C. It is the intention of forming at that meeting an association of electrical manufacturers. We note amongst the rules of the association that a register will be kept of manufacturers approved by the committee. This will be circulated throughout the contracting trade. Workmen will also be registered, and annual certificates will be issued to them upon the recommendation of members. The association's first annual dinner will take place at the Hotel Cecil on Feb. 13.

Chapel-en-le-Frith.—Mr. Walker, the owner of the Chapel-en-le-Frith gasworks, who is making application to the Board of Trade for a provisional order to extend his works and supply gas to Chinley, has intimated that he could not see his way to entertain the proposals of the Council. A special committee has considered the matter, and their recommendation that the District and Parish Councils of Chapel-en-le-Frith, Chinley, Bugsworth, and Brownside oppose Mr. Walker's application for a provisional order, and that the District Council be recommended to apply for urban powers for gas, water, and electricity has been adopted so far as affects the parish of Chapel-en-le-Frith.

Redding.—The Co-operative Society have been discussing the question of introducing electric or acetylene gas lighting at their Redding premises. They have consulted the electrical engineer of the Wholesale Society, who has reported that the oil-engine in the bakery was capable of generating electricity to sufficiently light their own premises, but he was not able to tell them what the cost would be of fitting-up all the apparatus. In view of the coal workings, and considering that they had not the proper information as to whether electricity would be the better and cheaper light compared with acetylene gas, the directors have decided to leave the question over in the meantime.

Electric Mining.—Under this heading Messrs. John Davis and Son (Derby), Limited, of All Saints' Works, Derby, and 26, Victoria-street, S.W., have issued an illustrated catalogue dealing with all appliances used in mining. This is a branch of the electrical industry which has made great and rapid progress lately. This company undertakes the supply and superintendence of all systems of electric power and lighting plants, and to furnish, when called upon, expert engineers to teach the officials of mining companies how to maintain the machinery in efficient condition. At the end of the catalogue we find a schedule of questions which ought to save a good deal of time in the case of enquiries for schemes and estimates.

Twickenham.—The Surveyor reported at last week's meeting of the Council that he had seen the electric lighting company's engineer with reference to the plans of the mains and other works in the district, and that amended plans were now being prepared, and would be deposited for the Council's approval as soon as completed. He also reported with reference to the company's proposal to submit a scheme for the lighting of the whole or part of the public streets of the district by electricity, and that the company's engineer would submit particulars of a scheme for lighting a portion of the district which would form a basis to enable the committee to determine the question of the cost as compared with the present system of street-lighting.

Bury St. Edmunds.—The electrical engineer's last report states much progress has been made during last year. At the end of 1900, there were 57 services connected. At the close of December, 1901, there were 94, an increase of 37. There were 2,590 8-c.p. lamps connected at the end of 1900. On Dec. 31, 1901, there were 4,827, an increase of 2,327. The maximum load demanded in 8-c.p. lamps up to Dec. 31, 1900, was 878; up to a corresponding period of 1901, 1860, an increase of 982. Units sold during October, November, and December, up to the end of 1900 amounted to 6,136; to the close of last year, 18,632—an increase of 12,496. Units sold per 8-c.p. lamp connected during October, November, and December, up to Dec. 31, 1900, 2·3; Dec. 31, 1901, 3·9—an increase of 1·6.

Colne.—The Electrical Committee have resolved that in making out the accounts for electricity consumed during the first half-year, the maximum demand be based in each case on the number of days the consumer has had the mains connected with his premises. The engineer's monthly report states that since his last report the switch gear for the underground chambers at Dockray-street and Keighley-road has been delivered, and is now in course of erection. As soon as these feeding points are put to work a closer regulation will be effected. The boiler and economiser are now fixed and waiting to be bricked up, but, unfortunately, very little progress can be made in this direction owing to the present state of the weather. The boiler-house is now free from water since the drain was put in.

Worksop.—Colonel Hepper has held an enquiry into an application of the Urban District Council for sanction to borrow £8,500 for the extension of the electric lighting plant. The Consulting Engineer (Mr. A. B. Mountain, of Huddersfield) stated that the present number of consumers was 77, representing 3,879 8-c.p. lamps, and there were 35 arc lamps in the streets. Nineteen prospective consumers had applied, and it was proposed to fix 40 incandescent lamps in the side streets, making a total addition equivalent to 1,023 8-c.p. lamps. The present plant was capable of supplying 6,000 lights, and it was not safe to face the next year without addition, as they were nearly up to the maximum. As the works had only been running three months, they could not reliably give the financial results. There was no opposition.

Telephones in Ireland. The Postmaster-General, replying to the Association of Chambers of Commerce, says he has caused enquiry to be made as to the probable cost of providing telephone communication between Cork and Youghal, Mallow, Killarney, Fermoy, Dungarvan, and Waterford. The cost would be too considerable to justify him in recommending the case to the Treasury, but if guarantees are forthcoming he will be prepared to provide local connections to subscribers' premises at £7. 10s. a year, under a three years' lease, for circuits within half a mile from the post office. Subscribers would be entitled to communicate over the trunk wires, on payment of the appropriate fee, with subscribers of the Post Office, the National Telephone Company, and other licensees in all towns of the kingdom connected with the trunk-wire system.

Lightning Conductors.—An enquiry was held at Chatham on the 10th inst. by Mr. Alfred Hands, F.R.Met.Soc., in reference to a claim by the churchwardens of Holy Trinity Church, New Brompton, against the insurance company for damage alleged to have been caused to the spire of that church by lightning on some date unknown. Some stones having fallen on July last, an examination was made, and cracks being found of such a nature as to render immediate repairs necessary, they were carried out, and compensation was claimed under the fire policy, which, as usual, contained a clause including lightning risks. The insurance company having disputed the claim, Mr. Hands was appointed arbitrator, and after hearing expert evidence on both sides and examining the broken stones, which had been preserved for the purpose of the enquiry, decided that the damage was not caused by lightning, but was due entirely to the rusting of the vane rod which passed through the stones, and, therefore, that the insurance company was not liable.

Hull.—Colonel Hepper on Wednesday held an enquiry into the application of the Corporation to borrow £47,900 for electric lighting purposes, and £5,664 for the purchase of land for proposed new street from Alexandra-street to Wawne-street, connecting Londesborough-street with the Spring-bank. The Electrical Engineer (Mr. Barnard) said that the present loan was required for the extension of the generating works in Sculcoates-lane, for the purchase of additional machinery, high-tension mains to connect the works in Sculcoates-lane with the original works in Dagger-lane, now a transformer station, also for the purchase of new low-tension distributing mains to be laid in various streets where the residents have demanded a supply. The buildings included in the loan consisted of an extension to the Sculcoates-lane works engine-room and boiler-room by 150ft., to accommodate plant of nearly 5,000 h.p., of which about one-third of the machinery it is proposed to instal at present. It was also proposed to erect a new chimney of 200ft. high to accommodate plant of about 7,500 h.p. Application had been received from the School Board to supply current to many of the schools in Hull, and an arrangement had been made with Earle's Company for the supply of a large quantity of electricity for lighting and motive power, amounting to 500,000 units per year.

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Pemberton.—The engineer has been instructed to obtain wire and other materials necessary for the lighting of the station at once, and get in tenders for meters and service cable. Particulars of a number of tenders will be found in another column. The Council have decided to offer the Worsley Mesnes Ironworks a supply of current at a charge of 3d. per unit for lighting, and 1½d. per unit for power, with a minimum fixed rent of £100 per annum, to be reached by the charges named, all used beyond that amount, whether for lighting or power, to be charged at 1½d. per unit. The engineer has submitted an estimate of the cost of station to supply Goose Green and Worsley Mesnes, the estimate being for a cable similar to that laid in Ormskirk-road, with a conduit required for the tramway cable, but not the cable itself. The estimate amounted to £3,205. Mr. J. B. Robb has been appointed assistant electrical engineer.

Perth.—The Council on Tuesday adopted a suggestion by Mr. Lambert, electrical engineer, who stated that owing to a likely number of small fan motors being used in the future for ventilating purposes, which the Corporation are bound to supply with electric energy at the power rate of 2d. per unit, he considered there should be a minimum consumption for electric energy fixed in order to give a return on the money spent in providing meters, etc., in connection with these motors, and that the current required to run them is a mere fraction of an ampere, and that consequently the number of units consumed at the end of a year is not, as a rule, sufficient to pay for the outlay incurred. The Council, therefore, resolved that a charge of 5 per cent. be made on the cost of the necessary meter and demand indicator on those who used current to the extent of £1 a year, and a sum of £2 a year for a fan motor.

Margam.—The South Wales Electrical Power Distribution Company have offered to the Urban District Council a minimum bulk electrical supply of 50,000 units at 2·90d. per unit., any greater quantity to be supplied at a proportionate reduction. It is pointed out that to make such favourable terms it is necessary that the company should be able to make an agreement with each of the local authorities—such as Neath, Briton Ferry, and Aberavon; and, this being procured, the company will undertake to have the lighting available before next winter. The Council have decided to defer the question to see what arrangements could be made with the other authorities. At Tuesday's meeting a letter was read from Messrs. Cuthbertson and Powell offering to strike the power to lay a conduit into the Margam district out of their Bill if that would satisfy the objection of the Council. It was unanimously decided to petition against the Bill in any event, whether the clause was struck out or not.

The "Rochdale Observer."—By the acquisition of adjacent property the proprietor of the *Rochdale Observer* has been enabled to make considerable extensions to the premises in which that paper is produced. Coincident with these alterations new machinery has been laid down for the more rapid production of the *Observer* in an improved form. The new machinery consists of a two-reel "Victory" press, embodying the very latest ideas in newspaper printing. It will produce papers of four, eight, twelve, or sixteen pages, fixed as regards the number of columns but variable as regards their length. The press is driven by a double electric motor of the Holmes-Clatworthy type, the slow-starting gear being a capital arrangement, avoiding many breaks when beginning a reel. The printing machine started without a hitch, and the whole impression, when it was used for the first time, was run off at a speed of fully 12,000 per hour without a single break—a fact almost unique, we should say, in newspaper printing, and reflecting great credit on the makers both of the machine and the motors.

Jarrow.—At the last meeting the Town Council adopted a special report presented by the deputation appointed to confer with the electric lighting company's representatives as to the reinstatement of the lighting cable trenches in the public thoroughfares. The deputation stated that they met Mr. Steinitz, engineer to the company; Mr. McDougall, the local engineer; Mr. Graham, the architect; and Mr. Noton, representing Messrs. Callender and Co., the contractors. It was agreed that all carriageways should be thoroughly reinstated by the company forthwith to the satisfaction of the borough surveyor. With regard to the footpaths it was agreed that in all cases where there are broken flags or cement beyond the actual width of the trench, the work should be done by the Corporation, the company to pay their fair proportion of the cost, to be agreed at a subsequent conference before the work is commenced. In all other cases the footpaths are to be reinstated by the company in accordance with the specification supplied by the borough surveyor. With regard to the depth of cable in Bede Burn-road, Mr. Steinitz gave an undertaking to lower the cable at the company's expense if and when required to to do so by the Corporation for the formation of any new road, railway crossing, or other purposes.

Durham.—The electric light has now been switched on to 47 customers in the city. The power-house stands on an area of 100ft. by 56ft., and is well and substantially built by Mr. Weatheritt, of Newcastle. In the boiler-house are two water-tube boilers of the Babcock-Wilcox type, one of which only is used at present. Bunkers are very conveniently situated opposite, and can be filled from outside by tipping. There is a storage tank which will hold 60 tons of water. The water runs from the large storage tank to the smaller one at the other end of the boiler department, and from thence into the boilers. Two Weir feeding pumps are in use, and a Wheeler feed heater. In an adjoining large house space is left for a boiler, which will give the extra power necessary for the running of the electric cars. In the machine-room there are two dynamos and engines by the Brush Electrical Engineering Company, the balancers for the three-wire system, and the switchboard, which is divided into four sections. In the adjoining accumulator-room there are 250 storage cells, forming two batteries, by the Hart Accumulator Company. Practically there is at present 250 h.p. in the station. Mr. W. F. Snowdon, Newcastle, did the cover piping; Messrs. Abbot, Gateshead, the ironwork; Messrs. Carrick and Ritchie, Edinburgh, supplied the crane; and the Barrowfield Iron Company, Glasgow, the tank. Mr. J. S. Frain is the chief engineer, and Mr. Rumford is his assistant.

Cheltenham.—At Monday's meeting of the Town Council a letter from the manager of the National Telephone Company was read, complaining that the telephone service was suffering severely through the electric lighting works of the Corporation, and asking them to take steps to remedy the disturbance complained of. It was resolved to instruct the engineer to obviate, as far as possible, any causes for complaint. The engineer's last report states that all work, both of extensions and ordinary running, had progressed satisfactorily during the past month. The number of customers connected was 549, and the equivalent number of 8-c.p. lamps was 34,560—increases of 11 and 660 since Nov. 20. There were 21 intending customers, with the equivalent of 755 8-c.p. lamps, to be connected shortly, and applications had been received from others. An application had been received from the committee of the Home for Sick Children for electric supply to the equivalent of 109 8-c.p. lamps at their new premises at Harp Hill. The total cost of the extension, exclusive of the transformer, which was in stock, would be £105, and the annual bill should amount to £20 per cent. on this outlay; he therefore recommended that this application be acceded to. As it was desirable to encourage the use of electric heating apparatus and motors as much as possible, and particularly of those used for a considerable time daily, he recommended that the price of energy for these purposes be 6d. per unit for an average use of one hour per working day and 1d. per unit for additional use. This corresponded to 3d. per unit for a 2½-hour-a-day customer, and 2d. per unit for a four-hour-a-day customer. These recommendations were approved.

Gloucestershire Electric Power Co.—With regard to a note in our last issue upon the above Company's proposed Bill, the following additional information may be found of interest: The Company are also prohibited from supplying energy within the area of supply of any authorised distributors without their consent, "which shall not be unreasonably withheld." For the purposes of this Bill, power is sought to erect generating stations in the parish of Caincross, Stroud, and in the parish of West Dean, near the Parkend Station. We have already mentioned that the capital of the proposed company is to be £250,000, divided into 250,000 shares of £1 each, with power to divide these into preferred half-shares and deferred half-shares. Upon this capital power is sought to create debenture stock to the extent of one-third of the capital actually issued from time to time. The Bill, however, prohibits the Company from putting in force any of their powers for the compulsory taking of land until £25,000 of the capital of the Company has been fully subscribed, and "until the expiration of four years from the date of the passing of the Act" power is sought to pay 4 per cent. interest out of capital on the amount from time to time paid up on any shares. The dividend payable by the Company is proposed to be limited to 10 per cent., but subject to a sliding scale based on a standard price of 3d. per unit. The promoters of this Company named in the Bill are Sir William Henry Marling, Bart., Mr. James Grainger Bellamy, Mr. John Hamlyn Borrer, Mr. Thomas George Clissold, Mr. James Evans, Mr. Thomas Newcomen, Mr. Archibald Grove, Mr. William John Paley Marling, Mr. John Drummond Robertson, Mr. James Henry Stephens, Mr. Athol Thorne, and Mr. Edward Weedon Winterbotham.

Cornwall Electric Power Co.—Under a Bill deposited for next session it is proposed to incorporate this Company with the object of supplying electricity throughout the whole of the county of Cornwall, exclusive of the Scilly Islands and the rural districts of Stratton and Holsworthy. The electrical energy will be supplied in bulk to any authorised distributors at any point within the area of supply where such persons may reasonably require it. The capital of the Company is to be £450,000, divided into 45,000 shares of £10 each, with the power to subdivide these shares into preferred half shares and deferred half shares. Upon this capital power is sought to raise £150,000 by the creation of debenture stock. The promoters of the Bill, who are also to form the first board of directors, are Mr. F. H. Lewis, Mr. Chas. Foster, and Mr. Oliver Wethered. The generating stations required by the Company are proposed to be erected at Tywardreath and Phillack, and will cover an area in each case of about four acres, but provision is made prohibiting the Company from acquiring any lands until £50,000 of the capital of the Company have been subscribed. The profits of the Company are to be limited to 10 per cent., subject to a sliding scale under which the dividend may be increased and shall be decreased by ¼ per cent. in respect of every 1¼ per cent. by which the prices charged by the Company have been above or below the maximum price set out in a schedule attached to the Bill. These maximum prices are to be liable to revision every 10 years on the application of the Company or of any three authorised undertakers. It is expected that about four years will elapse before the Company can begin business, and during this period it is proposed to pay interest at 3 per cent. per annum on their shares out of capital to an extent not exceeding £10,000.

Ayr.—The Council have adopted a graded scheme of wages suggested by the electrical engineer (Mr. Fuller), as follows: fitter (one), 35s. to £2; fitter's labourer (one), 21s. to 25s.; drivers (three), 25s. to 32s.; stokers (three), 25s. to 30s.; cleaners (one), 5s. to £1; arc trimmers (three), 25s. to 30s.; jointers (one), 35s. to £2; assistant jointer (one), 25s. to 30s.; shift engineers (four), 30s. to £2; switchboard attendants, 15s. to 25s. The annual increments in each case to be 1s., except in the case of the switchboard attendants, who receive 2s., and the shift engineers, who receive 5s. The electrical engineer in his last report states that he has now fixed almost the whole of the new suspension brackets on the tramway poles. It is intended that a start be made next week with the erection and transferring of the

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present arc lamps to the centre poles. The incandescent lamps are now finished as far as the intermediate posts are concerned, with the exception of the glasses, which will be fixed as soon as they are ready. The erection of No. 3 traction generator is now completed, and a run will be made as soon as the steam-piping is fixed. The cable extension to Castlehill is now completed. The maximum load was reached on New Year's Eve—viz., 312 kw., or the equivalent of about 11,000 lamps burning at the same time out of 21,000 lamps already installed. It is interesting to note this has absorbed the whole of the power load for alternate-current distribution. There is, however, with the present extension under completion, a margin for a further 6,000 lamps burning, or, say, 12,000 lamps installed, making a total station capacity of about 30,000 lamps. The Council have agreed to extend the cable along St. Leonards-road, as far as necessary, to supply all intending consumers, and also along the new road leading northwards from St. Leonards-road.

Enfield.—The Board of Trade is to be asked for a provisional order relating to electric light in Enfield. Application is to be made by the North Metropolitan Electrical Power Distribution Company, who have already arranged terms with the Enfield District Council, and have, therefore, the support of that authority. The company have already got to work in High Barnet, and more recently in Hertford, and it is part of their scheme that extensive generating plant will be laid down in a large building which it is proposed to erect near Ponders End—a part of Enfield. Under the order the area of the supply will be Enfield, but it is not proposed to lay down the mains, etc., through the entire district at once. As the result of negotiations with the Council, it has, however, been agreed by the company that within a period of two years after the commencement of the order, they will lay down distributing mains for the purposes of a general supply in the following roads: High-road, Ponders End; Southbury-road, the Town; London-road, Sydney-road, Church-street, Market-place, Palace-gardens, Little-park, Windmill-hill, Ridgeway-road, to Chase Farm Schools, Silver-street, Baker-street, Lancaster-road, and Chase Side. The order proposes to fix the maximum prices thus: where the company charge any consumer by the actual amount of energy supplied, they shall be entitled to charge him per quarter, if the quantity does not exceed 20 units, 11s. 8d.; and if the quantity consumed exceeds 20 units, for any quantity not exceeding the equivalent of 100 hours of supply at the maximum demand in such quarter at the rate of 7d. per unit; and for any further quantity exceeding the equivalent of 100 hours of supply at that maximum demand at the rate of 2d. per unit. The local authority (the District Council) may at the expiry of 14, 21, or 28 years from the commencement of the order require the company to sell to them the undertaking upon the terms of paying the fair market value; and after the expiration of 35 years from the commencement of the order the Council shall be entitled to purchase upon the terms and in the manner specified in the Electric Lighting Act, 1888. The order is to come into force upon the day when the Act of Parliament (in the ensuing session) is passed, which day will be the commencement of the order.

Nottingham.—On Thursday, the 9th inst., the last brick in the chimney shaft of the new electric power station was laid by the chairman of the Electricity Committee, Sir John Turney, with a trowel presented to him by the city engineer, Mr. Arthur Brown. At the top of the chimney Sir John Turney made a short speech, and after the ceremony was completed the company descended the chimney safely and partook of refreshments supplied by the chairman. The electrical engineer (Mr. H. Talbot), the deputy city engineer (Mr. T. W. Gordon), and Mr. Thos. Barlow (contractor) also attended. The height of the chimney above the ground is 220ft., and the total height from the bottom of the foundation 254ft. The foundation of the chimney is upon a concrete base 39ft. square. The diameter of the chimney at the top (inside) is 13ft. 6in., and is surmounted by an iron cap, 9ft. in depth, and weighing upwards of 25 tons. Inside the chimney are two iron pipes, each 30in. diameter, through which the exhaust steam is taken and delivered at the top of the chimney; the weight of these exhaust pipes amounts to 80 tons. The total weight of the chimney is over 4,000 tons, which gives a pressure on the foundation of about 2¾ tons per square foot. In the construction of the chimney over three-quarters of a million bricks have been used. The work has been carried out without the slightest hitch or accident, and reflects great credit alike upon the engineers and the builder. It is understood to be the highest and largest chimney in the county of Nottingham. The new station has been rendered necessary by reason of the additional sections of electrical tramways undertaken by the City Council, and the increasing demands of private consumers for electricity as a motive power, and it will be, in point of equipment and convenience, thoroughly up to date and efficient. Advantage has been taken of labour-saving inventions, and in the case of the eight boilers fixed it is claimed that by the introduction of automatic feeders the services of only two men will be required to look after them. Following the system which has proved so satisfactory in Talbot-street, the committee have, in relation to their machinery, adopted uniformity of pattern and the best workmanship, while a novel and exceedingly useful feature is an electric railway crane, which, it is estimated, will save its own cost in the fixing of plant, in addition to being of exceptional utility thereafter. This ingenious contrivance has three motions—travelling, transverse, and lifting—and, while moving in any direction desired, will lift a weight of not exceeding 15 tons.

King's Lynn.—The engineer's last report states that during December applications were received for 214 additional lamps of 8 c.p. or equivalent, making a total of 9,846 from private consumers. Also that the working expenses for November, 1900, were £307. 11s., and for November, 1901, £146. 6s. 10d.; units generated (35,111), 38,730; units sold to private consumers (11,883), 12,938; and that all the plant and mains had been kept in thorough working order. Tenders will be invited for the second boiler, pipes, etc., so that same may be fixed about June or July next. A report of the engineer on the comparative cost per unit for public and private lighting in 1901 has been entered on the minutes, in which he says: "I have ascertained the amount spent on capital account, on public lighting to be approximately as follows: Lamps, posts, brackets, joints, and connections, £5,000; mains, £2,875; gas plant, dynamos, and switchboards, £4,143; buildings, £1,520; clerk of works, £875—total, £14,413. To all appearance there will be an increase of 27 per cent in the output to private consumers during the current year, resulting in a sale of 92,297 units. The output for street-lighting will be approximately 174,000 units. The working expenses in the station—*i.e.*, the cost, which varys nearly directly as the output, will be approximately 1·15d. per unit. The cost of street-lighting per unit is as follows: Generation (engine-room expenses), 1·1500d.; lamplighting and attendance, £164—·2249d.; lamp repairs and renewals, £30—·0411d.; rent and rates (half of last year, £77—·10056d.; management, law charges, and insurance, £180—·2463d.; repayment on £14,413 (576·10) and interest on £13,300 (365·15), 1·2922d.—total cost per unit, 3·060d. The charge per unit last year was 2·64d. The cost of private lighting per unit works out as follows: Generation (engine-room expenses), 1·1500d.; distribution (wages on mains, etc.), £33—·0859 l.; rent and rates (half of last year), £77—·2004d.; management, law charges, insurance, £180—·4685d.; repayment, £1,330, less for public lighting £567. 10s., £762. 10s., interest £1,002, less on public lighting £365. 15s., £636. 5s.—3·9386d., 5·8434d.; revenue from meter rent, say £100, ditto from wiring profits, say £50, ·3904—total, 5·4530d. Estimated revenue per unit, 4·75d. The most noticeable features in the figures are the very low working costs and the high fixed charges—*i.e.*, interest and sinking fund. This shows how important it is that a system of charging should be used which will encourage long-hour consumers, and also bring as many new consumers as possible. The interest and sinking fund charges, as well as rent, rates, and many other other expenses, are the same whether the plant is running or standing idle.—Your obedient servant, JOHN PILLING, Nov. 26, 1901."

PROVISIONAL PATENTS, 1902.

JAN. 1.

8. **The duo incandescent (electric) lamp.** John Isherwood, 14, Suffield-road, Newington, London.

18. **Improvements in or connected with electric tramcars and the like.** John Henry Peters and Lewis Peters, Market-place, Huddersfield.

21. **Improvements in and relating to electric tramways or street railways.** Henry Schuster Cowx, 556, Chester-road, Old Trafford, Manchester.

53. **Improvements in or relating to electric relays or the like.** Pierre Picard, 111, Hatton-garden, London.

77. **Improvements in the method and means of registering the consumption of electric current, or other forms of energy developing heat.** Edward Swift Isham, jun., 18, Buckingham-street, Strand, London. (Complete specification.)

JAN. 2.

102. **Improvements in Nernst lamps.** Sydney Gowan and the Nernst Electric Light, Limited, 18, Southampton-buildings, Chancery-lane, London.

106. **An improved electrical indicator.** David Wells, 48, Dudley-gardens, Leith, Edinburgh.

109. **An electrical device for the ignition of petrol and other motors.** Frank Howles and George Jackson Blunn, Ladywood-road, Birmingham.

117. **Improvements relating to overhead tramway, telegraph, and telephone wires.** James Townsley Pearson, 8, St. James's Hall, Burnley.

118. **Improvements in or relating to anodes for electrolytic operations.** Maurice d'Audrimont, 24, Temple-row, Birmingham. (Complete specification.)

120. **The electric car trolley guide.** John Reynolds, 3, Berkeley-place, North-road, Plymouth.

146. **A method of utilising two conductors and earth for transmitting a number of different electrical communications.** Charles Mark Jacobs and Arthur Harold Nicholson, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

155. **Improvements in lens combinations for telephoto purposes.** Carl Paul Goerz, 18, Buckingham-street, Strand, London. (Complete specification.)

173. **Improvements in and relating to electric lighting arrangements, particularly applicable for railway trains.** Friedrich Wilhelm Schneider and Abraham Strauss-Collin, 27, Chancery-lane, London.

JAN. 3.

185. **Improvements in electric resistances.** William Du Bois Duddell and Thomas Mather, 47, Hans-place, London.

189. **Improvements in and relating to trolley pulleys for overhead electric traction.** William Bentley Dixon, 254, Colne-road, Burnley.

239. **Improvements in electrical transformers for polyphase currents.** Arthur Francis Berry and the British Electric Transformer Manufacturing Company, Limited, 46, Lincoln's-inn-fields, London.

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JAN. 4.

252. **A new and improved switch suitable for high-voltage electric currents.** Julius William Hintze, Hanway House, Hanway-street, Oxford-street, London.

297. **Improvements in and connected with electric ignition devices of internal-combustion engines and the like.** John Alexander McMullen and Kenric James McMullen, 323, High Holborn, London.

303. **Improvements in circuit closers for portable electrical apparatus.** William Roche, 53, Chancery-lane, London. (Complete specification.)

JAN. 6.

333. **Improvements relating to electric lighting.** Richard Bertram Leach, 64, Barton-arcade, Manchester.

337. **Improvements in or relating to arc lamps.** Stefano de Stefani, 12, Kingdon-road, West Hampstead, London.

344. **A new or improved means for electrically imprinting, marking, branding, ornamenting, or decorating objects, articles, or fabrics.** Thomas Newton, 75, Yeldham-road, Hammersmith, London.

351. **Improvements in connection with electrical bells, telephones, ringing keys, contacts, switches, indicators, relays, and the like.** Isaac Hardy Parsons, of the firm of Gent and Co., 4, South-street, Finsbury, London.

360. **Improvements in contact devices for electric railways.** Earl Porter Wetmore, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

361. **Improvements in contact boxes for electric railways.** William Milton Brown, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

365. **Improvements in magnetic separators.** Anders Eric Salwén, 322, High Holborn, London.

380. **Improvements in contact shoes for electric railways.** William Milton Brown, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

381. **Improvements in electric cables.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Adolphe Borel and Charles Borel, Germany.)

382. **Improvements in galvanic cells.** Erich Friese, 8, Quality-court, Chancery-lane, London. (Complete specification.)

JAN. 7.

416. **Improvements in self-registering time, speed, and distance indicators and automatic electric safety check.** Richard Paulson, 16, Rutland-road, Hove, Sussex.

418. **Improvements in the construction and working of electric batteries.** Benjamin James Hall, 41, Castelnau, Barnes, London.

452. **An improvement in electrical ignition apparatus for internal-combustion engines.** Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (La Société Anonyme des Anciens Etablissements, Panhard et Levassor, France.)

473. **Improvements in or in connection with trolleys, switches, junctions, or the like used in connection with overhead wires for electric traction.** David Blythe Foster, 6, Lord-street, Liverpool.

493. **Improvements in electrical demand or rebate indicators.** Friedrich Lux, jun., and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

506. **Improvements in insulating secondary sections of induction coils.** Mortimer Arthur Codd, 5, Roxborough-park, Harrow-on-the-Hill.

JAN. 8.

509. **Improvements in synchronous electric motors.** Charles William Scott Crawley, 44, Castletown-road, London.

513. **Improved trough or carrier for electric cables.** William Ingham and Benjamin Langton, Basinghall-street, Leeds.

527. **Improvements in and relating to electric tram and other seats.** Charles Evans, 67, Stockport-road, Ashton-under-Lyne.

561. **Improvements relating to electrical heating apparatus.** The British Westinghouse Electric and Manufacturing Company, Limited, Westinghouse Building, Norfolk-street, Strand, London. (John S. Peck, Karl C. Randall, and Charles F. Scott, United States.)

577. **Improvements in insulators.** Louis Hackethal, 1, Queen Victoria-street, London. (Complete specification.)

JAN. 9.

597. **Improvements in connection with electrical advertising lamps and the like.** William Ellicott and George A. Howitt, 195, West George-street, Glasgow.

603. **Spring shade carrier for electric lamp-holders.** Herbert Farrar, South View, Private-walk, Dee Banks, Chester.

609. **Improvements in electrical switches and cut-outs.** Robert Frederick Hall, 24, Temple-row, Birmingham. (Complete specification.)

636. **Improvements concerning electric lamps.** Thomas Terrell, New-court, Temple, London.

654. **Improvements in fusible cut-outs for electric lighting and power circuits and the like.** Albert Henry Hunt and John Hewett, 5, Budge-row, London.

667. **Improvements in connection with surface-contact electric traction systems working with magnetically-operated switches.** The Dolter Electric Traction, Limited, 46, Lincoln's-inn-fields, London. (Henri Dolter, France.)

699. **Improvements in electric recording logs.** Jacques Fua, 18, Buckingham-street, Strand, London.

JAN. 10.

737. **Improvements in railway sleepers, brake blocks, driving pulleys, rollers, insulators for electric wires, and other similar articles.** Samuel George Board and George Frederick Freeman, 6, Bank-street, Manchester.

750. **Improvements in wireless telegraphy.** Sidney George Brown, 9, Putney-hill, Putney, London.

751. **Improvements in wireless telegraphy.** Sidney George Brown, 9, Putney-hill, Putney, London.

4777A. **Improvements in electromagnets.** Reginald Walter Barker, 56, Ludgate-hill, London. (The Murphy Safety Third-Rail Electric Company, United States.) (Date claimed under Patents Rule 19, March 6, 1901.) (Complete specification.)

JAN. 11.

809. **Improvements in lifeguards for electric cars and other self-propelled vehicles.** Arthur Royle, 6, Lord-street, Liverpool.

825. **Improved method of protecting electric cables.** Bernard Mervyn Drake and John Marshall Gorham, 66, Victoria-street, Westminster, London.

837. **Improvements in electrically-actuated devices for locking the doors of tramway, railway, and like vehicles.** Max Fels, Rudolf Zwack, and the firm of W. Burri, 6, Lord-street, Liverpool.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Jan. 23.

1901.

74. **Switches for controlling electrical circuits.** Lundberg and Lundberg.

90. **Device for regulating electric motors.** Monthiers.

310. **Electrical switches.** Richardson.

1181. **Electric switches.** Spark.

2127. **Electric fuse heads for blasting purposes.** Malson and Malson.

2933. **Electrodes for secondary batteries or accumulators.** Wilde.

4366. **Safety devices for the trolley poles of electric cars.** Bellamy, Turner, and Hardman.

13840. **Stops for trolleys on electrically-propelled tramcars and the like.** Lowdon, Lowdon, and Balfour.

17565. **Means for starting and working electrically-actuated lifts with two cages.** Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

20258. **Electrical measuring instruments.** Reiniger and Lion.

To be published Jan. 30.

1900.

20856. **Arc lamps for projection purposes.** Drysdale.

1901.

1087. **Electric meters.** Atkinson.

2317. **Electric stop motions for warping machines.** Thomas Holt, Limited, and Holt.

4519. **Construction of rail for electric and other railways or tramways.** Hengst.

4576. **Electric furnaces.** Contardo.

4597. **Electric demand indicators.** Wright and Reason Manufacturing Company, Limited.

4736. **Swivelling trolley heads employed in overhead wire electric traction.** Munro, Brecknell, and Rogers.

4841. **Swivelling trolley heads employed in the overhead wire system of electric traction.** Brecknell.

5042. **Glow bodies for Nernst incandescent electric lamps.** Drake and Nernst Electric Light, Limited.

5063. **Secondary batteries.** Hansen and Petersen.

5263. **Receivers for electric demand indicators.** Wright and Reason Manufacturing Company, Limited.

5402. **Electric pendant lamps.** Best.

6207. **Method of and means for automatically switching off the current in trolley wires used for electric traction in case of a breakage or other accident.** Swales, Stamford, and Swales.

6403. **Automatic electric circuit breakers.** Eckstein and Mellis.

11172. **Electricity meters.** Kallmann.

14235. **Audible electric signalling devices.** Brown and Points.

14969. **Electric synchronism and frequency or speed indicators.** Lincoln.

15461. **Electric clocks.** Wise. (Actiengesellschaft "Magneta" (Elektrische Uhren ohne Batterie und ohne Contacte).

22953. **Electromagnetic cut-outs.** Joseph and Gardner.

23215. **Electrical accumulators.** Cheval and Lindeman. (Date applied for under International Convention, April 22, 1901.)

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23915. Method and means for securing electric incandescent lamps to service wires. Lambert.

24192. Protective mechanism for high-tension systems of electrical distribution. De Pass. (Cheatham and Stewart.)

24627. Electric batteries. D'Infreville.

24672. Electric motors for driving spinning machines. Schönfeld.

25081. Telephone receiver box. Sensenschmidt.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	Jan. 11	616	557	+ 58	—	—
Birmingham Tramways	—	—	—	—	—	—
Blackburn Corporation	,, 10	606	507	+ 99	948	806
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 11	144	142	+ 2	265	283
Bolton Corporation	,, 12	1,385	1,191	+ 194	78,391*b*	65,456*b*
Bradford Corporation	,, 12	1,055	754	+ 301	1,877	—
Bristol Tramways Company	,, 10	4,023	3,386	+ 637	—	—
Carlisle Tramways Company	,, 11	126	111	+ 15	236	193
Central London Railway	,, 11	6,664	5,676	+ 988	12,772	11,523
City and South London Railway	,, 12	3,034	2,047	+ 987	6,210	4,071
Cork E. T. and L. Company	,, 10	404	327	+ 77	517	485
Dærwen Corporation	,, 10	202	152	+ 50	280	253
Dover Corporation	,, 11	176	153	+ 26	312	301
Dublin & Lucan Electric Railway	,, 12	93	66	+ 29	162	136
Dublin U. T., electric cars	,, 10	3,617	3,222	+ 395	—	—
Dublin S. District, Electric	,, 10	726	651	+ 65	—	—
Dundee Tramways Company	,, 8	863	532	+ 331	—	—
Glasgow Corporation	,, 11	10,689	8,525	+ 2,164	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 11	1,676	1,522	+ 154	—	—
Liverpool Corporation	,, 4	9,508	8,430	+ 1,078		
Liverpool Overhead Railway	,, 12	1,453	1,512	− 59	2,855	3,055
Newcastle-on-Tyne Corporation	—	—	—	—	—	—
Portsmouth Corporation	,, 11	1,043		—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 12	3,555	—	—	—	—
Southampton Corporation	,, 9	797	557	+ 240	—	—

* Fortnightly. *b* Since Jan. 1, 1901.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £599 decrease.
Barcelona Ensanche y Gracia, £2 increase. Barcelona, £427 increase.
Brisbane, £223 increase (month of Dec., £1,322 increase).
Buenos Ayres and Belgrano Electric, £38 decrease.
Calcutta, £20 decrease.
Cape Town (month of Dec.), receipts, £16,925; expenditure, £6,792.
La Capital Traction and Electric, Buenos Ayres (month of Nov.), £1,973 increase.
Mexico Electric (month of Dec.), receipts, £18,259; expenditure, £10,750.
Perth Electric, £201 increase.
Port Elizabeth (month of Dec.), receipts, £3,898; expenditure, £1,898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Tramways.—	£	£
Anglo-Argentine, 1-260,007	5 ..	3⅝-3⅞
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	123-126
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2½-3
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4½-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	101-103
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6½-7
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9-9½
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13¼-14¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12-12½
—— 5 per cent. Perpetual Debenture Stock	100 ..	126-129
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1¾-2
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	1⅞-2¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5½
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11½-12½
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	102-104
New General Traction, Ordinary	5 ..	2½-3½
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	8s. ..	7/16
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	40 p.c. ..	40 p.c.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅜-⅝
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅜-⅝
—— Ordinary, 1-125,000	1 ..	⅜-⅝
British Electric Works, Ordinary, 50,001-95,000	1 ..	1/16-3/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	3/16-5/16
—— 4½ per cent. First Mortgage Debentures	100 ..	85-90
British Insulated Wire, Ord., 1-70,000	5 ..	8¼-9¼
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¾-6¼
—— 5 per cent. Mortgage Debentures	100 ..	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5¼-6
Brush Electrical Engineering, Ordinary	2 ..	1⅛-1⅛
—— Nos. 90,001-105,731	2 ..	1⅛-1⅛
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	97-100
Callender's Cable, Debentures	100 ..	110-114
—— Ordinary	5 ..	16½-17½
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	3-3½
—— 5 per cent. Debentures	— ..	99-104 p.c.
Edison and Swan United, Ordinary	3 ..	⅛-⅜
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	78-83
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	84-89
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16¼-17¼
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	112-116
India Rubber, Gutta Percha, and Telegraph Works	10 ..	20-21
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15¼-16¼
Telegraph Construction and Maintenance	12 ..	34-38
—— 5 per cent. Bonds	100 ..	102-104
Telegraph Manufacturing, Ordinary	5 ..	10¾-11¼
—— 5 per cent. Cum. Pref.	5 ..	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	9¼-10¼
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	103-105
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-⅝
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	97-102
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9¼-10¼
—— Debenture Stock, Red.	100 ..	100-103
Brompton and Kensington, Ordinary	5 ..	8¾-9¼
—— 7 per cent. Preference	5 ..	8¾-9¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7¼-8¼
—— Nos. 20,001-30,000	5 ..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10½ xd
Charing Cross and Strand	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5-5¼
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	103-105
Chelsea Electricity Supply	5 ..	5¼-6
—— 40,501-50,936	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	108-111
City of London, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	121-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	105-108
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5¼-6
—— 6 per cent. Cum. Pref.	5 ..	5¼-6
—— 4½ per cent. First Mort. Deb.	100 ..	106-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-4¾
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5⅜
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	103-106
Kensington and Knightsbridge and Notting Hill	100 ..	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1¾
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	95-100
Metropolitan, Ordinary	10 ..	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7½-8
—— £4½ Shares, New	4½ ..	6¾-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-2¼
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15¼-16¼
—— 7 per cent. Pref.	5 ..	8¾-9¼
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	11¼-12½
Electric Railways.—		
Central London, Ordinary	100 ..	105-108
—— 4 per cent. Pref.	100 ..	105-108
—— ,, ,, deferred	100 ..	106-109
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-119
City and South London, Consolidated Ordinary	100 ..	65-67
—— Ordinary	10 ..	6-6¼
—— Nos. 60,001-70,000	10 ..	6-6¼
—— 4 per cent. Debenture Stock	100 ..	112-116
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Telephones.—		
National Telephone, Ordinary	5 ..	3⅛-3⅜
—— 6 per cent. Cum. First Pref.	10 ..	11-13
—— 6 per cent. Cum. Second Pref.	10 ..	11-13
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-5
—— 4 per cent. Deb. Stock, Red.	100 ..	94-97
—— 3½ per cent. Deb. Stock, Red.	100 ..	101-105
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

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NOTES.

London Electrical Contractors' Association.—We are asked to state that the first annual dinner of this association will be held in the Grand Hall of the Hotel Cecil on Thursday, the 13th prox.

Inspection of Meters.—A law has recently come into force in the State of Massachusetts, in America, providing for the State inspection of electric meters. No provision, however, is made for the general inspection of electric meters except on the application of a customer or a company. Under this new Act a meter is deemed to be correct if it does not vary more than 5 per cent. from the standard approved by the Board.

Electric Waves.—Mr. Sydney F. Walker gave a lecture on Sunday last at St. George's Hall, Langham-place, for the Sunday Lecture Society, on "Electric Waves." The experiments were conducted with Mr. Neville Maskelyne's apparatus, the special feature of which is the use of a closed resonator circuit, in place of the open circuit used by Marconi. A large audience followed the experiments and Mr. Walker's explanation of the same with deep interest.

Electro-Harmonic Society.—The next smoking concert in connection with this society will be held on Friday, the 31st inst., in the banqueting hall of St. James's Hall Restaurant. A good programme has been arranged. Songs will be given by Mr. F. Tebbutt and Mr. Arthur Stringwell, violin and piano solos and duets by Mr. T. E. Gatehouse and Mr. A. E. Izard; humorous songs and sketches by Mr. F. W. Stephens and Mr. Chas. Frood; while Mr. Chas. Capper, Dr. Boyd-Page, and Mr. Ernest Meads will contribute whistling solos, sleight-of-hand tricks, and recitations respectively.

The Post Office Telephones.—A deputation from the London Unionist members of the House of Commons has had an interview with the First Lord of the Treasury with reference to the telephone question in the Metropolis. It was hoped that a satisfactory arrangement might be come to which would render it unnecessary for the Lord Mayor to proceed with his amendment to the Address in the Commons demanding an enquiry into the agreement between the Post Office and the National Telephone Company, but it was pointed out by the representatives of the Government that the agreement existed until the year 1905, and that no substantial revision of rates could be effected until then. Sir Joseph Dimsdale will accordingly move his amendment on Monday next, which asks for a "complete enquiry" into the matter.

Electroplating.—Experiments have lately been carried out by Mr. W. Pfanhauser, jun., in order to determine the dispersion of the lines of current in electrolytes. His results are embodied in a paper recently published, from which we gather that the author has found that in electroplating objects of irregular shape the current lines tend to concentrate at the points of the cathode nearest to the anode, just as the lines of force in the magnetic field of a horseshoe magnet are most concentrated at the points of the poles which are nearest together. The lines of current are more evenly spread over the whole surface of the object with some electrolytes than with others, and the author proposes the theory that the spreading is proportional to the difference between the discharge potentials of the cathions of the "conducting salt" (usually $K^{\cdot}$, $Na^{\cdot}$, or $H^{\cdot}$) and of the metal which is to be deposited.

Electric Lighting Criticisms.—We have received an extract from the *Daily Express* which tends to disparage the electric light undertaking in the borough of Poplar. The undertaking of the Poplar Board of Works was only opened last September, and our contemporary thinks fit at this early stage to presume on the unprofitable nature of the supply. We do not believe that these criticisms are worth the paper they are written on, as the following quotation will show: "In the original report of the Electric Lighting Committee it was estimated that electricity could be generated at the works for 3d. per unit. The actual cash price works out at 5s. 0½d., including meters." Such statements make us discredit the rest of the comments as being utterly outside the mark and meaningless. The inhabitants of the borough of Poplar and the local gas company should contain themselves until the undertaking has had a fair trial.

Platinum in British Columbia.—It is reported from Vancouver that considerable quantities of platinum have been found in the gold-mining districts of British Columbia. The presence of this valuable metal in any quantity was first discovered by the American consul at Vancouver in some specimens of gold which had been brought to him to be refined. In many of the mining districts of British Columbia and the Yukon Territory, he asserts, large amounts of platinum and kindred metals must have been thrown away by miners who do not know platinum when they see it. With the present high price of platinum, it is thought that it will pay prospectors to be on the look out for the metal, which doubtless exists in considerable quantities in British Columbia. So far as is known, platinum is not found in ledges, excepting in one place in the world. It is usually located in black sand containing a large percentage of magnetic iron ore and a varying quantity of gold.

Electrical Engineers Volunteers.—It is most pleasing to hear that the services of the corps of Electrical Engineers (R.E.) at the front are being appreciated by the military authorities in South Africa That this is so is shown by the fact that the following appointments have been made officially: Sapper G. Francis (of the corps of Electrical Engineers now in South Africa) has been appointed an assistant electrical engineer under the Public Works Department of the Transvaal, at a salary of £315 per annum, and is stationed at Johannesburg. Corporal J. Coxon (of the Electrical Engineers (R.E.), now in South Africa) has been appointed to the electrical staff of the Imperial Military Railways, at a salary of £270, rising to £400 per annum. He is stationed at Johannesburg. These appointments should be a great encouragement to those thinking of joining the Electrical Engineers Volunteers for active service in South Africa. We understand that one, if not two, new detachments may be required shortly.

Royal Meteorological Society.—Mr. W. H. Dines, B.A., the president, took the chair at the annual general meeting of this society, which was held on Wednesday evening, the 15th inst., at the Institution of Civil Engineers, Westminster. Previous to the presidential address, the Secretary read the report of the council for the past year, which showed the society to be in a satisfactory condition, there being an increase in the number of Fellows of 28. The Symons gold medal, which has recently been founded as a memorial to the late Mr. G. J. Symons, F.R.S., the distinguished meteorologist, was presented to Dr. Alexander Buchan, F.R.S., for his work in connection with meteorological science. The President then delivered his address on the "Theory of Probability Applied to Various Meteorological Problems," at the conclusion of which he remarked that meteorology is far more than a statistical science, and is very closely dependent upon

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theoretical mechanics and thermo-dynamics; and in the application of these subjects to meteorology lies the best hope of advance.

Bust of Sir Frederick Bramwell.—The Duke of Northumberland, as president of the Royal Institution, last Friday evening unveiled a bust of Sir Frederick Bramwell, which has been presented to the members by a number of his friends and admirers. The bust, which is a remarkably lifelike piece of work, by the late Mr. Onslow Ford, R.A., is an appreciation of the way in which Sir Frederick Bramwell served the institution in his capacity as hon. secretary from 1885 to 1900. In his reply to the laudatory remarks of the Duke of Northumberland and of Sir James Crichton-Browne, who accepted the bust on behalf of the members, Sir Frederick acknowledged that the 15 years he had served as secretary had been years of hard work, but at the same time of great enjoyment, for he had been brought into intimate contact with many men whom it was a pleasure and an honour to know. He was glad the bust had been given, for he believed the work of the world was done by average mediocrity pegging on, and it was well to encourage men in that sort of thing. The process of making the bust, Sir Frederick further remarked, had been anticipated by him with horror, but it became an actual enjoyment to sit to the genius and genial man who had made it and watch the clay growing into a likeness of himself. The death of Mr. Onslow Ford was to him a source of infinite sorrow.

Steam-Turbines.—More information has now come to hand respecting the turbine-generators which the Westinghouse Company proposes to instal in the generating station of the Metropolitan District Railway. This station, as we have mentioned before, is to be situated at Chelsea, and ultimately will contain some 10 units of 7,000 h.p., or giving, say, 5,000 kw. at the generators. The turbines are to be designed to run at 750 revolutions, which enables the size of the three-phase generators to be very largely reduced. For instance, we are informed that these 5,000-kw. machines, which at the frequency adopted will only require to have four poles, will be only about 9ft in diameter. When this diameter is compared with the large size of machines of even smaller outputs when coupled to slow-speed steam-engines, the great advantage of turbine driving as regards first cost can be gathered—in fact, the use of steam-turbines will in this case greatly simplify the financial arrangement on account of their lower first cost. It will be interesting to learn whether the turbines are to be built by the Westinghouse Company, who control the Parsons patents in America, or by the English firm under the supervision of the Hon. C. A. Parsons. The largest turbine manufactured by the English firm already at work is that at Elberfeld, the output of which is 1,000 kw. It is an interesting fact that the use of these turbines enables the firm to compete successfully with the engine-driven dynamos of Continental firms, in spite of the high import duty which electrical plant going into Germany has to bear.

Electric Lighting Bills.—It seems to us that the one thing to be avoided in drawing up a system of charging for electrical energy is the possibility of a case arising in which a consumer, by using more energy, can get the total of his bill reduced. This was often the case where the reduction was given wholly in consideration of the total quantity consumed and as a percentage. With the maximum demand system as ordinarily applied this does not occur, as the reduction is given in accordance with the power factor of the consumer's load, and not in accordance with the total quantity which is actually used. The case now before us arose at Harrogate, where they have adopted the maximum demand system, but with variable limits. Thus for the ordinary consumer the charges are practically 6d. and 4d. per unit. If, however, the consumer burns more than 15,000 units per annum the rate becomes 6d. for the first period and 2d. per unit for all afterwards. In the instance in point the consumer used 14,790 units, and only required to take 211 more units in order to get a very substantial reduction in his bill. He has accordingly written to the committee, asking for this reduction, saying that he is quite willing to pay at 2d. per unit for the extra quantity required to bring him in at the lower rate. In fairness this should be done, but the scale of charges should be so altered that a similar case would not arise in the future. We think those who have read the recent discussion on Mr. Wright's paper before the Institution of Electrical Engineers will agree that it is better to charge 7d. per unit for the first hour's average use of the maximum demand, and thus give all the reduction possible for the energy consumed in excess of this.

Municipal Trading.—This subject was discussed at a representative meeting of the Northern Section of the National Association of Electrical Contractors at Manchester on Saturday. The chair was taken by Mr. H. Bland, who adversely criticised the general extension of municipal trading. He explained that the object of their association was combination for the purpose of defending all the interests of the electrical industry and repelling the attacks of the municipal authorities who went in for electrical undertakings, which attacks could not be met by individual effort. Corporations were now undertaking free wiring and using the ratepayers' money for the purpose of competing with private firms. Such powers, he maintained, were never intended to be given them by Parliament, and their association would be able to lay their opinions before Parliament, and, he hoped, prevent such infringement of their business. He urged the formation of a local branch in every town. In Leeds they had a powerful organisation, but in Manchester and Liverpool they did not receive much support. In the latter town they had many abuses to contend with, and contractors were suffering considerably through municipal trading. A number of gentlemen took part in the discussion which followed, with the result that a resolution was adopted requesting the National Association of Electrical Contractors to take action in conjunction with all kindred associations for the purpose of defining limits of legitimate municipal enterprise as regards electrical work, and of strengthening the hands of those "who are unfairly exposed to competition by municipal and other authorities trading under parliamentary powers."

The City Explosions.—Last week Mr. A. P. Trotter, the electrical adviser to the Board of Trade, held an enquiry as to the explosions which occurred on the 4th and 5th inst. in Newgate-street and Old Bailey in connection with the mains of the two electric lighting companies supplying the City. The evidence of a technical nature given by Mr. Patchell tends to show that the first explosion was caused by the inflammable vapour given off by the bitumen used for the solid filling-in system igniting. The second explosion was attributable to practically the same cause. Mr. Patchell remarked that it was the first explosion he had known of due to this bitumen vapour. The workman who lowered the light which caused the explosion had experience, and could hardly be blamed for what happened. The question is one which requires to be carefully looked into by electrical engineers, but we should think that there must have been some contributory cause which has not been brought forward. The chief engineer of the City of London

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Electric Lighting Company, Mr. F. Bailey, tried in his evidence to throw the blame for the explosions which had occurred in his system on the rival company. His suggestion that the whole ground in the City was being heated up from the mains of the Charing Cross and Strand Company, is one that is exceedingly difficult to believe. The question arises, however, as to how far overheating had occurred, and whether this overheating had resulted in the driving off of the explosive gas which is admitted to have been found in the boxes of the Charing Cross and Strand Company. An independent expert found it extremely difficult to suggest any connection between the two explosions, and we feel the same ourselves, but shall await with interest the report of Mr. Trotter.

Electricity in Cotton Mills.—Mr. George E. Walsh contributes a good article to the *Electrical Review* of New York on the use of electricity as the motive power in the cotton mills of the Southern States of America. The ideal method of operating the mills seems to be to use water power for generating electricity. This makes the cost from 20 to 40 per cent. cheaper than when the water power is used directly for operating the machinery, and from 20 to 30 per cent. cheaper when the steam is used for electric transmission where no water power is convenient. This saving has been demonstrated in many cases in the Southern States in the last few years, and the experience is sufficient to cause a general adoption of this form of power. Thus electric transmission from water power costs from 16s. to £2 per horse-power per year. Everything depends upon the natural conditions and environments. The author instances a case in South Carolina where there is a large mill, the cost of which is computed to be at the lowest figure just mentioned, and another at Columbia, in the same State, has been run at an average cost of £1 per year. There are innumerable streams of water scattered throughout the cotton belt which are eminently suited to the generation of electricity, and the work of building mills on the line of these is going on with great rapidity. The best sites are naturally selected first, and these have been largely taken up to-day. But the cotton belt is wide, and Texas, in particular, offers a wide field for this sort of development. The greatest difficulty is experienced in the summer time, when the streams dry up and the mill lose much of their power. In some sections the water power becomes practically useless for several months in the year. Mills located in such places are usually built for the purpose of being run either by steam or water power. The engines are employed in the dry season to produce the electric power to operate the spindles and looms until the water power is restored in winter.

Electric Railway Motor Performance. — Mr. Hanchett, in a paper published in some of our American contemporaries, takes up the problem of determining the heating of electric railway motors under practical load conditions, and proposes a new method which he believes to be more accurate than any heretofore suggested. Briefly stated, the method is as follows: The heating inertia capacity of the motor is experimentally determined and the quantity, C, which represents the amount of heat in kilowatt-hours required to bring the motor to a certain limiting temperature, is definitely known. The radiating rate, R, at this temperature in kilowatt-hours, is also made determinate, and it is assumed that $C \div R$ represents a constant which, when multiplied by the heat in the motor at any given time, will give the rate of radiation at that time. This proposition is true if the rate of radiation is proportional to the temperature, which is also assumed to be proportional to the amount of contained heat in the motor. This amount of heat is readily determined at any given time by integrating a loss curve with reference to time and dividing by the elapsed time, subject, if necessary, to certain corrections. If the contained heat in the motor is known, multiplying by the constant will give the rate of radiation, and if the motor is to ascend a grade where it will be overloaded—that is to say, where the heat given to the motor is greater than the maximum rate of radiation—the difference between the contained heat and the total heat capacity represents a reserve which must not be exceeded. Therefore, dividing this reserve heat capacity by an average rate of radiation, which is mathematically determined by the given data, will give the time that the motor will operate under this overload before reaching the limit temperature. The author suggests empirical modifications of the formulæ and method of testing for developing and refining this system of measurement.

Electrical Progress in Japan.—The last mail from Tokyo, in Japan, has brought us some newspaper cuttings which show the great opening there is in that country for electric light and tramways. From these we see that the Tokyo Electric Railway Company is paying a dividend of 26 per cent. per annum, which indicates a success not often attained in this country. In Tokyo at the present time there is no other means of street communication, if we except a small line of horse cars, and it would be a matter for great surprise if the electric cars did not pay handsomely. The field in Japan for electric traction is certainly a large one. There is water power at various places, plenty of coal, and labour is cheap. In electric lighting the country is just in the same primitive position as it is in regard to electric trams, but what electric lighting undertakings there are are proving most successful. To quote the case of Tokyo again, the company which is conducting the electric lighting business in that place paid a dividend at the rate of 10 per cent. per annum for the last half year, the net profit being £13,700. Some progress in electric traction in other parts of Japan is shown by the announcement of the Yokohama Electric Tramway Company to commence work in the construction of an electric system in that city, but enterprise in this direction is at present very slow. There also appears to be a great want in Japan of electric railways. From the reports before us it does not seem that the country is very well served by the steam railways, which in some cases are barely able to give accommodation to passengers and carry on their goods traffic at the same time. We are sure that the presence of a few enterprising electrical engineers in Japan would do much to remedy the present inanimate state of affairs in regard to electric lighting and traction. An amusing incident is recorded in connection with the electric tramways running between Kozu and Yumoto, which shows the spirit in which the peasantry regard the electric cars. It seems that a man living in a village through which the line passed was unfortunate enough to have his legs crushed under the wheels of an electric car. Immediately his fellow-villagers assembled around the tramcar, and were wreaking their vengeance on the vehicle, which had apparently brought about similar mishaps before, when the police put in an appearance and succeeded in suppressing the disturbance.

Lord Rayleigh on Sound.—The Friday evening discourse at the Royal Institution last week was delivered by Lord Rayleigh, who took for his subject the "Interference of Sound." The first part of the lecture was devoted to some experiments illustrating the interference of sound, and using a bird-call as his source of sound and a sensitive flame as his detector, he showed how the phenomena of interference could be used to measure the wave-length of a sound which was too shrill to be heard

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by the human ear. Lord Rayleigh proceeded to speak of the experiments which he has recently been making with fog-horns for Trinity House. He found that advantages were to be gained by using elliptic cones instead of the circular ones hitherto employed, and he demonstrated by experiment that the sound was best spread in a horizontal direction when the long axis of the cone was exactly vertical, the sensitive flame used as a detector showing a remarkable falling-off in the effect whenever the cone was turned a very small distance from the most favourable position. He next discussed the phenomena of the "silent area" in which the sound might be inaudible at, say, a mile from the source, yet be heard again at two or three miles. The obvious explanation was that it was due to interference, and it was certainly possible that sound-waves reflected from the sea might be different in phase from those travelling direct, when they reached the observer, and thus neutralised each other. But he was doubtful whether this was the true explanation, for if it was, the observer would always be able to recover the sound if he altered his position by going up to the masthead or nearer to the water. But Lord Rayleigh had tried this device several times on board the "Irene," and had in every case failed to recover the sound. He then showed some experiments with two sources of sound, and said that here again it was a question of distance whether the effect perceived by the observer was reinforced by combination of the two or neutralised by their being out of phase. In the latter case cutting off one of them would actually render the effect stronger. The travel of sound was also affected by the medium through which it travelled—*e.g.*, it moved more slowly through carbonic acid gas than through air. His general conclusion was that the effect perceived by the observer was not necessarily increased in amount by increase in the number of sources of sound brought into use; the result depended on whether the sound-waves issuing from them reached the observer's ear in phase, so as to strengthen one another, or out of phase, so as to neutralise one another.

Incandescent Lamps.—The satisfaction or dissatisfaction felt by consumers of electric light with the illumination they obtain, is intimately connected with the type of incandescent lamp which they use. Although a large number of consumers recognise this, and have, after considerable trouble, arrived at the conclusion that it is best to pay a fair price for a good lamp than to obtain the cheapest lamp in the market, there still remains a large number of consumers who look upon an incandescent lamp merely as an incandescent lamp. They are also freely canvassed by the agents of foreign lamps, who bring with them instruments, the use of which is quite unintelligible to the consumer. The result too frequently is that lamps are bought at a low price and of an exceedingly low efficiency, or perhaps they are lamps of a type which, while giving a comparatively high efficiency for the first few hours' life, quickly blacken and become exceedingly costly transformers of electrical energy into light. We have recently had one such instance brought to our notice in which the dissatisfaction expressed by a consumer with his electric light was wholly due to the inferior lamps which he employed, and which, although giving him barely half their normal candle-power, were considerable consumers of electrical energy. It is, of course, one of the duties of a central-station engineer to advise customers on the question of lamps, but with the large growth of the supply undertakings the intimate connection which used to exist between engineers and those they supplied is considerably lessened. The right solution appears to us to be for the central-station engineer to adopt the American practice of supplying incandescent lamps free of charge to consumers. This has already been done by certain municipal undertakings with great success, and although it may bring up the cost per unit to a slightly higher figure, the economical result is assured. These lamps should be given out in proportion to the energy consumed, and the central-station engineer, purchasing in large quantities, is able to ensure both a cheap and economical lamp to all his consumers. At the same time, by issuing lamps in the way suggested, the consumer has nothing to gain from the too frequent practice of leaving lamps in circuit long after their efficient periods of life have been passed. In these days of strong competition between the incandescent gas and electric lighting, this question of the supply of lamps by the undertakings is one of extreme importance, and we commend it to the consideration of all central-station engineers who find such competition in any way hampering the extension of their businesses.

Costs and Charges in the United States.—The *Electrical Review* of New York for the 4th inst. publishes some interesting averages of electric light costs and charges in the United States. The first matter considered is the price of fuel. Our contemporary has discovered, as the result of a large number of enquiries to representative electric light stations in the States, that the highest price paid for coal is 24s. per ton, and the lowest price 4s. per ton. The average price of coal paid by stations representing all but a few States is about 11s. 6d. per ton delivered at the plants. Concerning water power, we find that 20 per cent. of the stations considered use water power either wholly or in part for power production. As regards the basis of sale of power, about 9 per cent. of the stations adhere to the old contract system, 4 per cent. use both the contract and meter basis, while 87 per cent. use the meter basis entirely in determining their charges for supply of current. The next matter considered by our contemporary is the basis of charge. This is in many respects the most interesting of the figures obtained. The highest basic rate of charge made anywhere in the United States is 10d. per kilowatt-hour, this rate, however, being confined to a few stations in the Eastern States. The lowest minimum rate charged is one halfpenny per kilowatt-hour. Only one such case exists, however, this rate referring to a water-power plant operated in connection with a long transmission line, and supplying customers with power for general purposes, including electric tramways. The average base charge per kilowatt-hour through the United States is 6d., while the average minimum charge to large consumers is 2½d. Assuming that the price of fuel is a fair indication of a reasonable basis of charge, it will be seen that the rate per kilowatt-hour figures out at about 4 per cent. of the cost of a ton of coal. In other words, the average efficiency of conversion of coal into power is at the rate of one ton for 20 kw. sold. On the same basis, the average minimum is 1·7 of the cost of coal, representing an apparent maximum efficiency of conversion of one ton of coal into 59 kilowatt-hours. An examination of the data collected by our contemporary, however, shows that there is little apparent connection between the price paid for fuel and the amount charged for power. For example, a station paying 20s. a ton for coal has a basic rate of 5d., with a minimum of 1d., whereas another station paying only 4s. a ton for coal has a basic rate of 7½d. and a minimum charge of 2½d. It seems, therefore, that the cost of fuel is not the determining factor in the output cost of electric current in the States, but that some other element prevails, or else that the subject has never received that scientific investigation which it deserves.

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Telegraphic Interruptions.—Representing the Postmaster-General in the House of Commons, Mr. Austen Chamberlain at question time on Tuesday gave some official information with regard to the breakdown of telegraphic communication in November and December last. Replying to questions put by Mr. Renwick and Sir John Leng, Mr. Chamberlain stated that the loss of revenue from the November interruptions was about £2,500, and from the interruptions in December about £5,500. The cost to the Post Office of making good the November breakages was about £2,500, and the December repairs will probably cost nearly £27,000. These sums do not include the expenses incurred by the railway companies in carrying out their obligations to the Postal Department. Mr. Chamberlain further remarked that it would not be possible to prevent interruptions, but that the Postmaster-General hoped the measures which have been taken to strengthen the lines and to provide reserve wires would render them less serious. The continuation northwards of the Birmingham underground line would be of great help. The latter part of this statement is repeated in a letter from Lord Londonderry to Sir John Leng, with reference to the latter's proposal, that a submarine cable should be laid along the East Coast, say from Harwich to Aberdeen, from which branches could be taken to Hull, Newcastle, Leith, Dundee, and Aberdeen. The Postmaster-General asserts that the underground line to the North which is now being laid will afford security against the interruption of telegraphic communication with the northern towns and Scotland, and increase the stability of the telegraphic service generally. He points out that a submarine cable of the character suggested would cost about 50 per cent. more than the underground line to the North, and would afford no security to Birmingham, Manchester, Liverpool, Leeds, or Glasgow. The underground line is now approaching Stafford, and will be extended as soon as possible to Warrington, whence there are underground wires already to Liverpool and Manchester, and the scheme will be so carried out as to fit in throughout with the overground system, and be available for making good interrupted aerial wires at a great many points. Referring more particularly to the financial side of the question, Lord Londonderry shows that submarine cables would be more costly to maintain, they would be often and for considerable periods interrupted, and they would require to be entirely renewed much sooner than the underground line. Another reason is that no satisfactory type of paper-insulated cable for submarine use has yet been produced, and it is still necessary to use guttapercha for this purpose. Therefore, Lord Londonderry concludes, if the Post Office resorted to submarine cables, they would lose the advantage in electrical efficiency which they have gained in the underground line by the adoption of paper-insulated wires.

The May-Oatway Fire-Alarm.—Nearly 10 months ago now we had the pleasure of describing in the *Electrical Engineer* (vol. xxvii., p. 704) the automatic fire detector and position indicator of the May-Oatway Fire Appliances Company. What we believe, however, to be the first demonstration in London of the company's system as installed for actual service in a public building was given last Friday afternoon at Ilford Town Hall. The attendance, which was very large, included representatives of the War Office, the Board of Trade, the London County Council, the London Fire Brigade, and some of the principal insurance companies, while a number of engineers had also accepted the invitation of Sir Eyre Shaw and the other directors of the company to witness the interesting demonstration. The new town hall at Ilford has been installed throughout with the May-Oatway fire-alarm system, and the tests on Friday last were the final trials before the Municipal Council formally take over the installation from the company. For a detailed description of the system we must refer our readers to the article mentioned above. It is sufficient for our purpose at present to state that the May-Oatway apparatus consists of a thin copper wire, which is stretched near the ceiling of the room to be protected. At its centre is a vertical wire carrying a weight, which is so adjusted that when the stretched wire has reached the temperature decided upon as implying danger, the increased sag due to the expansion of the wire allows the weight to drop sufficiently to close an electric circuit. This instantly sets the alarm-gong ringing, and automatically telegraphs to the fire station with which the installation is connected. Only a sudden increase in the temperature of the room, such as occurs in the case of an outbreak of fire, will affect the apparatus, because a compensating bar of steel is used as the support to keep the margin between safety and danger the same both in winter and summer. It may be mentioned that the contact arrangements as finally adopted consist of two platinum springs slightly separated, between which a wedge-shaped block of hard carbon, forming part of the suspended weight, is forced, making a rubbing contact. The results of the tests, which we witnessed on Friday afternoon, were satisfactory in the extreme. The first part of the town hall tried was the platform, which, owing to the greater element of danger from fire, has been fitted with three of the apparatus described above. The conditions of an actual outbreak in this part of the building were obtained by means of spirit fires, which were lighted at intervals of 10 seconds in order to represent as nearly as possible the progress of a fire. In exactly 1¼ minutes the alarm was given, and the caretaker had reached the fire from the top of the building, where under ordinary circumstances he would be at night time. A minute and a quarter later the fire brigade had arrived, and the hose had been run in and ready for action. Thus, in the space of 2½ minutes from the outbreak everything was ready for subduing the flames. This first test was conducted by Messrs. C. E. May and G. H. Oatway, the inventors of the system; but in order that it might be subjected to a perfectly independent trial, a committee was formed out of the gentlemen present to carry out the others. The most searching test of all was that made in the hall itself, where are two of the apparatus fitted close up to the ceiling at either end. In order that the conditions might not be unduly favourable to the successful working of the system, the windows were left open. The spirit fires were lighted at the same intervals as before, and it took exactly 2 minutes 16 seconds from the outbreak before the alarm was given. The caretaker or house-fireman arrived 24 seconds later, and had his private hose ready by the time the brigade put in an appearance, precisely 2 minutes 59 seconds after the outbreak. This achievement was considered most satisfactory, both from the point of view of the time occupied in raising the alarm under the existing conditions, and the efficient working of the system. The Council-chamber having been subjected to a similar trial with comparatively equally successful results, the testing of the apparatus installed in the other parts of the town hall was only a matter of time. At length the committee, having religiously carried out the duties assigned to them, reported that without exception the tests had been thoroughly satisfactory. We are pleased that the May-Oatway apparatus is to have such a full trial at Ilford, and trust that faithful records of its working will be kept.

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TESTS OF THE BOLTON 1,100-KW. DYNAMOS.

On Thursday of last week we were invited by Messrs. Dick, Kerr, and Co. to witness the tests of the two direct-current dynamos which they are supplying to the Bolton Corporation for lighting and tramway purposes. These machines were being tested by the Hopkinson method at the works of the English Electrical Manufacturing Company at Preston, and besides witnessing a portion of the trials, we were able again to look round these interesting works. When we first had the opportunity of visiting the same the manufacture of tramway motors was in full swing, but now the heavier machine tools employed for the manufacture of large continuous-current generators are at work.

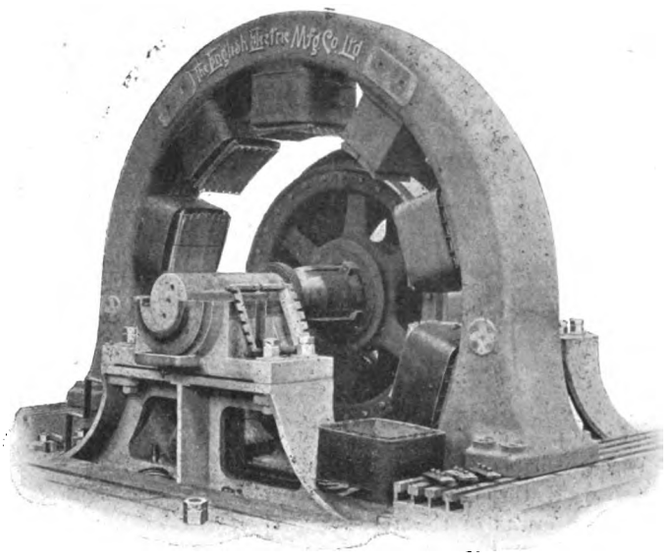

FIG. 1.—Complete Magnet Frame of Typical Dynamo of the English Electric Manufacturing Company, Limited.

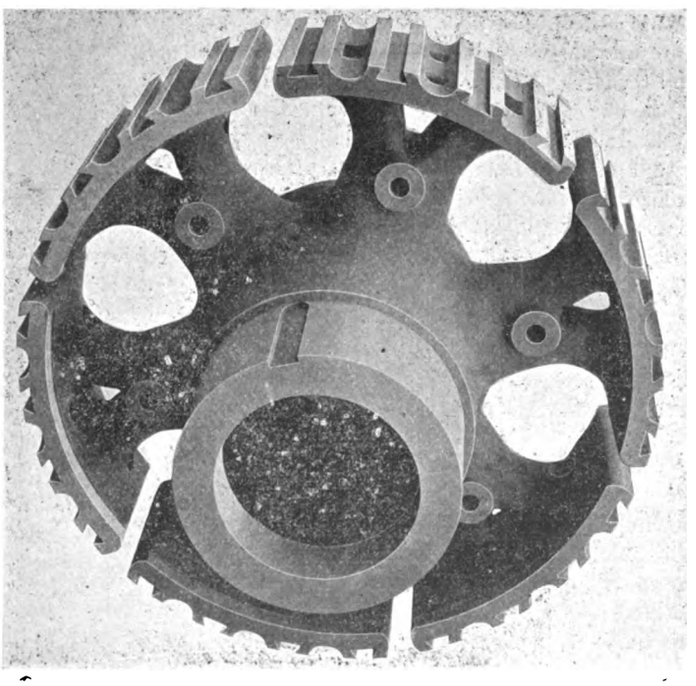

FIG. 2.—Armature Spider, showing Sleeve for Supporting Commutator.

These two dynamos for Bolton may be looked upon as typical examples of the type which the company is turning out in various sizes, and hence a somewhat detailed description of the construction of these machines will be of interest before proceeding to the tests which we had the opportunity of witnessing. This description of the details ought really to commence in the pattern shop and store, where we saw the patterns from which the large frame castings are obtained. The magnet frame is in two halves, dividing on a horizontal diameter, and the pattern is so arranged that both the upper and lower half can be cast from it. In order that this may be done, the two feet required in the lower half are made removable. The field magnets supported by this frame are built up of laminated steel, and they are cast in. When we proceeded into the foundry, we found this method of casting in actual operation, and were impressed with the care which is taken to secure a good magnetic connection between the steel laminations and the cast metal. When the mould has been formed and the laminated magnets placed in position, they are then heated up to a considerable temperature by means of brazier fires of coke placed on them. In this way, when the metal is poured it is not chilled by the surface of the laminations, but produces a welded joint which has a very low reluctance—in fact, the whole arrangement of the foundry, with its special facilities for turning out these magnet frames, impressed on us the advantage which it is to an electrical firm to do its own casting work. We understand that in this department the English Electrical Manufacturing Company propose to go still further, and to lay down a plant for steel casting. In this way they will be free from the annoyance and delay which frequently results from a dependence upon independent steel firms for tramway motor castings, etc.

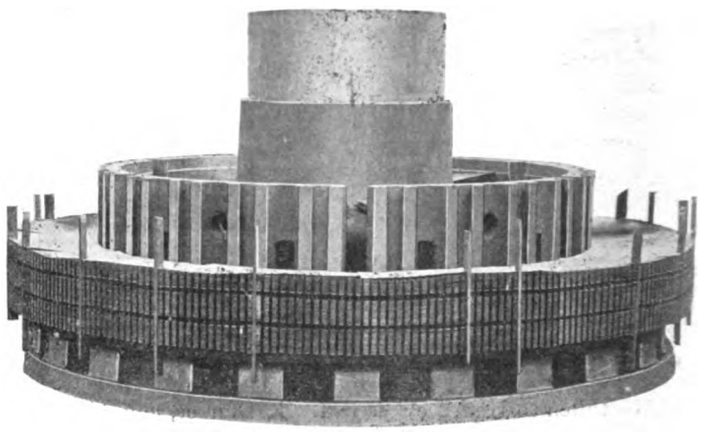

FIG. 3.—The Armature Core in process of Building, showing Segmental Plates.

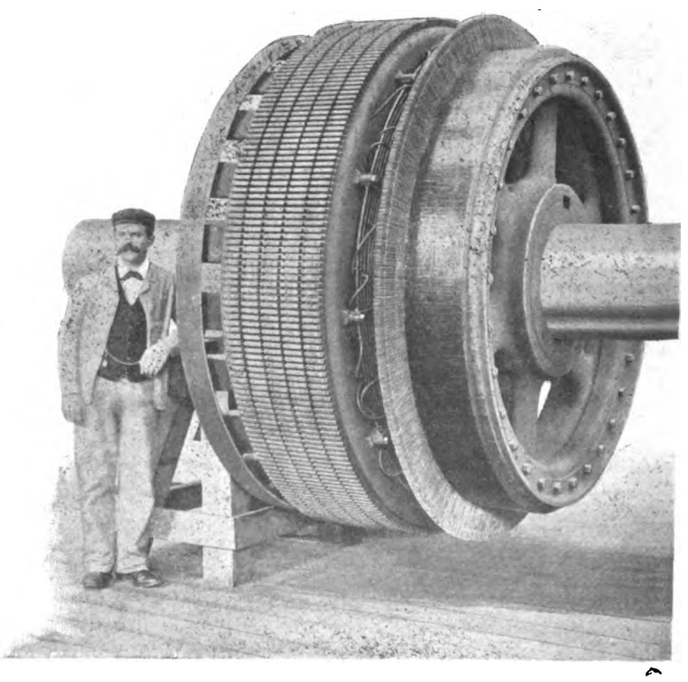

FIG. 4.—Completed Core, ready to receive Armature Coils. The equalising rings can be seen between the commutator and armature core.

The steel laminations which build up the magnet poles are prepared in the main shop. The punching machines for cutting up the same to a uniform shape require to be

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somewhat heavier than those for the armature laminations, as they have to deal with thicker plates. The poles are provided with detachable shoes, which act as a support for the field coils. These coils are wound upon steel bobbins having brass ends. The shunt and series windings are placed, as a rule, side by side, and the arrangements for bringing the ends out are excellent. The shunt coil is insulated from the series coil by a combination of mica and paper, and ¼in. of the same insulation separates both these windings from the bobbins. In the drying of these coils great care is taken, and they are frequently in the baking ovens for several days. The result is that while all moisture is expelled, the varnish is also hardened, and thus prevents the re-entrance of moisture after the coils are again under normal atmospheric conditions. A complete magnet frame with armature removed is shown in Fig. 1.

We now come to the most important part of the machine—*i.e.*, the armature. In Fig. 2 is shown an armature spider, and the method adopted to ensure that this casting shall not break due to a combination of the working stresses and those due to shrinkage in casting.

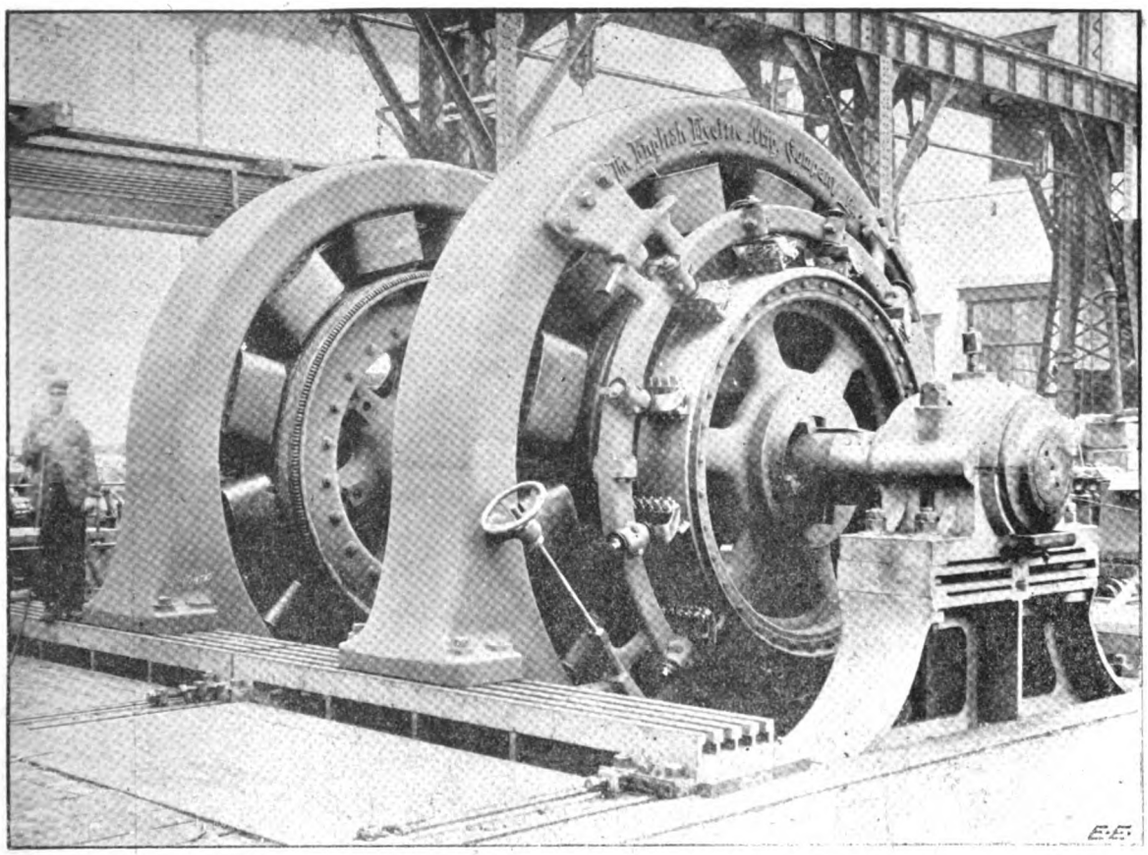

FIG. 5.—The Bottom 1,100-kw. Dynamo on test. The girders supporting the field can be shifted to support either larger or smaller dynamos, and packing under the bearings gives the necessary vertical adjustment for the shaft.

To this end each arm carries an independent portion of the peripheral support for the core plates. The process of building up these core plates is shown in Fig. 3. It will be seen that they key into the recesses of the spider, and hence are individually supported against centrifugal action. Before being placed in position the steel laminations are first annealed and japanned in order to reduce as much as possible hysteresis and eddy-current losses. At intervals of between 3in and 5in. ventilating plates are inserted in the core to allow of air currents passing out through the same. These plates are of thicker steel than the ordinary core plates, and they have bosses impressed in them which serve to keep the core plates about ½in. apart. Also the outer edges of these plates have teeth cut in them in the same way as the ordinary plates, but the teeth are twisted by hand through 90deg., so that they may support and keep apart the outer edges of the teeth of the ordinary core plates. In this way a cheap and efficient distance piece is secured between the core plates, affording ample ventilation. The armature conductors are all former wound, so that they are quite interchangeable. They are insulated from the core by means of a special material, largely consisting of mica, which is impervious to moisture. Fig. 4 shows an armature core built up all ready to receive the former-wound coils, and this illustration is also useful, as it shows the equalising wires in position between the armature and the commutator. The object of these coils is to secure an equal distribution of the work to be done between the various elements of a multipolar machine. With parallel-wound machines, as illustrated, with 12 pairs of poles, it is impossible to secure an exactly equal distribution of voltage between the various pairs of brushes which have to be connected in parallel. This is so because of slight differences in the magnetic qualities of the various poles. In consequence of this the windings under some poles tend to do more than their share of the work, and it is frequently found that in such machines a fluctuating distribution of the load ensues. This is particularly so with machines with magnetic circuits of low reluctance. It soon reaches a point in which some poles act as motors, while the rest as overworked dynamos, and enormous fluctuating mechanical strains are set up, which tend to wreck the machines. These phenomena, while interesting from a scientific point of view, are disastrous from a commercial standpoint, and are termed "bucking" in America. Mr. Short has by these equalising coils successfully prevented the occurrence of the same. A number of wires, as seen in Fig. 4, are placed round the armature, forming independent complete rings. Connections are taken from each of these to a succession of equal potential points round the commutator. In one machine we inspected at Preston there were eight such rings provided, each with as many connections to the commutator as there are positive brushes. It is found advantageous not to make the distance between the connections from the various rings of equal pitch round the commutator. With these rings so connected, should there be any inequality in the magnetic circuit, alternating currents pass through them, and cause armature reactions which wipe out the effects of the inequality.

The commutator is also carried on an extension of the armature spider, and careful attention is paid in the build-

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ing up of the same. The commutator is designed so that the maximum voltage between adjacent bars is under 10 volts, and at least $\frac{1}{32}$in. of mica is provided. The commutator bars are of drawn copper, and in the event of these bars not being of exactly the right angle to give equal tightness at the top and bottom when built up to a complete commutator, a slight reduction in the thickness of the mica is made so as to be correct for the same. This difference in the thickness of the mica at the top and bottom is obtained by means of a horizontal miller. In consequence of the care thus taken the commutators are exceedingly solid, and do not work loose as the wearing surface is reduced. The brushes for collecting the current from the commutator are made from the purest carbon. They are held in position by brush-holders carried on laminated copper strips, having an easy adjustable pressure. The brush-holders are so designed that no moving joints carry the current, and are mounted on a massive rocker ring supported by four brackets attached to the generator frame. All the brushes can be rocked simultaneously by means of a hand-wheel and screw geared to the brush rocker ring. Two massive copper cross connecting bars, placed inside the brush rocker ring, collect the main current from the brush-holders and deliver it to a connection board at the bottom of the machine. The support of the brushes terminate in a spindle passing into an insulated hole in the rocker ring, and this comes directly opposite the centre of the commutator. Thus, if the direction of rotation

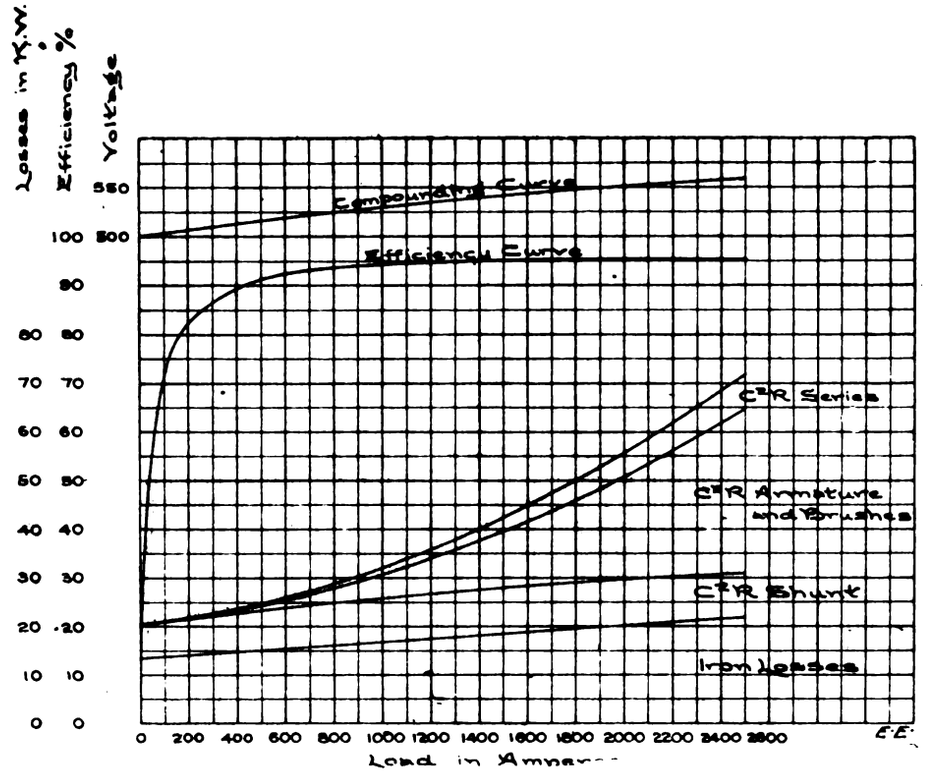

FIG. 6.—Efficiency and Loss Curves for the 1,100-kw. Bolton Dynamos.

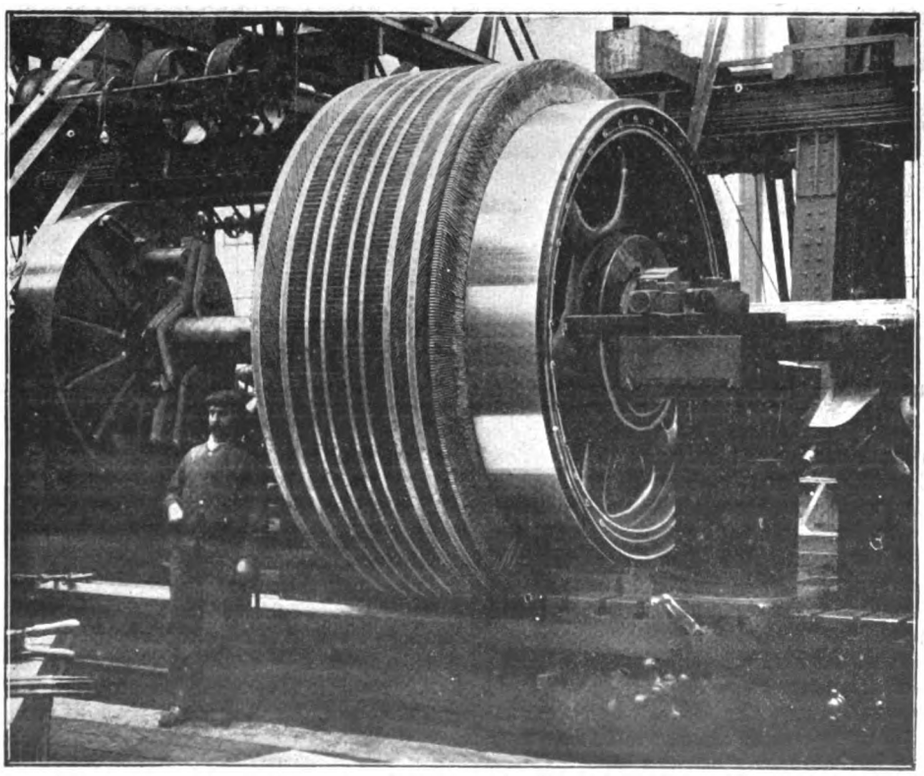

FIG. 7.—One of the 1,100-kw. Armatures in the Lathe after the final Turning-up of Commutator.

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has to be reversed, it is only necessary to turn round this spindle through 180deg. to get the brushes correctly placed again. We noticed that the carbon brushes on the Bolton machines were placed at an angle of about 10deg. from the vertical to the commutator, and against the direction of rotation.

We now come back to the Bolton machines, which were designed for a normal output of 1,100 kw. at 550 volts. They are compound wound, and will be placed between the cylinders of Musgrave engines running at 100 revolutions per minute. When we witnessed the trials, however, they were being run at 50 per cent. overload—*i.e.*, 3,200 amperes. The erection of such large machines for trial in a manufacturer's works is no slight undertaking. We were pleased to find, however, that the company above mentioned has made arrangements by which it can test even larger dynamos on the Hopkinson method. The arrangement is shown in Fig. 5. The shaft, running in three bearings, is considerably smaller than the bore of the armature spider, and supports the same by means of wedges and distance pieces which are secured in large keyways. The result is that any machine between certain outputs can be mounted on this same shaft and thoroughly tested. For instance, these two Bolton dynamos were on trial three days last week. They were completely erected on the Wednesday, and then for an hour under a load of 2,900 amperes on the Hopkinson method, using one machine as a motor to drive the other as a generator, while the losses in both machines were supplied from the works mains. On Thursday morning, the 16th inst., a series of tests were made in order to divide up the losses, and the results of these tests are given in Fig. 6. While these curves give the losses at all loads, it is interesting to see how they stand at the normal output of machines, 1,100 kw. or 2,000 amperes. Taking off the successive components along this ordinate, we find that the following are the figures in watts and in per cent. of the useful output:

	Watts.	Per cent. of full load.
Hysteresis loss in core	1,350	1·23
Eddy currents and friction	650	·59
Shunt excitation	950	·86
Armature resistance and brushes	2,150	1·96
Series coils	500	·46
Total	5,600	5·10

On Friday morning, the 17th inst., the machines were again started under a load of 2,200 amperes, and allowed to run continuously under this load during the whole day until the rise in temperature, indicated by both the thermometers and the voltmeters across the fields, showed the temperature to be constant. The machines were then shut down and the temperature of the various parts taken by the thermometer in the usual way. The results were as follows:

Atmospheric temperature, 58deg. F.
Motor armature, 105deg. F – 58deg. F. = rise 47deg. F.
Motor commutator, 96deg. F – 58deg. F. = rise 38deg. F.
Motor field, 110deg. F. – 58deg. F. = rise 52deg. F.
Generator armature, 103deg. F. – 58deg. F. = rise 45deg. F.
Generator commutator, 95deg. F. – 58deg. F. = rise 37deg. F.
Generator field, 116deg. F. – 58deg. F. = rise 58deg. F.

The total weight of machine equals 127,000lb., or 56 tons, of which the armature accounts for 21 tons and the fields for 35 tons.

The above tests were only partially witnessed by us, as we were only at the works on the afternoon of the 16th, but the results we took personally confirms the plotted result on the curve. It is interesting to add that these direct-current generators are finding great favour amongst purchasers, as the following orders are now passing through the shops: London County Council, 15,000 kw.; Cape Town, 1,600 kw.; Perth (Australia), 550 kw.; Ilford, 1,200 kw.; Bolton, 2,200 kw.; Birkenhead, 500 kw.; St. Annes, 200 kw.; miscellaneous, 600 kw.; or a total of 21,000 kw. The securing of large Colonial orders for these is worthy of special note, and both Messrs. Dick, Kerr, and Co. and the English Manufacturing Company are to be congratulated on the same.

GUARD WIRES ON TRAMWAYS.

The Board of Trade in December last notified a proposed alteration in its rules as regards guard wires, and asked for the observations on the same from tramway experts. The existing regulation reads: "Efficient guard wires shall be erected and maintained at all places where telegraph or telephone wires cross above the electric conductors of the tramways." And the proposed new regulation is as follows: "Efficient guard wires shall be erected and maintained at all places where telegraph or telephone wires unprotected with a permanent insulating covering cross above, or are liable to fall upon, or to be blown on to, the electric conductors of the tramways."

The explanatory memorandum as made by the Board is as below:

(*Note.*—The expression "telegraph wire" includes all telegraph and telephone wires.)

Each guard wire must be well earthed at one point at least, and at intervals of not more than five spans. The resistance to earth must be such that a short circuit between a guard wire and a trolley wire will open the circuit breaker, and this resistance should in no case exceed one ohm.

The earth connection should be made by connecting the support to the rails by means of a copper bond. When first erected the resistance to earth of the guard wires should be tested, and periodical tests should be made to prove that the before-mentioned resistance of one ohm is at no time exceeded.

Guard wires should be, in general, of galvanised steel, but in manufacturing districts in which such wires are liable to corrosion bronze or hard-drawn copper wires should be used.

The gauge of the guard wire must be such that it will carry, without fusing, a current of 50 per cent. greater than that required to open the circuit breaker, and the guard wire must be maintained in such a manner that it will at all times meet these requirements.

The supports for the guard wires should be rigid and of sufficient strength for their purpose, and at each support each guard wire must be securely bound in or terminated.

The rise of the trolley boom should be so limited that if the trolley leaves the wire it will not foul the guard wires.

For the purpose of this regulation telegraph lines are divided into two classes—namely, (*a*) wires weighing less than 100lb. per mile; (*b*) wires weighing 100lb. or more per mile.

Diagrams are then given of the guard wires required in different situations.

These, as a rule, are merely indications of ordinary tramway practice, the wires being 2ft. above the trolley wires and 8in. to one side. The chief criticisms made to the above amendments are, we believe, as follows: (*a*) That where telegraph wires are erected after the trolley wires, the cost of guard wires should be borne by the telegraph company; (*b*) that at crossings the tramway authorities should have power to make the telegraph authority substitute underground telegraph wires for those overhead on paying all reasonable cost; (*c*) that guard nets under the telegraph wires should not be confined to the case of wires weighing under 100lb. per mile; (*d*) that when guarding against parallel telegraph lines, a single earth-wire on the trolley wire poles should be used. We are indebted for the above to the secretary of the Tramways and Light Railway Association

BERMONDSEY COMBINED REFUSE DESTRUCTOR AND ELECTRICITY SUPPLY WORKS.

Before these lines appear in print a regular supply of electricity will have been formally inaugurated from an important addition to the already long list of electricity supply stations, destined, we hope, to supply in increasing measure the lighting and power requirements of London. The addition in question is owned by the metropolitan

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borough of Bermondsey, and takes the form, as above indicated, of a combined refuse destructor and electricity supply works. It is claimed that the installation constitutes a part of the most complete and up-to-date municipal undertaking to be found in the United Kingdom. But it is not our intention to test this claim on its merits further than to say it seems to be justified, in that on one compact site off the Spa-road, Bermondsey, are the following municipal properties—viz.: the town hall, baths and washhouses, public library, electricity supply works and offices, dust destructor, flag making plant depôt and offices, stables, mortuary, disinfecting chamber, artesian well, and water-softening apparatus. Incidentally the exceptional facilities thus offered for the efficient supply of electricity to this group of municipal buildings, etc., for lighting, power, and heating purposes will be readily appreciated.

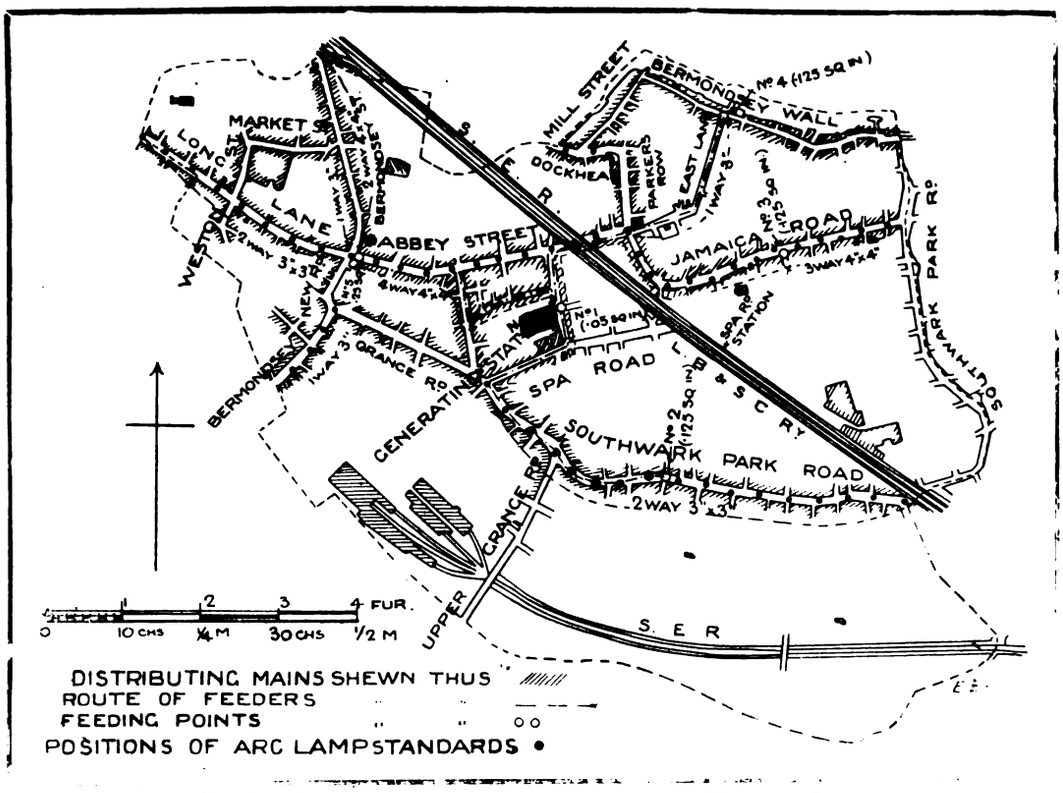

FIG. 1.—Map of Supply Area, showing position of Generating Station and Mains, etc., Bermondsey.

HISTORY OF ELECTRICITY SUPPLY UNDERTAKING.

So far as the history of the undertaking immediately in question is concerned, it may be said to date from 1896, when the late Vestry appointed a special committee to consider and report upon the advisability of applying

FIG. 2.—Exterior View of Station Buildings, Bermondsey.

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to the Board of Trade for a provisional order authorising the Vestry to supply electricity within the parish, and as to the provision of a dust destructor in conjunction with electricity works The next step was to appoint Mr. E. Manville, M.I.C.E., of Messrs. Kincaid, Waller, and Manville, to report upon the matter and to advise the Vestry as to the best method of carrying out the order when obtained. After considering Mr. Manville's report, it was decided on Sept. 21, 1897, to apply to the Board of Trade for an order. Upon the memorial and draft provisional order being deposited with the Board of Trade, notice of intention to oppose the Vestry's application was given by the London Electric Supply Corporation, Limited, the company having powers in the parish, and by the County of London and Brush Provincial Electric Lighting Company, who were themselves applying for an order. An enquiry was duly held by Sir Courtenay Boyle, the above-mentioned companies opposing. However, the Vestry's application was granted, that of the Brush Company being refused. A Bill to confirm the order was introduced into the House of Commons, and read a first time on May 16, 1898. Subsequent procedure showed that the opposition to the order was very far from exhausted. Although the Bill got through to the House of Lords, the opposition had so delayed it as to prevent all chance of its being passed during the session, despite the strenuous efforts of Mr. Fredk. Ryall, the town clerk. Thus, through no fault of their own, the Vestry had to commence *de novo*, and on Oct. 24, 1898, a resolution to apply for an order was passed at a special meeting of the Vestry as required by the Electric Lighting Act, 1882. This time the Bill, having reached its parliamentary stage.

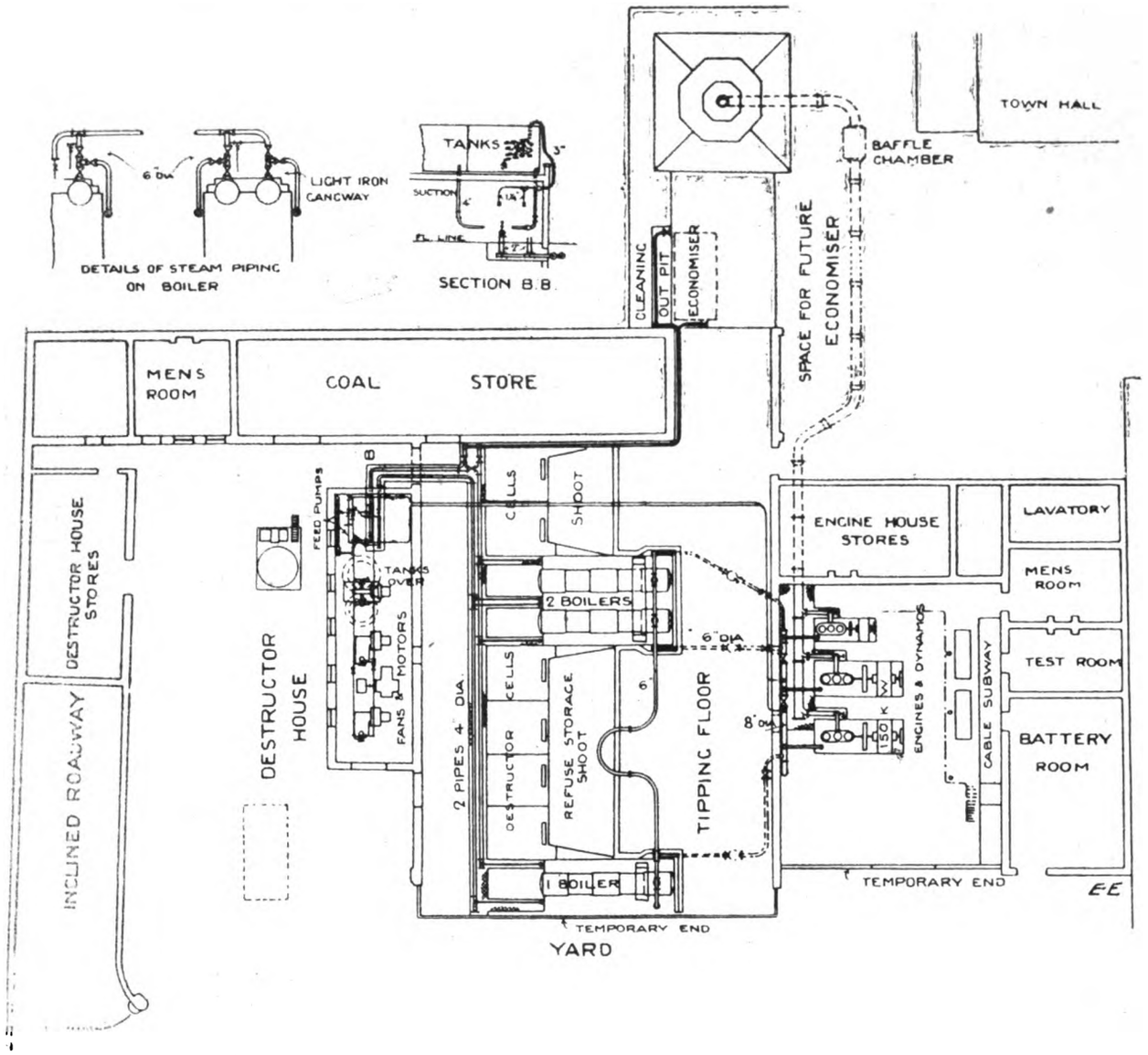

FIG. 3.—Plan of Station Buildings, showing Disposition of Plant and Arrangement of Steam Piping, Bermondsey.

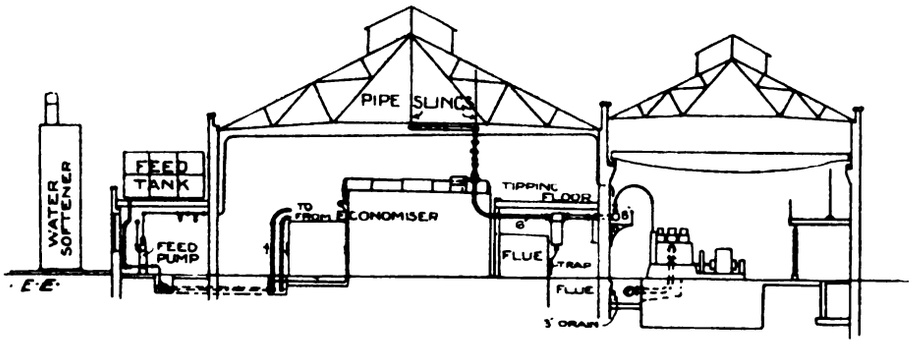

FIG. 4.—Section through Refuse Destructor and Boiler-House, Bermondsey.

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was steered successfully through all opposition, and the order duly confirmed.

Meanwhile, the matter of providing Bermondsey with electricity works best suited to its particular requirements was receiving very careful consideration from the engineer, who was accompanied by a deputation of the Electric Light and General Purposes Committee to many dust

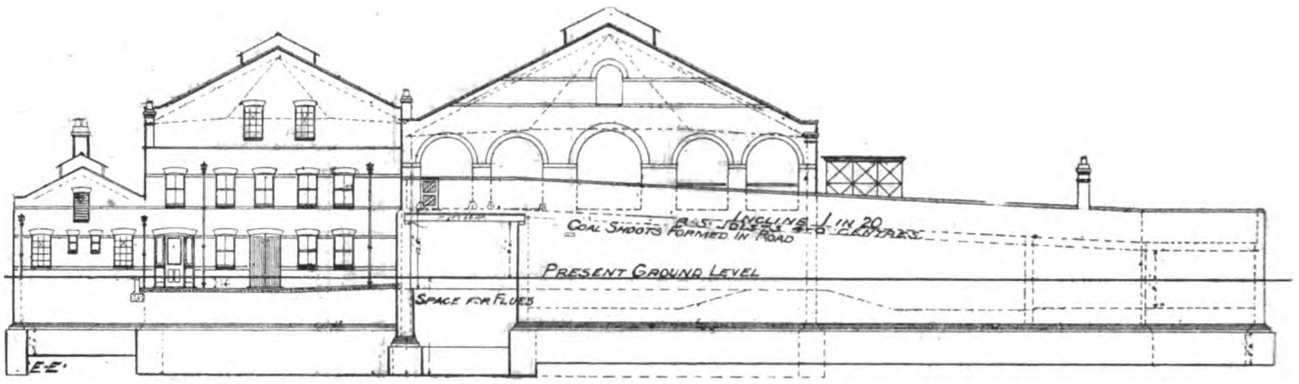
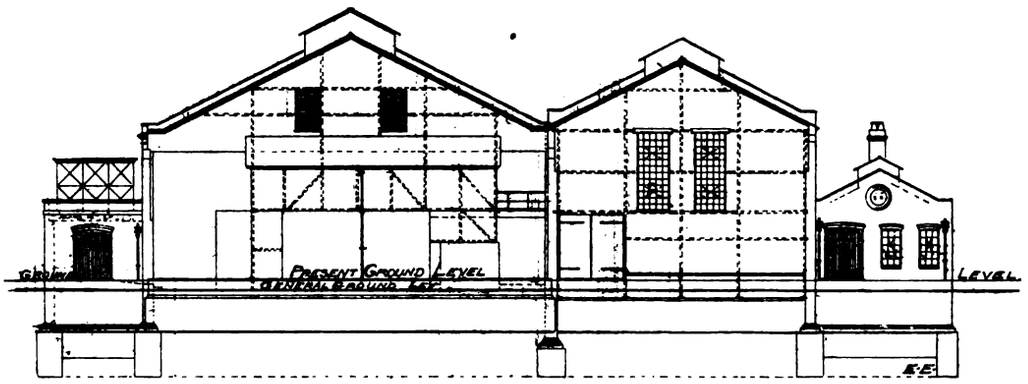


FIG. 5.—Elevation of Station Buildings (South), Bermondsey.

destructor and electricity supply installations throughout the kingdom, one of these being the combined electricity and dust destructor installation erected, under the advice of Messrs. Kincaid, Waller, and Manville, for the Shoreditch Vestry in 1896, the first successful instance of the combination of an electricity supply undertaking with a dust destructor. From the information thus gathered the com-



6.—Elevation of Station Buildings (North), Bermondsey.

mittee, acting on Mr. Manville's advice, presented a report to the Vestry recommending that a combined installation should be carried into effect, and pointing out that the refuse could be burnt at a smaller cost than that incurred by the Vestry in otherwise disposing of it, after allowing for the value of the steam which would be produced from the combustion of the ashbin refuse, while at the same

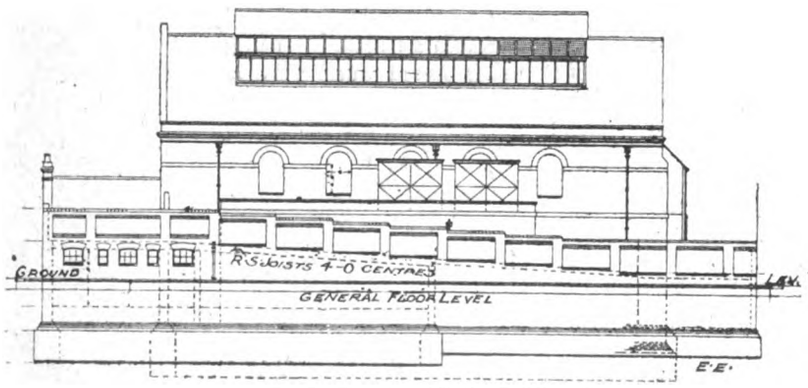


FIG. 7.—Elevation of Station Buildings (East).

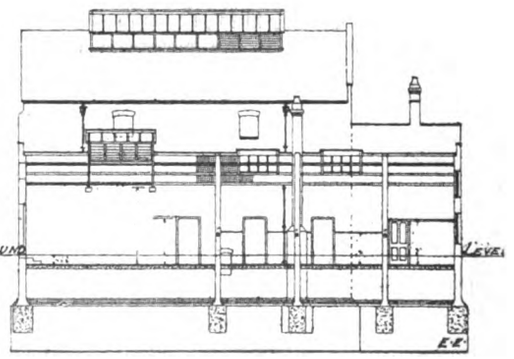


FIG. 8.—Elevation of Station Buildings (West).

time a considerable saving in the fuel required for steam generating purposes would be effected. The Vestry accepted the views of the committee and their engineer, and decided to proceed with the actual construction of the works.

A convenient site was found at the back of the town hall, and in close proximity to the several other municipal buildings already enumerated. This site, as shown in Fig. 1, is situated approximately in the centre of the area of supply, and allows of future extensions to the present buildings. No source of water for condensing purposes is at present available, and the town mains are depended upon for the necessary supply to the boilers. An artesian well in course of construction will provide a duplicate supply. It may be mentioned that the site in question cost £16,500, the purchase money being borrowed from the London County Council at 3¼ per cent., repayable on the annuity system within 50 years. This site having been secured, the Vestry instructed Messrs. Kincaid, Waller, and Manville to prepare plans and specifications for carrying out the combined scheme, and the following is a list of the contractors successful in obtaining the contracts for the different sections of the work: buildings, Messrs. Todd and Newman; dust destructor, with boilers, fans, economiser, chimney shaft, and tipping platform, Messrs. Hughes and Stirling; dynamos, engines, balancer, and booster, Thames Ironworks Company; mains and conduits, Messrs. W. T. Glover and Co., Limited; public lighting and switchboard, Messrs. Crompton and Co., Limited; steam, exhaust, and feed pipes, pumps and tanks, Messrs. Spencer, Limited; accumulators, Tudor Accumulator Company, Limited; water softener, Stanhope Engineering Company, Limited; artesian well, Messrs. W. Brown and Son; wiring generating station and depôt, National Electric Wiring Company, Limited; electricity meters, Messrs. Venner and Co.

Mr. W. H. Vincent, M.I.E.E., who was appointed borough electrical engineer, has, in conjunction with Messrs. Kincaid,

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Waller, and Manville, supervised the erection of the plant and the laying of the mains.

Buildings.

An exterior view of the station buildings is shown in Fig. 2, while we would refer the reader to Fig. 3, 4, 5, 6, 7, and 8 for the general details of the same. The buildings comprise a destructor-house and engine-house, pump and fan room, accumulator-room, and suitable offices.

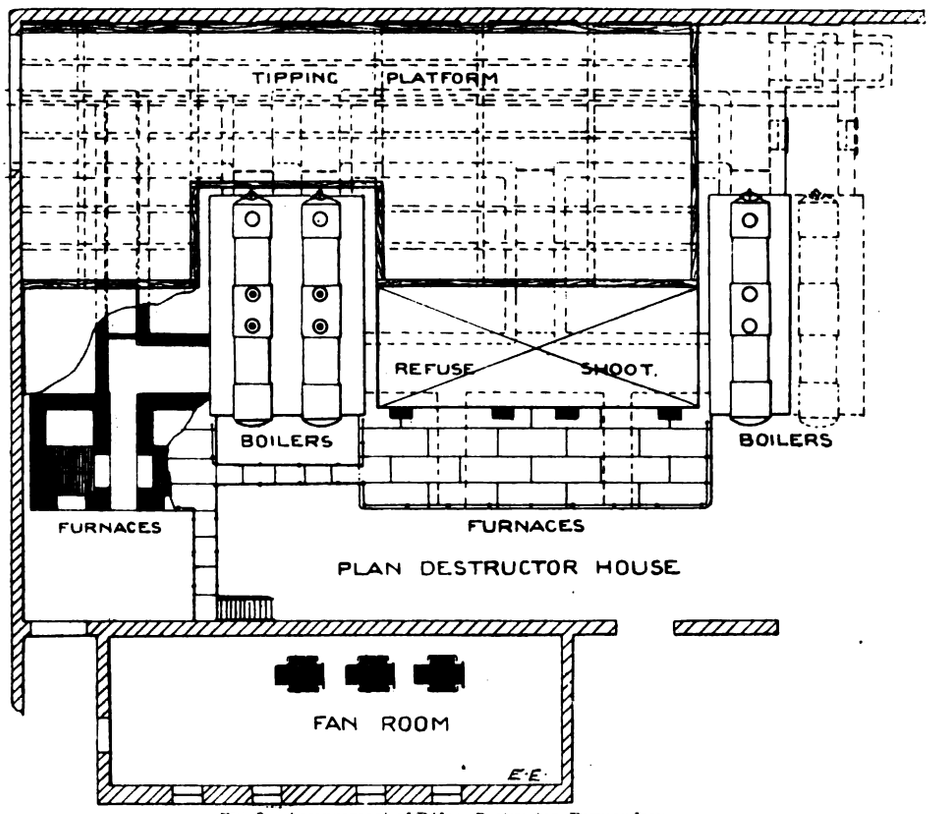

Fig. 9.—Arrangement of Refuse Destructor, Bermondsey.

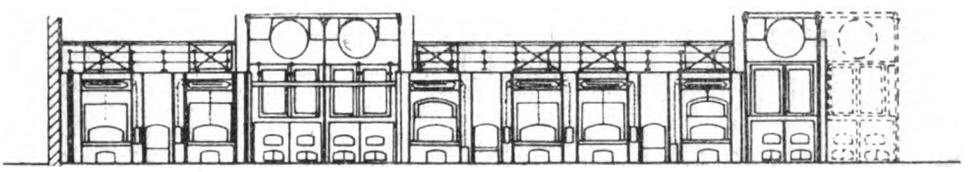

Fig. 10.—Front Elevation of Furnaces and Boilers, Refuse Destructor, Bermondsey.

The engine-house is 50ft. long by 39ft. wide, and has a temporary wall of corrugated iron at one end to facilitate future extension. A spacious gallery is provided along one side of the engine-house to accommodate the switchboard. A travelling crane, capable of lifting 10 tons, has been provided for handling the heavy portions of the machinery. In order to prevent as far as possible vibration from the running of the engines, the whole of the engine foundations have been connected together by a solid mass of concrete 8ft. in thickness, while the engine-house floor has been paved with wood blocks. Off the engine-house are the accumulator, test, store, and engine-house men's mess rooms. The test-room is equipped with a full complement of testing instruments and apparatus required for the calibration of meters. The offices, which are conveniently situated at the end of the engine-house nearest the town hall, are amply commodious for their purpose and well appointed in every respect. A large room is set apart for the use of the shift engineers, and baths are also provided for their use.

The destructor-house is a building 80ft. by 62ft., specially designed with a view to securing adequate ventilation. Off this house is the pump and fan room, as also the coal store, which latter is capable of holding a reserve of 230 tons. In connection with the destructor-house are provided a second store, men's bath and mess rooms. The

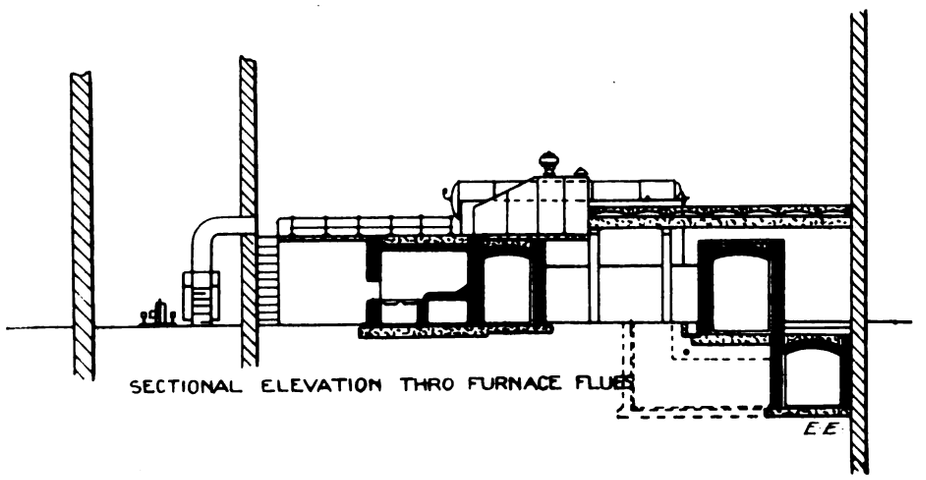

Fig. 11.—Details of Refuse Destructor, Bermondsey.

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chimney shaft is 150ft. high, and of 6ft. 6in. internal diameter at the top. It is lined for one-third of its height with firebrick, and surrounded at its base with a dust-separating chamber. With commendable foresight the Bermondsey authorities placed their contract for the chimney shaft at an early date, thus permitting the construction of the shaft to be carried on at a reasonable rate of progress, and its completion sufficiently early to allow ample time for the thorough drying and consolidation of the structure before being put into regular use.

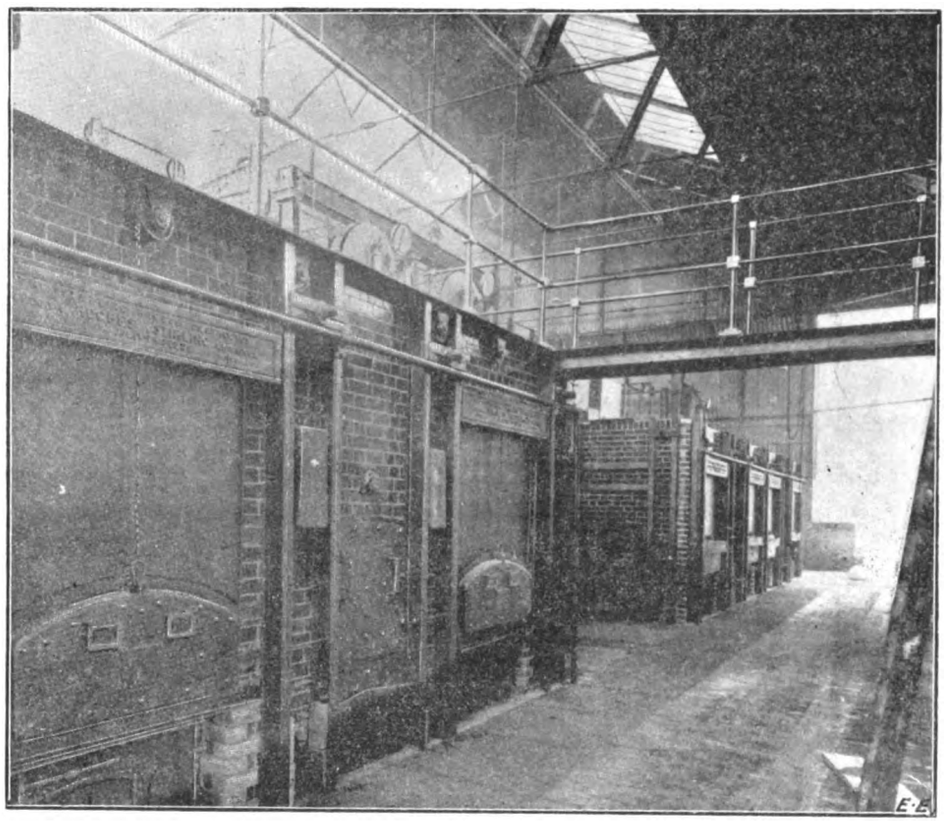

FIG. 12.—Interior of Refuse Destructor House, Bermondsey.

REFUSE DESTRUCTOR, BOILERS, AND ECONOMISER.

The refuse destructor has been built to the designs and under the patents of Mr. A. J. Liversedge, A.M.I.C.E, and the work carried out under his supervision. It may be noted that since the Bermondsey authorities placed their contract for their new destructor they have, by the operation of the recent London Boroughs Act, come into possession of another destructor, that of Rotherhithe, which was also built by Mr. Liversedge when acting as chief engineer for the late firm of Beaman and Deas, Limited. The Bermondsey destructor will be the fourth which Messrs. Hughes and Stirling have put into operation during the past few months, the three others being at Barry, South Wales; Aston Manor, Birmingham; and Morecambe, Lancs. Like so many other London boroughs, the Bermondsey authorities in considering their plans had to face at the outset the difficulty of limited area, and the disposition of their works

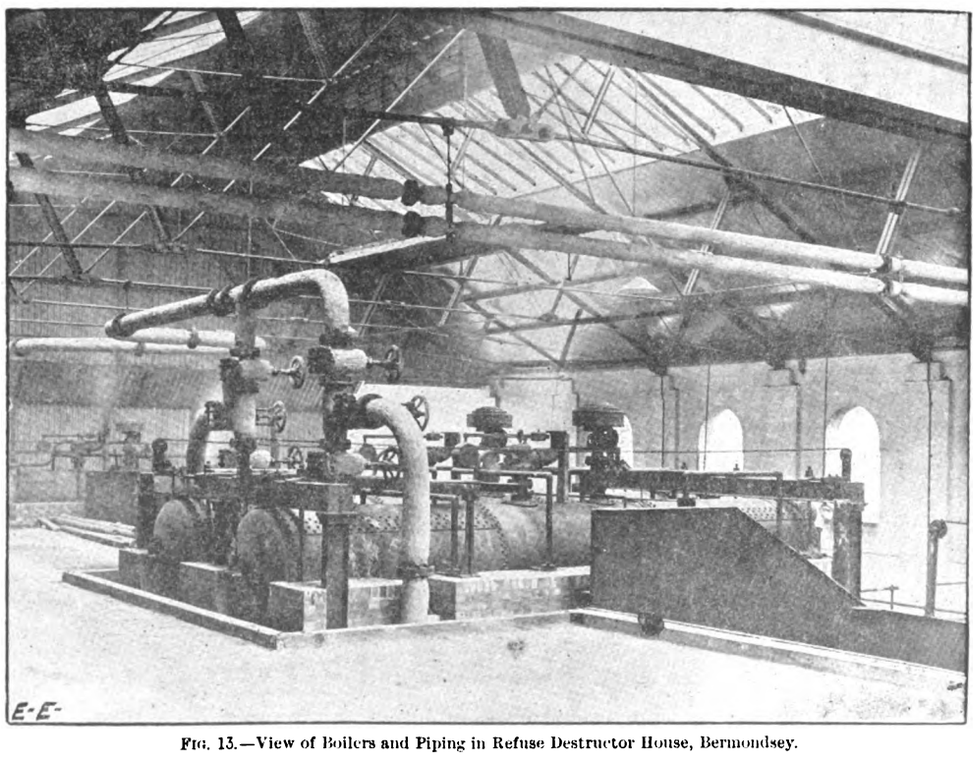

FIG. 13.—View of Boilers and Piping in Refuse Destructor House, Bermondsey.

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had consequently to receive the very careful consideration of their consulting engineers.

The destructor plant proper comprises three pairs of destructor cells, each pair having a large combustion chamber sandwiched between the cells and made large enough to admit, not only mattresses and bedding, but an entire ox if at any time it is required to cremate an animal whole. Three water-tube boilers of Messrs. Babcock and Wilcox's type are provided, each receiving the gases from one pair of cells. From the plan (Fig. 9) it will be seen that the fronts of the cells are parallel with the fronts of the boilers, but that the boilers are set back a considerable distance from the cell faces. The destructor gases from the cells, after meeting and mixing and throwing down most of their suspended dust in the combustion chamber, travel by a throat at the back of the cells to the boiler,

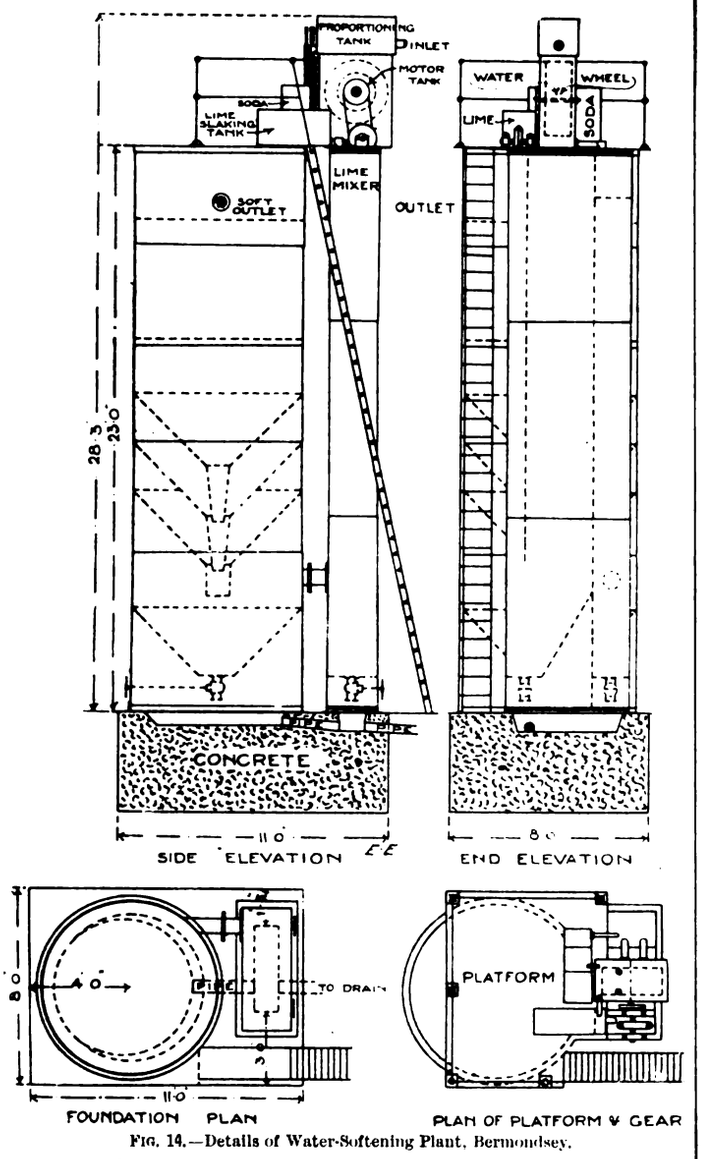

FIG. 14.—Details of Water-Softening Plant, Bermondsey.

which they enter at the side. The boiler fronts are, therefore, left in the ordinary way, and are fitted with the usual coal-burning grates and doors. By setting the boilers back as shown, considerable area is provided in the front of the boilers for the use of the coal stokers. The boilers can, therefore, be fired with coal at any time whether refuse is being burned or not, and under the former condition, without interfering in any way with the working of the destructor cells or the removal of the clinker. Figs. 10 and 11 give further details of the destructor, while Figs. 12 and 13 are interior views of the destructor house.

While it is, of course, intended to utilise the fuel value of the refuse to the utmost possible extent, it may, and probably will, occur in the early stages of the working of the undertaking that refuse will have to be burnt when only a limited amount of steam is required. A complete arrangement of by-pass flues is therefore provided, by which the destructor gases can be taken direct into the main flue at any time. As also it is inevitable that more dust will be deposited in the flues than would be the case were coal only to be burnt, a complete duplicate set of main flues has been built; the by-pass flues being connected to both. This set of duplicate flues extends beyond the economiser, and the gases, whether coming direct from the destructor cells or through the boiler, may go either direct to the chimney or through the economiser. Ample provision is made for the deposit of dust before reaching the chimney shaft and for its ready removal. The tipping platform is placed at the back and partially at the sides of the boilers, this arrangement being necessary in consequence of the limited ground area available. The platform is reached by an inclined approach road. Large wrought-iron bins or shoots are provided for the storage of the refuse. No mechanical appliances for the handling of the refuse have been adopted, the storage and charging arrangements having been designed for use with manual labour, but to minimise the labour required as much as possible.

The plant for providing forced draught to the destructor cells is very complete, consisting of three powerful fans,

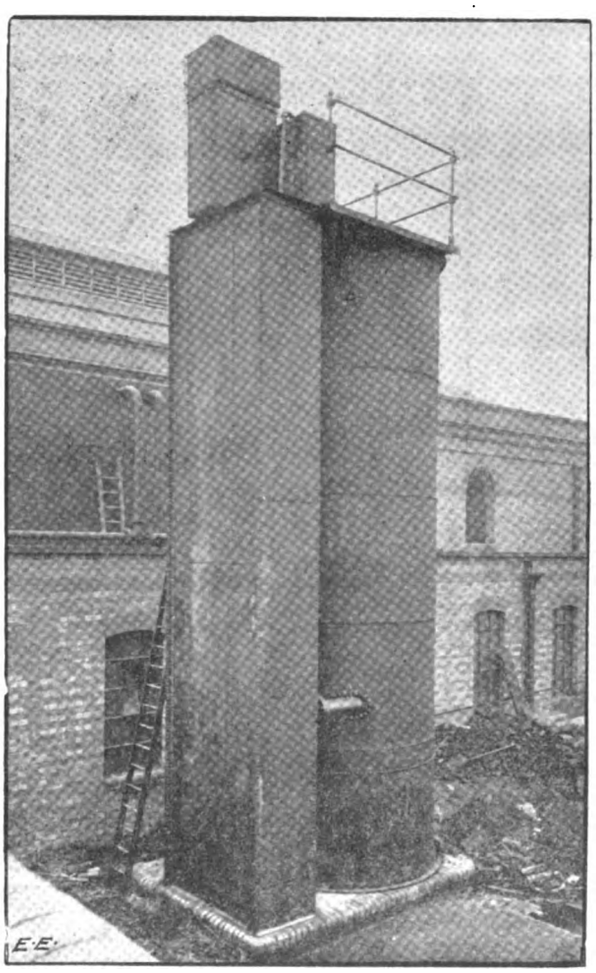

FIG. 15. Water-Softening Plant, Bermondsey.

two being in duplicate and driven by high-speed steam-engines and one driven by a direct-coupled electric motor. It will thus be possible to drive the fans by steam direct during the hours of slack demand for steam in the electricity generating station, and thus minimise losses in conversion. Any two of the fans provided will supply ample air for the combustion at any time. Not only is the forced-draught apparatus connected to the destructor cells, but also to the steam-boilers, whilst the destructor cells are, in addition, provided with steam-jet forced-draught apparatus for use if at any time the entire fan installation is cut off. Each of the destructor cells provided will be easily capable of destroying 15 tons of refuse per day, this amount having, indeed, been considerably exceeded on trial at all the destructors already installed by Messrs. Hughes and Stirling. The 15 tons per day will, therefore, represent a daily destruction of 90 tons, which exceeds the contract guarantee. For the present, at any rate, all the

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steam required by the electricity station is to be generated by the destructor boilers, there being no special supplementary coal-fired boilers. Provision is made, however, for the addition at a future time of a fourth steam-boiler, which may either be arranged to be worked by coal alone, or to have an additional pair of destructor cells attached.

It may be mentioned that the boilers at present installed are of Messrs. Babcock and Wilcox's single-drum type, each having a grate area of about 90 square feet and a heating surface of 2,010 square feet. The boilers are designed for a working pressure of 160lb. per square inch. Each boiler is fitted with an internal steam spray to enable the tubes to be cleaned of soot. An economiser of Messrs. Green's pattern is erected in the main flue. This economiser consists of 200 tubes in two groups. The scrapers are worked by means of a 1-h.p. electric motor, taking current at 500 volts. The refuse to be destroyed is brought in by the collecting vans, and conveyed along an inclined roadway to the tipping floor at the back of the destructors, whence it is discharged into spacious bins placed over the tops of the cells, and from which it is fed as required through rectangular shoots. After passing through these shoots the refuse is deposited on a hearth at the back of the furnace, and is there thoroughly dried before the actual cremation takes place. In connection with the boilers there are two feed pumps of Messrs. Hall and Co.'s differential type, single acting on the suction side and double acting on the discharge side, each capable of delivering 1,800 gallons of water per hour against the working pressure of the boilers. The water is drawn from the supply tank over the pump-room, this tank having a capacity of 10,000 gallons. The tank has a connection to the town water-main, and will also be supplied from the artesian well under construction. The delivery from the pumps is in duplicate, and the pumps are so arranged that either can be connected independently to each of the two pipes. One of these pipes is provided with a connection to the economiser and a by-pass, so that the economiser may be cut out if required. A water-softening plant (Figs. 14 and 15), by the Stanhope Engineering Company, Limited, has been provided for treating the feed water before its admittance into the boilers. This plant is capable of dealing with 2,000 gallons of water per hour.

(To be continued.)

The Opening Ceremony.

The ratepayers of Bermondsey thronged the large town hall yesterday afternoon to witness the inauguration of the municipal electric lighting undertaking and dust destructor works by their Mayor (Colonel S. B. Bevington, J.P.). The ceremony was altogether successful. The Mayor was supported on the platform by the aldermen and councillors of the borough, and there were also present the consulting engineer, Mr. E. Manville; Mr. Henry Cust, M.P. for Bermondsey; Mr. J. C. Macdona, M.P. for the Rotherhithe Division, and other gentlemen, including several members of the London County Council. The interesting proceedings were opened by Mr. Thos. Cox (the chairman of the Electric Lighting Committee), who, after giving an elaborate history of the undertaking, called upon Mr. E. Manville to describe the works. These were afterwards inspected by the visitors (under the guidance of the borough surveyor and the electrical engineer). A short speech from Mr. Cust, who proposed "Success to the Undertaking," immediately preceded the formality of "switching on" the electric light. This was successfully done by the Mayor, who then declared the works and depôt open amidst general and loud applause.

Mr. Macdona having returned thanks to the Mayor on behalf of the visitors for his presence among them that afternoon, the Mayor replied in an amusing speech. A very handsomely gotten-up pamphlet describing the whole works had been prepared by the Electric Lighting Committee, which, besides making an artistic souvenir of the occasion, served to explain to the ratepayers the magnitude of the undertaking which the Borough Council have entered upon. We understand from the electrical engineer that consumers are rapidly coming on to the mains, and it is reasonably anticipated that, together with the numerous promises of support which have been received, and the system of free wiring which the Council propose to introduce, the undertaking will soon be in a flourishing condition. As one means of convincing the ratepayers of the great variety of purposes to which electricity can be put in everyday use, the Council have arranged for an electrical exhibition to be held at the town hall at the latter end of next month.

ELECTRICAL CONTRACTORS' ASSOCIATION.

CONFERENCE OF CONTRACTORS AND MANUFACTURERS.

Electrical contractors and manufacturers met in conference at Anderton's Hotel, Fleet-street, E.C., on Monday afternoon to discuss a matter of great importance to the trade. The contractors, it seems, have a grievance against the manufacturing electrical firms, who, they complain, are in many cases selling their manufactures to private individuals and firms outside the electrical trade at the trade discount. The conference on Monday was convened at the instance of the London Electrical Contractors' Association, with the specific purpose of evolving some plan of future working with a view to giving the contractors some protection against this practice. A number of manufacturing firms responded to the invitation of the association to send representatives to the conference, and a large bundle of letters was read by the hon. secretary (Mr. Ed. J. Hogan) from some of these sympathising with the movement. Among the firms who thus communicated we may mention the following: Messrs. O. Berend and Co., Messrs. Veritys, Limited, Messrs. Witting Bros., the Union Electric Company, Messrs. Crompton and Co., Limited, Messrs. Hands, Limited, Messrs. Drake and Gorham, Limited, Messrs. Williamson and Joseph, Limited, the International Electric Company, the General Electric Company, Messrs. Braulik, the Zurich Incandescence Lamp Company, the Incandescent Electric Lamp Company, Cryseles, Limited, and the Sunbeam Lamp Company. The following firms wrote sympathising with the movement, but declining at present to take an active part in the proposed formation of an association of electrical manufacturers: the Edison-Swan Company, Limited, Messrs. Faraday, Messrs. Siemens Bros., Arc Lamps, Limited, and the Electrical Company. Many of the above-mentioned firms also sent representatives to the conference, as well as the following: the Conduit and Insulation Company, Messrs. Croggon and Co., the Telegraph Manufacturing Company, the Westminster Engineering Company, Messrs. Hodges and Todd, Messrs. Pritchetts and Gold, the India Rubber, Gutta Percha, and Telegraph Works Company, Messrs. Simon, Berry, and Co., the Atkinson Testing Works, Messrs. A. P. Lundberg, the London Electric Fittings Company, the British Thomson-Houston Company, the Stewart Electrical Company, Messrs. Nalder Bros. and Thompson, Messrs. Fuller, Macleod, and Co., and Messrs. Ernest Roberts and Blower.

Mr. W. R. WOODWARD, the president of the London Electrical Contractors' Association, put forward the case for the contractors in clear terms. He contended that such men as architects and consulting engineers had no title to any discount at all from the electrical manufacturer. The shipper also ought only to get the trade discount on goods which the contractor delivered at the ship under bills of lading. It was an abuse of the privileges of the trade that electrical goods should be sold to the shipper at the trade discount for private use. As regards municipal authorities, he urged that prices were being cut largely through the action of these authorities in endeavouring to induce consumers to take their current by wiring their houses free of cost. Under this system of free wiring, the contractors were asked to do the work at such a price that it was impossible for them to live at. He concluded by moving the following resolution: "That this meeting of manufacturers, supply houses, and contractors consider that the best interest of the electrical trades will be served by manufacturers and supply houses adopting the principle of allowing no one outside the recognised electrical trades

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a greater percentage of discount than one-third of the trade discount, and that electrical trades shall mean any house carrying on business as such or that have a department under the superintendence of a duly qualified man."

A long and animated debate ensued on this resolution. The manufacturers, on the whole, appeared to be in sympathy with the contractors, but were unable to suggest a course that would be acceptable to both parties. Their case, in effect, was that if they did not sell to the architect and consulting engineer at the trade discount, the German agent would step in and the orders would go abroad. It was strongly urged by the contractors, however, that if all manufacturing firms were to refuse the trade discount to all outside the trade, the orders would still go to them through the contractors, to the mutual benefit of both parties. During the discussion a pertinent question was put as to what was meant by "electrical trades." Were such undertakings as docks, quarries, railways included in the term? Mr. Woodward, for the contractors, had to admit that orders from these sources could not be expected to come through them.

Mr. H. BEVIS, of the General Electric Company, quoted the case of the London Dock Company, who had a large contract with his firm for carbons. If, as was suggested in the resolution before them, they were only to give the dock companies one-third of the trade discount they would lose every contract, and the German agent would simply run away with the whole business. He further stated that at the present time 50 per cent. of the trade at least bought from the German agent.

Mr. H. OPPENHEIMER wanted to know how they were going to discriminate between the shipper who bought the goods to be sent abroad, and the shipper who wanted them for private purposes. Although he was fully in sympathy with the movement, there were so many points to be considered that it was impossible to decide at this conference, representative as it was, what course of action should be adopted.

Mr. WM. BLAND, a contractor in the North of England, thought it was not right that shipyards, quarries, railways, etc., should have the full trade discount.

Mr. C. L. TROUP quoted the case of the trade discount being allowed to the employés of dock companies for their own private use. He maintained that anyone with "a friend in the camp" could get trade discounts.

In reply to an enquiry as to how such people as ironmongers were to be dealt with, Mr. WOODWARD explained that where there was an electrical department under a competent head, it should be entitled to the advantages of the trade discount.

Mr. JUSTUS ECK said the electrical contractor was the best friend of the manufacturer, and he ought to be helped by the manufacturer. If this were done, it would put the electrical industry on a much more flourishing footing. He was quite in sympathy with the difficulties put in the way of the contractors by those manufacturers and supply houses which gave discount indiscriminately. The only concession made to the private individual by the firm he presented was 5 per cent. off the list prices for cash.

Mr. W. R. RAWLINGS agreed that consulting engineers were not traders, and ought not to have trade terms Mentioning the case of hotels, he stated that in some instances he found that hotels could buy electric lamps at cheaper rates than were even allowed the contractors. If this were the fault of the German agent, they as contractors ought to give him a wide berth.

Mr. DOUGLAS BATE maintained that the contractor would not support the manufacturer in any way. He would buy in the cheapest market, no matter where it might be. The consulting engineer and the architect were continuously robbing the contractor of his profit. It was in the power of the contractor to stop this. If the manufacturer were supported, then he would support the contractor.

At this stage Mr. Woodward withdrew his resolution, and it was agreed to appoint a committee of manufacturers and contractors to confer as to the best course to take in the matter. The following gentlemen were then elected to constitute the committee—viz.: manufacturers—Messrs. Eck, Bevis, Bate, T. J. Granger, P. F. W. Simon, C. S. Northcote, and Oppenheimer; contractors — Messrs. R. Phipps, Woodward, W. Duncan, Troup, F. A. Glover, H. Marryatt, and Hogan (hon. secretary). The conference closed.

A general meeting of the National Electrical Contractors' Association was held in the evening, with Mr. W. R. Rawlings, A.M.I.E.E., in the chair. Reports were submitted by the secretaries of the metropolitan and a number of the provincial associations. The constitution and rules as drawn up by the general committee appointed some time ago were submitted and approved, and the following office bearers were appointed for the ensuing year—viz.: President—Mr. W. R. Rawlings, London. Vice-presidents—Messrs. N. H. Beilby, West Hartlepool; H. Bland, Newcastle-on-Tyne; A. E. Porte, Dublin; C. L. Troup, London; M. Wallis, Leeds; T. Wright, Glasgow. Hon. treasurer—Mr. H. Marryat, 28, Hatton garden, London, E.C. Secretary—Mr. Thos. Guthrie, C.A., 46, Queen Victoria-street, London, E.C. The Central Board will consist of these officers and other members to be elected forthwith by the metropolitan and provincial associations from amongst their own members.

FORTHCOMING EVENTS.

FRIDAY, JAN. 24.

North-East Coast Institution of Engineers and Shipbuilders.—At 7.30 p.m., general meeting at Newcastle-upon-Tyne. Mr. J. W. E. Littledale will reply to the discussion on his paper on "The Speed of Machine Shop Tools"; discussion on Mr. E. C. Chastons' paper on "The Ballasting of Modern Tramp Steamers"; paper on "Some Notes on Steam Turbines," by Mr. F. J. Warburton.

SATURDAY, JAN. 25.

Institution of Junior Engineers.—At 7 p.m., seventh anniversary dinner, Hotel Cecil.

Institution of Electrical Engineers.—(Students' Section): At 10 a.m., visit to the works of the Silvertown Company.

Glasgow Scientific Society.—At 7.30 p.m., ordinary meeting. Paper: "Large Storage Batteries and their Application to Central-Station Supply," by Mr. Henry MacEwen.

MONDAY, JANUARY 27.

Institution of Electrical Engineers (Newcastle Section).—Ordinary meeting. Paper: "Sub-Station Polyphase Machinery," by Mr. Andrew Stewart.

Society of Arts.—At 8 p.m., Mr. Samuel Rideal, D.Sc., on "The Purification and Sterilisation of Water" (Lecture III).

TUESDAY, JAN. 28.

Royal Institution.—At 3 p.m., Dr. Allan MacFadgen on "The Cell: Its Means of Offence and Defence—Immunity" (Lecture III.).

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., ordinary meeting. Paper: "Supply of Electricity in Bulk," by Mr. H. A. Earle.

WEDNESDAY, JAN. 29.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., ordinary meeting. Paper: "Notes on Continuous-Current Testing."

FRIDAY, JAN. 31.

Royal Institution.—At 9 p.m., Prof. A. Crum Brown on "The Ions of Electrolysis."

Electro-Harmonic Society.—Smoking concert at St. James's Hall Restaurant.

Institution of Mechanical Engineers.—At 8 p.m., further discussion on "Workshop Methods," by Mr. H. F. L. Orcutt.

SATURDAY, FEB. 1.

Institution of Electrical Engineers.—At 2.30 p.m., students' visit to the Willesden station of the Metropolitan Electric Supply Company.

NEW COMPANIES REGISTERED.

Motormobile, Limited.—Capital, £1,000. Objects: to acquire any patents and inventions, and to carry on the business of manufacturers of and dealers in cycles and carriages and motors of all kinds.

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THE
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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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GARCKE'S MANUAL.

It was Goethe who said, "What you do not understand you do not possess," and if the writers and speakers at random about electrical subjects would only pay heed to such words, many of them would feel they did not possess the knowledge requisite for the due treatment of their subject. Since Mr. Garcke six years ago commenced the publication of his manual he has annually presented a good educational medium for the ignorant, and provided information of the greatest importance. During these six years the capital invested in the electrical undertakings referred to in this work has increased from 61 millions to 165 millions. This capital is divided into that invested in telegraphs, telephones, supply, traction, manufacturing, and miscellaneous. Taking the current amount of 165 millions, 32 millions belongs to telegraphs outside the Government, nine millions to telephones outside the Government. Upon this it must be remarked that in the above amounts we have dealt with round numbers, but perhaps it would be as well to mention that £103,450 is the capital invested by three municipalities in telephone work. Coming to supply, the number of companies is given as 142, with over 18 millions capital; of municipalities, 192, with a capital of 19 millions, while there are 125 traction companies, with a capital of 39 millions, and forty seven municipalities, with a capital of 10 millions. There are 154 manufacturing companies, with about 26 millions of capital, while there are included in the miscellaneous lot 134 companies with nearly 10 millions of capital. We have given these figures merely to show what large interests are involved, and the large army of workers that must necessarily be interested in all electrical matters. An emphatic protest, however, must be made against taking any text from the average rates of interest mentioned as paid on capital issued by electrical companies. No real information to guide in any particular case can be obtained from statistics of the kind referred to, except it may be to promoters of trust companies. A far more interesting feature of this issue is a coloured diagram showing revenue per unit and cost per unit in various undertakings. By means of different colours the cost is analysed into various items, such as cost of generation, distribution, etc.; but to be more useful the diagram should be complete—that is, all municipal and all company undertakings should be given. Even with diagrams, and figures, and statements in the text it is only the expert interpreter that can hope to deduce proper conclusions. It may be noticed that in a proportionately few cases the concerns do not pay, but closer examination into the conditions surrounding each particular case is almost certain to clearly indicate why that particular concern does not pay. The voluble but indiscriminate users of this manual and other works concerning central stations are too often, like politicians, seeking only one object—namely, to prove their particular point. Take a simple example of the fatuousness of general statements. Two concerns are initiated in districts of similar areas and similar classes of population. The one concern is controlled by business men who calmly and conscientiously consider the whole question, and from the very first make arrangements, say, for a probable five years' development, while the controllers of the other scheme push through the work looking only at immediate necessities. Surely, if the latter pays expenses and earns a profit in its first or even in its second year, that result cannot be compared with the former, even if in that case a small loss be made on the first year's working, and both ends met only on the second year. The probability is that in the first case profits out of all proportion will be made as soon

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as revenue and expenditure balance than will be made in the second case, because the latter will be hampered by extensions and by inability to accommodate customers. Of course, this particular problem is fairly simple. Does it pay in the long run to spend initially more, to incur more liability for interest and repayment (in the case of a municipality), than to expend capital only as demand is proved? The intelligent reader of Garcke's manual will be able to go far towards the true solution of many interesting practical commercial questions by a careful examination of its information than will those who merely look upon it as a statistical library of electrical undertakings.

THE MANCHESTER CONTRACT.

At the end of last year a considerable stir was made in the daily Press due to the placing by the Manchester Corporation of a large order for electrical plant with a German firm. The amount of this contract was £113,000, and it was stated both in the Council and in the Manchester papers that this was £36,000 below the nearest English tender. We made no editorial comment on the matter at the time, because the Electric Lighting Committee at Manchester refused to publish any details or prices of the various tenders received, and without these details no fair comment could be made. The question does arise, however, as to how far the committee's report on these tenders to the full Council was fair in its conclusions. We believe we are correct in stating that the specification of the electrical engineer of Manchester on which the tenders were invited was divided into sections, so that each contractor should only tender for that part of the apparatus of which he was actually the manufacturer. The question that we should like this engineer to answer is, How much lower was the German tender than the price which would have had to have been paid if the Corporation had accepted the most favourable sectional tenders of English manufacturers? This comparison only is fair to all concerned, as there can be no object in filling in sectional prices if the committee will only consider the lump sum total. In fact, with the great increase in the size of generating units which now obtains, the old practice of a lump-sum tender for engine and generator combined is not to be recommended. If only the electrical engineer will fix definitely the speed at which the required plant is to run, there is every advantage in having direct tenders from the engine builders for the engines and from the dynamo builders for the dynamos. Any slight difference in the design of the dynamos can easily be allowed for, as far as the bed-plate is concerned, in the engine builder's tender. In this way the tenders when received would be directly comparable subject to criticisms from the engineer, as is not the case under the present system of lump-sum tendering. We shall be glad if the electrical engineer of Manchester will look into the above, and let us know how far, if at all, the English manufacturers were behind on the total of their most favourable sectionalised tenders.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

449. What is the cause of the deposit of sodium in glazed earthenware casing? Has the glaze on the earthenware anything to do with it, and is it the usual experience to find a greater deposit in the negative hole than in the positive? Describe fully the chemical action which takes place.—R. S.

450. What characteristics would a compound-wound motor manifest (1) on starting, (2) working under varying load, with the shunt and series coils connected in opposition?—W. R.

ANSWERS.

Question No. 443.—I have a three-phase generator connected in star group, with a common return to the junction of the star. The generator gives 100 volts between each line and common return and 100 amperes per phase. Two lines supply incandescent lamps only, and the third supplies arc lamps. How am I find the angle of lag, the self-induction, and the true power generated?

Best Answer to No. 443 (*awarded* 10*s.*).—When "M" asks how to find the angle of lag, the self-induction, and the true power generated, does he mean by test or by calculation? It is to be presumed he means by the former, as without knowing the power factor of the arc circuit it would be obviously impossible to tell (even with the data given) what the true power taken by that circuit is. As there is a common return, the simplest way to treat the matter is to consider each of the three legs of the "star" as a separate single-phase circuit. G (Fig. 1) represents

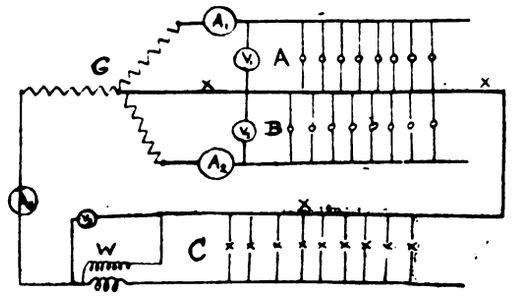

Fig. 1.

the generator, A, B, and C the circuits having a common return, X. A and B consist of incandescent lamps only, while C consists of arcs. The circuits A and B are, therefore, practically non-inductive, while C is partly inductive. A_1, A_2, and A_3 are ammeters placed one in each circuit. To get the true power in circuits A and B we need only connect voltmeters, V_1 and V_2, respectively across these circuits, wattmeters not being necessary. In circuit C a wattmeter, W, must be inserted, its current coil being in series with the line, and its potential coil across between line and X as shown. A voltmeter, V_3, is also connected across this circuit. Let the readings of the instruments in amperes, volts, or watts be denoted by the letters on them in the diagram. Then we have

True power in circuit $A = A_1 V_1$ watts.
" " " $B = A_2 V_2$ "
" " " $C = W$ "
Apparent power " $C = A_3 V_3$ "
$\therefore$ Total true power $= (A_1 V_1 + A_2 V_2 + W)$ watts, and
" apparent power $= (A_1 V_1 + A_2 V_2 + A_3 V_3)$ watts.

Power factor of circuit C is equal to $\frac{W}{A_3 V_3}$, and the power factor of the whole system is equal to

$$\frac{A_1 V_1 + A_2 V_2 + W}{A_1 V_1 + A_2 V_2 + A_3 V_3}.$$

Taking the data given in the question, if the generator is fully loaded we have

Power in circuit A = 10 kw.
" " B = 10 kw.
Apparent power in circuit C = 10 kw.

Total = 30 kw. (apparent).

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The power factor of the arc circuit will be perhaps 0·75 or 0·8. Taking it at the former figure, we have

True power in circuit C = 10 × ·75 = 7·5 kw.;

∴ Total true power = 27·5 kw.;

∴ Power factor of whole system = $\frac{27{\cdot}5}{30} = 0{\cdot}92$.

As the power factor is equal to the cosine of the angle of lag (assuming sine waves of current and E.M.F.), we can readily find this angle for each circuit when we know its power factor. For circuits A and B the power factor is practically unity, hence the lag will be zero for these circuits. For circuit C the power factor is $\frac{W}{A_3 V_3}$; hence the angle of lag is the angle having $\frac{W}{A_3 V_3}$ for its cosine. If this fraction be equal to 0·75 (as taken above), the angle of lag for circuit C is then about 41deg.

What "M" means by the "self-induction" in this case is not quite clear. If he refers to the self-induction of the separate circuits, it is clear that that of A and B is practically zero. Circuit C, however, possesses appreciable self-induction, owing to the coils of the arc lamp mechanism. The inductance, L, may be found as follows:

We have $\tan \theta = \frac{p L}{R}$,

where R = effective resistance of circuit in ohms;
p = 2 π × frequency of supply (n);
L = inductance in henries;
θ = angle of lag.

R can be found from the wattmeter and ammeter readings, and is equal to $\frac{W}{A_3^2}$.

This follows from the fact that

$$W = A_3^2 R.$$

Hence we now have

$$\tan \theta = \frac{p L A_3^2}{W},$$

from which $L = \frac{W}{p A_3^2} . \tan \theta.$

If A_3 = 100 amperes;
n = 50 ~;
W = 7·5 kw;
A = 41deg. lag;

then $$L = \frac{7{,}500}{6{\cdot}28 \times 50 \times 10^4} \times 0{\cdot}87$$
$$= 0{\cdot}0021 \text{ henry.}$$

As stated above, when the three-phase system has a neutral wire, it can be considered as, and tested as, a group of three single-phase circuits. But for measuring the power in an ordinary three-phase system without a neutral, the connections should be as in Fig. 2. Here W_1 and W_2 are

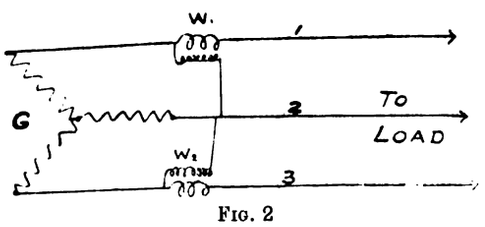


FIG. 2

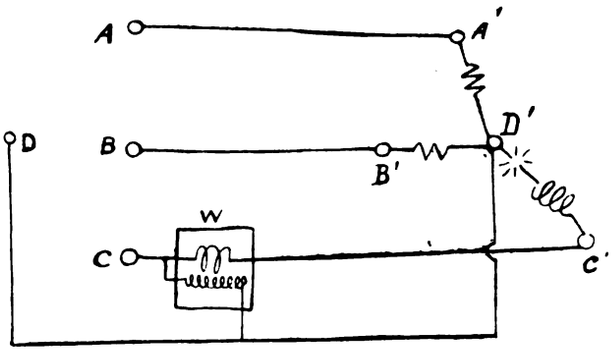
two similar wattmeters. When connected as shown, the sum of their readings gives the total power, whether the load be balanced or not, and whatever may be the value of the power factor. If the latter be less than 0·5 (60deg. lag or lead), one wattmeter reads negatively, and its connections must be reversed. In this case its reading must be deducted from that of the other wattmeter to give the total power.

For balanced load, the readings of the two wattmeters can be used to give the angle of lag or lead. If θ be this angle, and W_1 and W_2 the respective wattmeter readings, it can be shown that

$$\sin \theta = \sqrt{\frac{1}{1 + 0{\cdot}33\left(\frac{W_1 + W_2}{W_1 - W_2}\right)^2}}.$$

With a balanced load we may dispense with one wattmeter. The other has its current coil connected in leg 1, say, and readings are taken with the potential coil connected first from leg 1 to leg 2, and, secondly, from leg 1 to leg 3. The algebraical sum of the two readings gives the power. The latter method can only be used with accuracy, however, when the load is a steady one, such as a lighting load.—R. C.

Answer to No. 443 (*awarded* 5*s.*).—Let A, B, and C be the three terminals of the three-phaser, and D the terminal for the fourth wire. Let A A′, B B′, and C C′ be the mains, A′ D′ and B′ D′ the incandescent lamp loads, and C′ D′ the arc lamp load. Let also D D′ be the fourth wire. Then we are given that the currents in A′ D′ and B′ D′ are each



100 amperes, and the pressure between A′ and D′ and between B′ and D′ is 100 volts. Now, since an incandescent lamp circuit is non-inductive, therefore the power expended in A′ D′ and B′ D′ together is 20,000 watts. If we connect a wattmeter, as in the figure, putting the ampere coil in series with C C′ and the volt coil between C C′ and the fourth wire, then if the ohmic drop in the fourth wire, D D′, is negligible, the wattmeter will obviously read the power in C′ D′. Let this reading be W, then the power factor of C′ D′ is $\frac{W}{10{,}000}$. Since we have between C′ D′ a column of heated vapour whose ohmic resistance it is not easy to determine, except by very special and elaborate experiments, with the aid of an oscillograph we may say that the determination of the self-induction of the circuit C′ D′ is not practicable. If R be the resistance of the circuit, L its self-induction, and f the frequency, then

$$R^2 + 4 \pi^2 f^2 L^2 = (\text{impedance})^2$$
$$= 1.$$

We can determine f by a periodicity counter, but R and L are practically indeterminable.

If all the arms of the star were non-inductive, the output of the three-phaser would be 30,000 watts. Hence we can say that the power factor of the machine in the case under consideration is

$$\frac{W + 20{,}000}{30{,}000}.$$

Suppose, now, that the ohmic drop in the fourth wire is not negligible. Then to find the true output of the machine we put the ampere coil of the wattmeter successively in series with each main, and its shunt coil between that main and the fourth wire successively and take the three readings. If these readings be W_1, W_2, and W_3, then total output of the machine is

$$W_1 + W_2 + W_3.*$$

If V be the voltage between any two of the terminals, A, B, and C, then the power factor of the machine is

$$\frac{W_1 + W_2 + W_3}{\sqrt{3}\ V\ .\ 100}.$$

The self-induction is, for the reasons stated above, an indeterminate quantity.—J. C. R.

Question No. 444.—What is the best and cheapest way of getting the "testing constant" of a meter—*i.e.*, the relation between the revolutions of the spindle and the reading on the dial?

Answer to No. 444 (*awarded* 7*s.* 6*d.*).—The method of obtaining the constant of a meter varies according to the

* "Alternating Currents and Alternating-Current Machinery," by Prof. D. C. Jackson and J. P. Jackson. Vol. ii., p. 556.

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type and make of meter, as the term used by meter makers is somewhat arbitrarily chosen, and has not the same meaning in every case. The type of meter known as the ampere-hour type, and calibrated to read direct in Board of Trade units, may be taken first.

In the Hookham meter, the constant may be defined as "the time in seconds that one ampere at a given voltage will take to cause the armature to make one complete revolution." To obtain this the ratio of the armature speed to the units dial is first found. This is very readily found by multiplying all the "drivers," and finding the ratio to all the "driven" wheels.

For example, in a five-ampere meter the wheels may be found to be arranged as follows:

$$\frac{2\times 8\times 8}{70\times 80\times 80}=\frac{1}{3{,}500}=\text{ratio.}$$

Now, according to the above definition of the constant (K), we have

K = the time in seconds that one ampere at a given voltage will take to cause the armature to make one complete revolution;

K = time that one ampere will register $\frac{1}{w}$ unit;

w K = time that one ampere will register one unit;

$$\text{K}=\frac{\text{Time that one ampere will register one unit}}{w},$$

where w = ratio of the disc or armature to one division registering one unit. An example may make the above a little clearer.

In a meter the ratio is, say, $\frac{1}{3{,}500}$; that is, the armature will revolve 3,500 times before one unit is registered.

In 4·54 hours, or 4·54 × 3,600 seconds, 1 ampere at 220 volts will be equal to 1 B.O.T. unit;

$$\therefore \text{K}=\frac{4{\cdot}54\times 3{,}600}{3{,}500}=4{\cdot}67.$$

Constant required = 4·67.

In the watt-hour type of meter, such as the Thomson, the constant has a somewhat different meaning to that of the ampere-hour type described above.

The formula for testing these meters may be stated as follows:

$$\frac{3{,}600\times \text{revolutions}\times \text{K}}{\text{time in seconds}}=\text{watts} \quad . \quad . \quad . \quad (a)$$

where K = constant of the meter.

For example, by counting the gear it may be found that the moving disc has a ratio of 250 to 1—that is, 250 revolutions of the disc or armature register one unit on the dial.

From (a) $$\text{K}=\frac{\text{watt-seconds}}{3{,}600\times \text{R}} \quad . \quad . \quad . \quad . \quad (b)$$

Now, 250 revolutions = 1 unit;
1 unit is 1,000 watt-hours;
1 unit is 1,000 × 3,600 watt-seconds;
∴ 250 revolutions = 1,000 × 3,600 watt-seconds;

$$1 \text{ revolution}=\frac{1{,}000\times 3{,}600}{250}=14{,}400.$$

Substituting in (b) we have

$$\text{K}=\frac{14{,}400}{3{,}600}=4.$$

Constant required = 4.

—A. T. S.

Answer to No. 444 (*awarded* 7*s.* 6*d.*).—To find the testing constant of a Hookham meter, which is the figure that should be obtained by multiplying the current in amperes passing through the meter by the time in seconds required for one revolution of the armature, find the velocity ratio of the armature spindle to the units dial spindle. This may be found by counting the number of teeth on the wheels in the train. Example: In a 50-ampere 220-volt meter the armature is found to have a velocity ratio of 7,000 to 1—*i.e.*, the armature makes 7,000 revolutions in registering 10 units on the dial, therefore it makes 700 revolutions in registering one unit.

K = time that one ampere passing through the meter will cause the armature to make one revolution;
K = time one ampere will register $\frac{1}{700}$ unit;
700 K = time one ampere will register one unit;
one unit = 1,000 watt-hours = 1,000 × 3,600 watt-seconds;

$$\text{K}=\frac{1{,}000\times 3{,}600}{220\times 700}=23{\cdot}37;$$

i.e., in this particular meter, if correct, one ampere passing through it should cause the armature to make one revolution in 23·37 seconds. The constant can be read directly off the stop watch used for testing with; if the meter is fast, the reading on the watch will be less than K, if slow, greater. In practice it is advisable to count 10 times the number of revolutions of the armature as there is current passing through the meter, in passing 2·5 amperes through, count 25 revolutions 5 amperes, 50 revolutions, etc. This tends to eliminate errors due to observation, the decimal place requiring to be moved one place to the left. The testing formula for a Thomson meter is:

$$\frac{3{,}600}{t}\times n\times \text{K}=\text{watts} \quad . \quad . \quad . \quad . \quad (i.)$$

Watts = $c\times e$; t = number of seconds meter armature takes to make n revolutions; 3,600 divided by $t\times n\times$ K = watts.

To find K, find the velocity ratio of the armature spindle to the units index spindle. Example: In a 440-volt 25-ampere meter the armature is found to have a velocity ratio of 2,500—*i.e.*, the armature makes 2,500 revolutions to one revolution of the units index spindle—*i.e.*, in registering 10 units; ∴ in registering one unit it makes $\frac{2{,}500}{10}=250$ revolutions.

250 revolutions of armature = 1 unit;
1 unit = 1,000 × 3,600 watt-seconds;
∴ 250 revolutions = 3,600,000 watt-seconds;

$$1 \text{ revolution}=\frac{3{,}600{,}000}{250} \quad \text{,,}$$

$$=14{,}400 \quad \text{,,}$$

$$\text{K}=\frac{\text{watts}\times t}{3{,}600\times n};$$

$$\therefore \text{K}=\frac{14{,}400}{3{,}600\times 1}=4.$$

—W. W. A.

STARTING RESISTANCES.*

BY ARTHUR E. GOTT.

Of those amongst you who have experience of motor work there must be some who at some time or other have had considerable trouble with the starting devices. The defects have been sometimes mechanical, and many times more than suspected, electrical. Now, the object of this paper is not to discuss the mechanical details of switches, as these are too extensive and well known, and the defects in this direction are generally those of proportion rather than arrangement of mechanical parts.

The question must have suggested itself to many: Why is a certain type of starter satisfactory in one situation and the same apparatus an utter failure in another, even though the normal load be the same in both cases? How often has it occurred that it was not the mechanical portion of the switch that was at fault, but the electrical subdivision of the resistance. There is probably no detail of electrical apparatus more important, and at the same time less considered, than the correct subdivision of a starting resistance. Many manufacturers at the present time send out starters with the resistances divided up in such a "rule of thumb" manner as to render them utterly useless under certain conditions of load. They certainly do start the motors to which they are connected, but in a manner which can only be compared to the starting of a railway train by bumping every carriage. The effect of such starters on the supply system is to temporarily lower the volts by making abnormal current demands. In order to prevent these disturbances to their systems, some supply engineers insist on starters being operated by a screw in preference to a hand lever, but they have entirely missed the point, as the screw or slow-starting switch is only a very partial remedy. This had led others to make absurd regulations concerning current demand, the most popular of which is the "10-ampere rule," while a few insist on five amperes, and at least one corporation insists on motors taking only 2½ amperes per step of resistance. Such a rule is altogether imprac-

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, Jan. 13.

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ticable when dealing with large motors, and at the present stage of development is not conducive either to good design or to remedying the real defects. At the same time, some firms have attempted to produce an article to comply with the new rules, but in a most unsatisfactory manner. An actual example intended for 100 amperes × 200 volts was divided into 24 sections, 20 of which would only raise the current at five amperes per step up to 100 amperes with the armature *stationary*. It is, therefore, quite obvious that if the motor had to start under full load, the contact arm of the switch would travel over 20 steps before the motor moved, and only four steps would be left to accelerate it up to full speed. The current demand over these four steps would therefore be much worse than ever—it would exceed the full load current many times. The "5 and 10 ampere" rules, so far from achieving the desired result, have in some cases only served to introduce new defects into switches, particularly those designed for high voltage, and the arguments set forth in this paper are in favour of a more accurate division of the resistance, keeping in mind the practical difficulties involved. Generally speaking, resistances should be divided into a "geometrical ratio," with such modifications as considerations of voltage, current demand, method of operating the switch, and practical construction require. The principle involved is by no means new, having been expounded in the technical Press at intervals for some years past, but probably owing to the mathematical treatment given, it does not seem to be understood, and the author, after an extensive experience of starters, has yet to see a regularly manufactured article with a correctly divided resistance. At the same time there are a number of really good starters, in use on motors of large power, which comply accurately with the most stringent requirements, but in every case they have been specially made to order.

The worst evils of incorrectly divided resistances are only apparent in certain motor applications with particular conditions of load, inertia, etc., and the enormous stresses set up under such conditions have occasionally twisted off motor spindles, stripped gears, and wrecked parts of the driven machinery. There is no doubt that the continued manufacture of such starters is largely due to a want of appreciation of the real defects, and too often mechanical details are blamed for the electrical imperfections. One has heard of a flywheel having been removed from a machine in order to prevent the current being trebled when cutting out the last section of resistance. The correct remedy ought to have been to redivide up the resistance so as to reduce the ohmic value of the last step to a reasonable amount, and leave the flywheel in place to equalise the running load. The remedy adopted may sound absurd and exceptional, but it is not more so than the provision of fast and loose pulleys, friction clutches, etc., for the same object, and many motor applications are marred by unnecessary mechanical devices when a little attention to the design of the resistance would correct all defects. An attempt has been made in this paper to illustrate the arguments graphically, rather than mathematically, by following up the use of starting resistances from their earliest development to the present time, and the author hopes that this method of treatment will be appreciated by those whose duties comprise the design of starting resistances.

Starting without Resistance.—It is not many years ago that some engineers were entirely unaware that a resistance of some sort was at all necessary to start a motor, and the writer remembers an instance of one, who ought to have known better, attempting to start a shunt motor of some size without a resistance, and, needless to say, the attempt ended in smoke. Many manufacturers, on the other hand, and engineers, even at the present day, imagine that as it is possible it is quite the correct thing to start series motors of large size without a resistance, and motors up to 20 h.p. have been treated in this way. Some idea of the abnormal stresses set up in a motor under such usage may be gathered from an example of one of 15 h.p. working on 500 volts. The internal resistance of the motor was 1·67 ohms, and the calculated current on starting was therefore $\frac{500}{1{\cdot}67} = 300$ amperes. This, however, was damped down to about half this figure, or 150 amperes, by the effect of self-induction and extremely rapid and violent acceleration, the motor attaining full speed in much less than one second. As the running full-speed current under the starting conditions of load was only eight amperes, it will be seen that the momentary current was no less than 18 times that amount, and the full-load current of 25 amperes was exceeded no less than six times. Under such conditions it is not to be wondered that the most extraordinary breakdowns occur, one of the commonest being the snapping of the unsupported conductor between the armature coils and the commutator. In order to obviate the violent stresses introduced by starting large motors without a resistance, one has heard of these being regularly started by intermittent contact at the switch, but such a method certainly cannot be encouraged. It is quite evident from the foregoing that a resistance is necessary, but as it is equally certain that in some cases resistances are unnecessary, the question arises, Where are we to draw the line?

Take, for instance, an extremely small motor such as is used for dental tools, small fans, etc., rated at ½ h.p. at 110 volts and taking ·6 ampere at full load. Such a motor, series wound, has a resistance of 75 ohms and the current cannot exceed $\frac{110}{75}$, say 1½ amperes, even when the armature is held stationary. The excess of the momentary current over the running current is in this case so small as to be quite negligible, from which it may be safely assumed that no resistance is necessary. Stated more exactly, a resistance is never necessary when the ratio

$$\frac{\text{Volts of supply}}{\text{Volts of supply} - \text{back E.M.F.}}$$

is small, full load being assumed. The back E.M.F. in every motor is, of course, the difference between the volts of supply and the volts necessary to pass the full-load current through the internal resistance of motor. The above ratio may perhaps be better stated

$$\frac{\text{Volts of supply}}{\text{Full-load current} \times \text{internal resistance}}.$$

For series and compound wound motors the internal resistance of series and armature windings is necessary, but for shunt motors, armature only. In the small motor just considered this ratio is 2½, but in a motor of 5 h.p., on 230 volts with a resistance of ·4 ohm, this figure would become 28. This figure states the number of times that the full-load current would be multiplied if an attempt were made to start without a resistance when the motor is geared to a machine possessing great inertia.

Between the two extreme examples just considered there are sizes of motors in which a little consideration is necessary to determine whether a resistance is preferable. A certain ½-h.p. series motor at 100 volts has a resistance of approximately 5·8 ohms, and the excess current ratio will be 4½ under the aforementioned conditions. This figure is too large for the motor to be geared to an inert load without

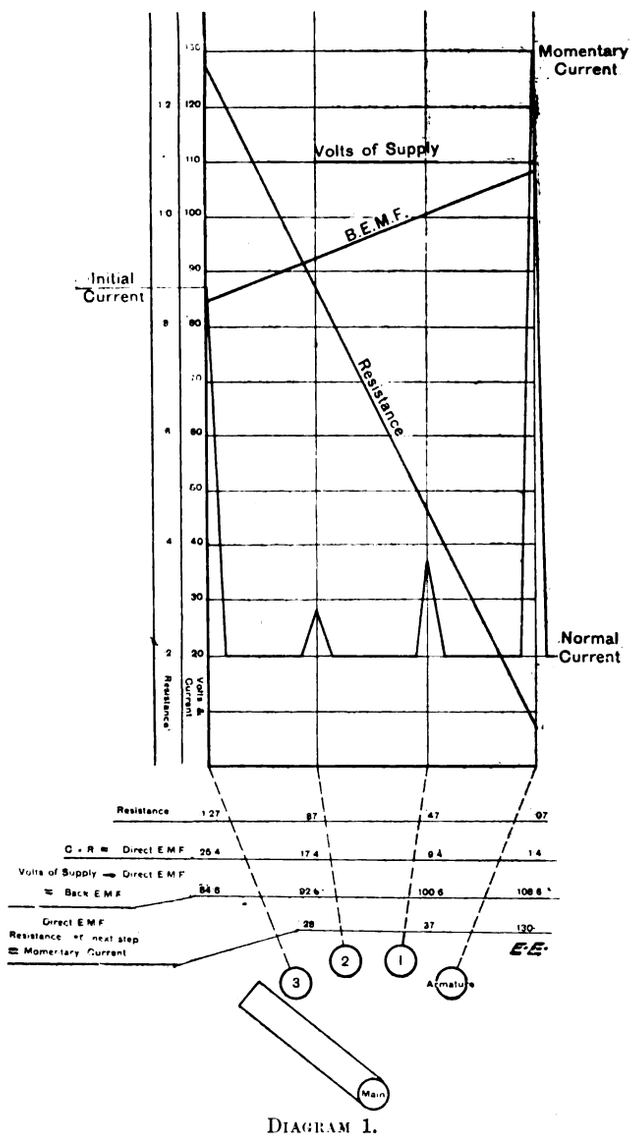

DIAGRAM 1.

a starting resistance, but if it is used to drive a light tool, say a portable drill, and is always started before the work is applied, it will be found that the full-load current is hardly doubled at starting, and such motors are frequently started without a resistance. The self induction introduced by the large number of turns in the windings of these motors, combined with the rapid acceleration due to starting on no load, tend to reduce the excess current ratio to an amount which should not be objectionable on an average supply system. In the case of portable electrical tools, it is often preferable to employ a simple make-and-break switch to the more complicated starting rheostat, which is too often not understood, is abused, and hardly designed to withstand the rough usage of a shipyard or heavy machine shop. As, however, supply station engineers have frequently something to say in the matter, simplicity is sometimes sacrificed in order to satisfy silly regulations concerning current demand. Motors of 2 h.p., series wound, may be started safely without a resistance under similar load conditions, but this size should never be exceeded on any account, as electrical and mechanical breakdowns may result. With shunt motors, owing to their lower internal resistance and the demagnetising effects of the excess current, only the very smallest sizes can be started without a resistance. Any attempt to start a motor of any size will probably result in burning out the armature before the field has attained sufficient value to give the necessary torque to overcome

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the resistance of load. This may seem an unnecessary statement, but it is overlooked at the present time by users of three-phase motors, with the result that the solder between the rotor bars and the crossings is occasionally melted out by the enormous currents induced n starting.

Early Starters.—Many of the earlier starters had a resistance of three to six sections only, and were divided into equal sections. It will be interesting to examine the behaviour of a motor with such a starter, taking as an example one of 12 h.p. at 110 volts starting under light load, driving shafting only, and taking 20 amperes at that load. This particular motor was provided with a flywheel, and the armature and brush resistance was approximately ·07 ohm. The resistance consisted of 24 coils, each of 0·5 ohm = 1·2 ohms, making with motor a total of 1·27 ohms in circuit on first step of switch. It was usual to pass practically the full current on the first step of the switch, and as will be seen, the armature resistance has so small a value to the total that it was always neglected. This resistance was divided up into three equal sections of eight coils each, and a study of the behaviour of the motor under such conditions will, as already stated, be interesting. With 110 volts supply the current, is of course, 87 amperes—*i.e.*, practically full-load current as predetermined by the amount of resistance (see Diagram 1). The motor at once runs up to a speed at which the falling current and machine resistance is balanced, and assuming the torque constant throughout, this will be at 20 amperes. The back E.M.F. is then

$$\text{Volts of supply} - (20 \text{ amperes} \times 1{\cdot}27 \text{ ohms}) = 84{\cdot}6 \text{ volts.}$$

The term "direct E.M.F." will hereafter be used to indicate the difference between the volts of supply and back E.M.F. This is now

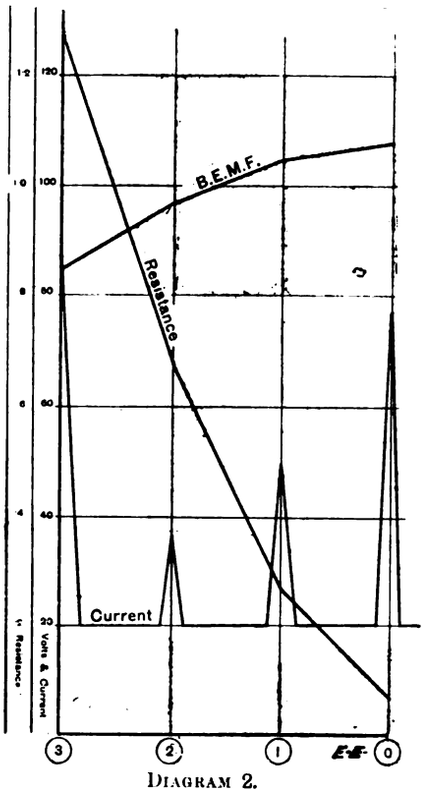

DIAGRAM 2.

110 − 84·6 = 25·4 ohms. On moving the switch on to the next contact, the momentary current will be

$$\frac{\text{Direct E.M.F. at 3}}{\text{Resistance at 2}} = 28.$$

The current will again fall until the motor torque balances the machine resistance and the back E.M.F. will have risen to 93 volts. On moving switch to contact 1 the momentary current will be

$$\frac{\text{Direct E.M.F. at 2}}{\text{Resistance at 1}} = 37.$$

A balance will again occur with an increased back E.M.F. to 101 volts, and on the last step—*i.e.*, direct on to the armature—the momentary current will be

$$\frac{\text{Direct E.M.F. at 1}}{\text{Armature resistance}} = 134.$$

It will be noticed that the increment has been increasing, and is very large on the last step, exceeding the full-load current (97 amperes) by nearly 40 per cent., and being many times in excess of the current corresponding to the normal load. Further, the motor accelerated with a violent kick on this last step, accompanied by considerable slipping of belt and sparking at the brushes. Before leaving this diagram, it should be noticed that the curve of resistance (which in this case is a straight line) is always repeated, but inverted in the back E.M.F. curve, and with a shunt motor the latter is practically proportional to the speed. In the case just considered it will be seen that an equally divided resistance is correct for giving equal steps of speed variation for the same current if required for regulating. There are, however, serious objections to equal steps for any purpose, and this will be considered further on. Now redivide this resistance simply by taking the connections off to the switch from new points in the resistance and see the improvement. The total will remain as before (see Diagram 2). Connection 2 will be taken off in the centre and 1, four coils from the end, thus splitting the resistance into three sections of 12, 8, and 4 coils. The numbers given to the sections indicate the number of sections in circuit at that particular point. The current on first step is as before, but as a much larger section of resistance is cut out between first and second, the peak is much larger, and a higher speed is attained on this step than previously. A similar change is noticed on the following step and a slight improvement is shown on the last step, the general effect being to level the peaks in the current curve. It must here be stated that under the conditions of load assumed—*i.e.*, starting under light load by means of a flexible attachment like a belt—an ammeter in circuit will not show these abnormal current demands to such an extent as calculation indicates, owing to the effect of self-induction and extremely rapid acceleration which serve to damp down these peaks very considerably. Starters of this sort have in consequence

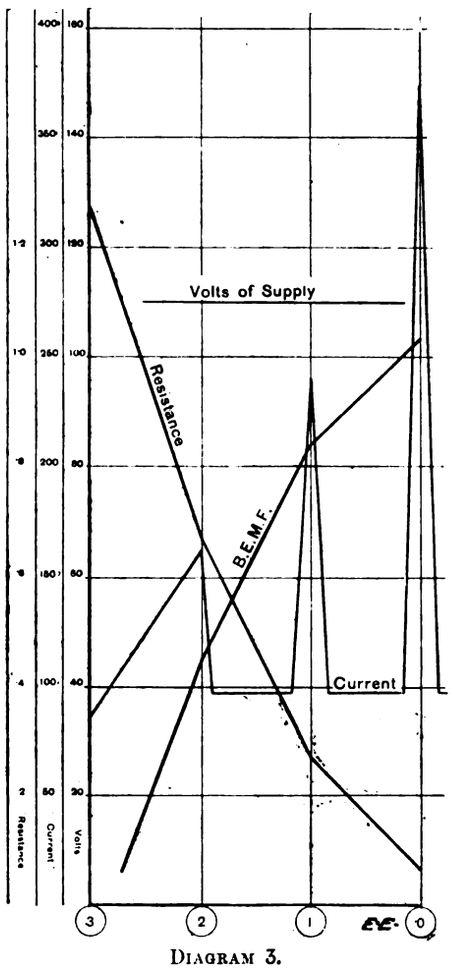

DIAGRAM 3.

been very successful with belted motors up to very large powers, and have been working for years without any repairs either to motors or switches. The motors generally started up the line shaft light, and after the full speed was attained the machine belts were transferred to the fast pulleys. The machines were generally stopped before the motor was shut off in order to enable the latter to start up under light load, this practice having previously been evolved by the use of gas-engines. It did, however, sometimes occur that the motor was stopped with a number of machines on, sometimes through neglect and occasionally through cessation of supply, and the attempts at restarting the motor with the load on is best illustrated in Diagram 3. The full torque is here assumed throughout, and taking the full-load current at 97 amperes, as rated, the motor does not necessarily move on the first step, as the torque just balances the assumed full-load machine resistances. On moving on to step 2 the current rises to a high figure; similarly on step 3 and on step 4 there is an abnormal demand of current, accompanied by a violent kick at the motor and excessive slipping of the belt. The violent torque not unfrequently brought the belt off altogether, and the incidental sparking at the brushes generally destroyed the high polish of the commutator, which is so essential to its long life. There was also most violent sparking at the switch contacts, and the last step was rapidly destroyed. The belt was the safeguard of the motor against the violent stresses imposed by these early starters, but with the advent of the geared motor a new set of conditions has arisen demanding the most perfect design in starting switches, in order that the motors and starters alike may be exempt from breakdowns. The obvious conclusion is that there are too few steps.

(To be continued.)

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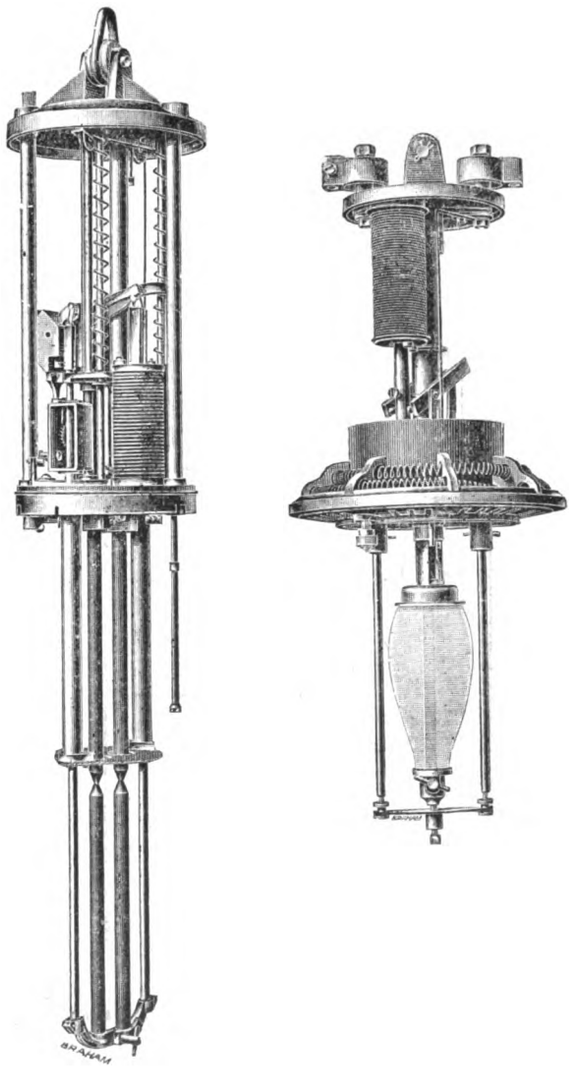
TRADE NOTICES AND NOVELTIES.

General Electric Company's Catalogue—Section E.

The General Electric Company, Limited, Queen Victoria-street, London, E.C., have recently issued Section E of their new catalogue. This section deals fully with the firm's "Angold" open and enclosed arc lamps, the information contained in leaflets previously noticed in these columns being included. It may be reiterated that these lamps are of the differential type. The carbons are fed from a compound brake and ratchet wheel, the carbon-holder slides being supported by a chain which engaged with a tooth wheel on the brake wheel spindle. As the upper carbon falls the lower one is lifted, so that the lamp is self-focussing. The mechanism is so constructed that the weight of the carbon-holders and brake wheel is supported either by a relieving block, a brake block, or a ratchet, according to the position of the core in the shunt and series solenoids. When the core is drawn into the shunt solenoid the weight rests on the relieving block; the brake wheel being free, the carbons are drawn together by the greater weight of the upper slide. Directly the circuit is complete through the carbons, the series



coil pulls on the core, and shifts the weight on to the brake block, at the same time rotating the wheel backwards slightly to strike the arc. The increasing voltage across the arc strengthens the shunt solenoid until it balances the pull of the series solenoid, the arc being then at its proper length. The increase of voltage across the arc, due to the consumption of the carbons, will gradually pull the core back, and so feed the carbons at exactly the same speed as they are consumed. For its consequent steady burning qualities the lamp has already won fame. A single-carbon continuous-current open-type arc lamp of the "Angold" ratchet pattern suitable for parallel or series working is made. This lamp, when used for series working on 200, 400, or 500 volt lighting or power mains, is provided with a special form of equivalent resistance and automatic cut-out, which serves to protect the shunt coils of the lamps. It will doubtless be remembered that this resistance was the subject of a recent notice in these columns. Several modifications of the same lamp for different methods of lighting are described in the catalogue. The mechanism of the "Angold" double-carbon open-type arc lamp is shown in the first of the accompanying illustrations. This lamp is made for continuous, alternating, and rectified currents, and is specially designed for public lighting and railway work. It may be classed as of the long-burning order, having, we are told, been made to work up to 38 hours. In the continuous-current double-carbon lamp the control is also of the differential type, and acts direct on to the carbon-holder slide rods by means of compensating clutches. These clutches, although fitted with rubber, are so constructed that the "feeding point" is constant and independent of the wear, so that no regulation is needed. The alternating and rectified current lamps are similar to the above in construction, except that the clutch rods and clutches are replaced by racks and pinions geared up to escapements. Enclosed arc lamps of the "Angold" type are also dealt with in the catalogue under notice. In this type the line resistance is mounted around the side of the lamp on an extension of the base, as shown in the second of the accompanying illustrations, its cover giving a symmetrical appearance to the lamp body. Each lamp of the alternating-current enclosed type contains a choking coil, which is regulated before it leaves the firm's Manchester works, where all the lamps are made, so that it may be connected directly on to the circuit for which it is ordered. A special improvement claimed on behalf of the "Angold" alternating-current enclosed-type arc lamp, is the means adopted to prevent "pumping" when the lamp is switched on. The alternating arc is very unstable when the carbons are cold, and will go out repeatedly if struck quickly. To overcome this difficulty, the arc is struck by means of a falling weight, checked with a large air dash-pot, whereby a constant slow rate of striking is obtained independent of rushes of current through the controlling coils. The makers also claim to have succeeded in preventing the vibrations of the iron core being transmitted to the frame of the lamp, thus rendering it noiseless in working. The lamps burn from 80 to 90 hours. Further on in the catalogue electrical equipments for theatres are dealt with at some length. These equipments the General Electric Company, Limited, are prepared to supply complete. The firm's reversible automatic lift controllers and accessories are fully described and illustrated. These controllers, it may be mentioned, make it possible to dispense entirely with anything in the nature of a hand rheostat. Electric fans and motor rheostats of the firm's standardised design, Crocker-Wheeler plant (the agency for which is held by the firm), besides a variety of other machines and accessories, help to bulk out this section of the General Electric Company's catalogue, making it quite a respectable volume in itself.

Commutator Segments, etc.

From the Forest City Electric Company, Piccadilly, Manchester, we recently received a copy of their new catalogue of dies for "drop-forged" commutator segments. It appears that the company are prepared to furnish most of the standard types and sizes of commutator segments used for traction motors. Pages 37, 38, and 39 of the catalogue are especially interesting, in that they show how one manufacturer of electrical machinery has standardised his commutators. The 15 different segments illustrated on these three pages are used in commutators of four different diameters only, so that only four different sizes of insulating rings and appliances for assembling and finishing are required. Besides commutator segments for standard traction motors, segments for many generators and special motors are illustrated in plane and section. In each case the cuts are full size, while the weight of each segment and the weight per corresponding set are given. We are told that 4,000 patterns are kept in stock, the segments being cast from high-grade copper and then forged by hydraulic machinery, whereby a dense accurate segment of superior durability is obtained. The segments require no milling to make them accurate to gauge and angle. Two types of flexible rail-bond are shown, as also an improved flexible cross-connecting bond. This completes the contents of the catalogue under notice.

Mica.

Messrs. Tulloch and Co., 4, Fenchurch-avenue, London, England, mica importers and exporters, in their annual report for 1901, sum up the present position as follows: "Whilst the important developments in electrical traction point to an even larger consumption of mica in the near future, other countries outside of India have been attracted to compete, and exploit their own deposits. Notably is this the case with Canada, which country supplies approximately three-fifths of the American mica consumption. Bengal miners, who are somewhat conservative in their methods, have to 'wake up' and recognise this fact, and that the trade here is in a transition condition. Hundreds of cases are every year exported from Calcutta of qualities absolutely unsaleable, and which not only mean a heavy loss to shippers, but help to prejudice the selling values of good merchantable qualities by unduly inflating stocks on the London market."

Donkey Pumps.

We have received from Mr. Charles E. Schlimper, Abbeygate Engineering Works, Colchester, a copy of a catalogue wherein is described the "Reliance" donkey pump. This pump is claimed to be the cheapest and best of its class on the market. It is made for working against the highest boiler pressures in vogue. All bearings are adjustable, while on the score of interchangeability of parts a further advantage is claimed.

Motors and Fuse Boxes.

The Keighley Electrical Engineering Company, Limited, Vulcan Works, Keighley, Yorks, have just published various matter descriptive of their special class of motors and of the patent house service fuse boxes manufactured by them.

Agency.

We are informed that Moores, Farrell, and Co., manufacturing electrical engineers, 26, Victoria-street, Manchester, have appointed Messrs. Alan Robson and Co., Imperial-buildings, Westgate-road, Newcastle-on-Tyne, to represent them in the Newcastle district as agents for the sale of accessories manufactured by the firm, and also the sale of Brockie-Pell arc lamps and the Consolidated Telephone Construction and Manufacturing Company's telephones, for which they are the sole agents for the North of England.

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COMPANIES' MEETINGS AND REPORTS.

CITY AND SOUTH LONDON RAILWAY.

Directors: Charles Grey Mott, Esq. (chairman), Harrow Weald, Middlesex; Charles Seymour Grenfell, Esq., Elibank, Taplow; S. Barclay Heward, Esq., 96, Ashley-gardens, Westminster, S.W.; Harvey Ranking, Esq., 28, Westbourne-terrace, Hyde Park, W.; Edwin Tate, Esq., 21, Mincing-lane, London, E.C.

Report of the directors (with statement of accounts) for the half-year ending Dec. 31, 1901, to be submitted to the half-yearly ordinary general meeting of the Company to be held at the offices of the Company, 71, Finsbury-pavement, E.C., on Tuesday, Jan. 28, 1902, at 12 noon:

The receipts from all sources for the past half-year have amounted to £62,601. 4s. 8d., and the cost of working has been £29,257. 16s. 2d., leaving a profit of £33,343. 8s. 6d. Inclusive of the balance brought forward from June 30 last, the net revenue account shows an aggregate total of £34,076. 5s. 2d. After making provision for the debenture stock interest, and the transfer to the renewal fund of £2,000, a balance remains available for dividend of £23,560. 17s. 8d. Out of this sum your directors recommend that the full dividend of 5 per cent. per annum be paid on the preference stocks, 1891, 1896, and 1901, and that a dividend at the rate of 2½ per cent. per annum be paid upon the consolidated ordinary stock for the half-year, and on the ordinary shares from Nov. 17, leaving a balance of £1,424. 12s. 8d. to be carried forward to the next account. The following table shows the number of passengers, exclusive of season-ticket holders, carried since the opening of the railway in each half-year:

Half-year ended	Number of passengers (exclusive of season-ticket holders).	Receipts (including season tickets).
Dec. 31, 1890 (11 days	165,000	£1,568 3 9
June 30, 1891	2,412,343	19,403 6 9
Dec. 31, 1891	2,749,055	19,798 16 6
June 30, 1892	2,813,162	20,931 4 2
Dec. 31, 1892	3,117,602	22,002 17 5
June 30, 1893	3,146,656	22,458 6 9
Dec. 31, 1893	3,093,351	22,067 14 10
June 30, 1894	3,383,154	23,664 10 6
Dec. 31, 1894	3,275,649	23,540 12 4
June 30, 1895	3,113,199	23,711 5 8
Dec. 31, 1895	3,172,438	23,780 3 7
June 30, 1896	3,192,672	24,021 13 0
Dec. 31, 1896	3,368,480	25,456 6 9
June 30, 1897	3,437,810	26,403 3 6
Dec. 31, 1897	3,337,861	25,472 12 10
June 30, 1898	3,478,977	26,356 16 4
Dec. 31, 1898	3,462,814	26,319 14 10
June 30, 1899	3,540,098	26,749 3 0
Dec. 31, 1899	3,442,942	26,197 14 10
June 30, 1900	4,169,717	33,608 2 3
Dec. 31, 1900	5,018,842	44,716 3 11
June 30, 1901	5,887,786	51,013 17 3
Dec. 31, 1901	7,008,842	59,734 14 8
Total since the opening of the line	79,788,450	£618,877 5 5

The directors feel justified in congratulating the proprietors on the result of the half-year's working. The extension to Islington was opened for public traffic on Nov. 17, and the increase in the receipts since that date has been satisfactory. The subway at London Bridge, connecting the platforms of this Company with those of the Brighton Railway, was completed and opened on Dec. 2, and is being largely used, and arrangements for through bookings on the lines of the two companies are now being made. The working stock of the Company has been increased by 36 carriages and 10 locomotives. An additional carriage has been added to all the trains, and materially assists in coping with the traffic in the busy hours of the day. In order to meet the increasing traffic it has been found necessary to order 16 more carriages, which are now in course of construction. In accordance with the authority given them at the last meeting, the directors have issued £150,000 of the 5 per cent. preference stock, 1901, enabling them to pay off loans and provide for other capital expenditure. The arbitration respecting St. Mary Woolnoth Church remains still unsettled, and it is feared that some time will elapse before a final conclusion is arrived at. The Islington and Euston Bill was favourably reported upon by the Joint Committee, and now waits the sanction of Parliament in the usual course. The increased traffic from the stations south of the Thames is making it difficult to deal with the growing traffic at the London Bridge Station, and the only way of affording relief is by constructing a station at London Bridge on the portion of the old line at present disused, so giving an alternative route to the City. To do this economically it is necessary to extend the disused line for some distance, and to effect this, arrangements have been made with the City and Brixton Company to abandon the larger portion of their railway, constructing only the short piece as far as Lambeth, cancelling the old agreement with this Company and substituting a new one to meet the altered conditions, which will be submitted for the approval of the proprietors at the special meeting. At the special meeting to be be held at the conclusion of the ordinary meeting, the proprietors will be asked to sanction the conversion of the ordinary shares, 1899 and 1900 issues, into consolidated ordinary stock of the Company. Interest at the rate of 3 per cent. per annum will be paid, as hitherto, out of capital on the ordinary shares, 1899 and 1900, up to the opening of the extension to Islington, and from that date up to Dec. 31 they will rank for dividend, *pari passu*, with the ordinary stock. The warrants for interest and dividends will be posted on the 11th prox. The directors retiring by rotation are Mr. Charles Seymour Grenfell and Mr. Edwin Tate, who are eligible for re-election. The auditor retiring is Mr. James L. Oliver, who offers himself for re-election.

Dr. Revenue Account.	£	s.	d.
Maintenance of way, works, and stations	1,133	18	10
Locomotive and generating power	9,475	16	1
Carriage repairs	1,083	6	2
Traffic expenses	12,974	17	7
General charges	2,394	0	4
Law charges	63	6	6
Rates and taxes	1,952	17	0
Passenger duty	179	13	8
	29,257	16	2
Balance carried to net revenue account	33,343	8	6
	£62,601	4	8
Cr.	£	s.	d.
Passengers (7,008,379)	57,547	12	2
Season tickets (946)	2,187	2	6
	59,734	14	8
Parcels, etc.	294	18	2
	60,029	12	10
Transfer fees	19	0	0
Rent of property	2,312	15	3
Sundry receipts	239	16	7
	£62,601	4	8

Dr. General Balance-Sheet.	£	s.	d.
Balance from net revenue account	23,560	17	8
Unclaimed dividends and interest	223	17	6
Interest payable or accruing and provided for	3,993	15	4
Contractor's retention fund	31,854	18	7
Sundry outstanding accounts	18,251	14	3
Loan account	61,300	0	0
	£139,185	3	4
Cr.	£	s.	d.
Cash at bankers and on hand	9,752	17	3
General stores	6,302	4	5
Sundry outstanding accounts	5,003	10	7
Renewal account	3,034	0	0
Debenture stock issued against loans	29,560	0	0
Balance from capital account	85,532	11	1
	£139,185	3	4

EASTERN TELEGRAPH.

The report for the half-year ended Sept. 30 states that the revenue amounted to £603,640, from which are deducted £142,638 for the ordinary expenses and £49,314 for expenditure relating to repairs and renewals of cables, etc., during the half-year. After providing £6,647 for depreciation of spare cables, £263 due to sundry differences in exchange, and £10,078 for income tax, there remains a balance of £394,698, to which is added £3,226 brought from the preceding half-year, making a total available balance of £397,924. From this balance there has been paid interest on mortgage debenture stock, dividends on preference stock, and two interim dividends of 1½ per cent. each on the ordinary stock. After carrying £10,000 to the reserve fund for maintenance ships, and £200,000 to the general reserve fund, there remains a balance of £24,533, which is carried forward. The revenue includes £23,025 dividends for the half-year on the Company's investments in other telegraph companies.

DIRECT UNITED STATES CABLE.

In their report for the six months ended Dec. 31, 1901, the directors of this Company state that the half-year's revenue, after deducting out-payments, amounted to £49,588, as compared with £50,533 for the corresponding period of 1900, showing a difference of £944 against the half-year under review. The working and other expenses for the same period, including income tax, but exclusive of cost of cable repair, amounted to £21,558, leaving a balance of £28,030 as the net profit, making, with £3,532 brought forward from the previous half-year, a total of £31,563. For the corresponding period of 1900 the working expenses and other payments amounted to £20,826. Interim dividends of 3s. per share, for the quarter ended Sept. 30, 1901 (paid Oct. 26, 1901), and of 3s. per share for the quarter ended Dec. 31, 1901 (payable 31st inst.), together amounting to £18,213, have been declared, and, after setting aside £10,000 to the reserve fund account, the balance of £3,350 on the revenue account has been carried forward. The reserve fund account has been debited with £47, balance of cost of cable repairs, and, after being credited with interest on the investments, profit on sale of securities, and amount set aside from revenue, the balance of the account, taking the investments at cost price, now amounts to £448,016.

Louvain (Belgium).—The period within which proposals will be received for lighting the city of Louvain by gas or electricity, or by a combination of the two systems, has been extended from 31st inst. to Feb. 19, 1902. Proposals, marked "Lighting Contract," to be addressed the Burgomaster, Louvain, Belgium.

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APPOINTMENTS VACANT.

Meter Repairer. Full particulars in our advertisement columns.

Electrical Engineer, Bridlington, Feb. 6. Full particulars in our advertisement columns.

Assistant for switchboard designing. Full particulars in our advertisement columns.

Assistant in central-station meter-room, 30s. per week. Full particulars in our advertisement columns.

Mains Superintendent, Harrogate Corporation, £150 per annum, Feb. 4. Full particulars in our advertisement columns.

Electrical and Tramway Engineer, Blackpool Corporation, Jan. 27. Full particulars in our advertisement columns.

Switchboard Attendant The Luton Town Council will shortly advertise for above at a commencing salary of 25s. per week.

Fitter-Driver, man with central-station experience preferred. 37s. per week of 56 hours. Full particulars in our advertisement columns.

Electrical Engineer, to estimate, plan, and carry out electric lighting installations. Full particulars in our advertisement columns.

Clerk, Electricity Department of the Dartford Urban District Council, £65 per annum, Jan. 29. Full particulars in our advertisement columns.

Assistant Meter Tester and Reader, Ilford Urban District Council, 30s. per week, 29th inst. Full particulars in our advertisement columns.

Draughtsman, Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board, Feb. 11. Full particulars in our advertisement columns.

Assistant Electrical Engineer, Stalybridge, Hyde, Dukinfield, and Mossley Tramways and Electricity Board, Feb. 11. Full particulars in our advertisement columns.

Switchboard Attendants, Harrogate Corporation, 30s. per week, Feb. 4; Ilford Urban District Council, 28s. per week of 56 hours, Jan. 29. Full particulars in our advertisement columns.

Electrician, with a technical college training, in dynamo and installation department, capable of preparing estimates, calculations of wiring, and supervising. Full particulars in our advertisement columns.

Meter Reader, with central-station experience, and who has a knowledge of Hookham and Ferranti meters and demand indicators, 35s. per week, rising to £2, Shoreditch Borough Council. Full particulars in our advertisement columns.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Tulcea (Roumania).—The Municipality invite tenders for lighting the town. Tenders by Feb. 25.

Ghent.—The Municipality require tenders for the electric lighting of the town. Tenders must be posted before March 1, 1902.

Madrid.—The Municipality invite tenders for the supply of material, maintenance, etc., of the electric lighting of the corn market. Tenders by 12 noon on Feb. 4.

Irun (Spain).—The Municipality require tenders for the installation of private and public electric lighting. The former is estimated at about £6,000. Tenders by Feb. 6.

Engoibar.—The Municipality invite tenders for a public electric lighting installation. Tenders will be received by the same until Feb. 2. Address as above, Province of Guipuzcoa, Spain.

Aberdeen.—The Tramways Committee invite tenders for the supply of steel tramway poles, bases, and trimmings for the same. Tenders by Feb. 12. Details in our advertisement columns.

Ilford.—The Urban District Council invite tenders for copper rail bonds (fixed), and stoneware cable conduits (laid and jointed), drawboxes, etc. Tenders by Jan. 27. Details in our advertisement columns.

Blackburn.—The Corporation invite tenders for supply of paper-covered cables. Specifications, etc., may be obtained from Mr. Alfred S. Giles, engineer and general manager, Electricity Works, Blackburn. Tenders by Jan. 27.

Hoylake and West Kirby.—The Urban District Council invite tenders for the supply and delivery of alternating-current prepayment or penny-in-the-slot meters. Tenders by Jan. 31. Details in our advertisement columns.

Warrington.—The Corporation invite tenders for the supply and delivery of feeder cables, etc. Specification, etc., can be obtained at the offices of Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W. Tenders by Jan. 28.

Fulham.—The Establishment Committee of the Borough Council invite tenders for the supply of transformers (20 of 50 kw. each), and mains, conduits, lamp-posts, and street-boxes. Tenders by Jan. 27. Details in our advertisement columns.

Blackburn.—The Corporation invite tenders for the various oils and greases required by the electricity and tramway departments for a period of one year ending March 31, 1903. Tenders by Jan. 27. Details in our advertisement columns.

Blackburn.—The Corporation are prepared to receive tenders for the various engineering stores required by the electricity and tramways departments for a period of one year ending March 31, 1903. Tenders by Jan. 27. Details in our advertisement columns.

Shipley.—The Urban District Council invite tenders for the supply, delivery, and erection, at their electricity works, of traction switchboard, boosters and balancers, and alterations to existing switchboard. Tenders by Feb. 10. Details in our advertisement columns.

Rochdale.—The Corporation invite tenders for the supply, delivery, and erection of all the additional panels, instruments, and switchgear, and connections for the extensions to the lighting switchboard. Tenders by Feb. 2. Details in our advertisement columns.

Ilford.—The Ilford Urban District Council invite tenders for copper rail bonds, fixed, and stoneware cable conduits, laid and jointed, drawboxes, etc. Specification, etc., may be obtained at the offices of Mr. John W. Benton, Council Offices, Ilford. Tenders by Jan. 27

Huddersfield.—The Corporation invite tenders for the construction of new tramways and the reconstruction of existing tramways. Specifications, etc., may be obtained on application at the offices of Mr. K. F. Campbell, M.I.C.E., borough engineer and surveyor, 1, Peel-street. Tenders by Feb. 3.

Madrid.—The Department of Agriculture invite tenders for the construction of an electric tramway from Linares to the mines of San Roque and Torilla, in the Province of Jaen. Tenders by Feb. 24. This is the extension of the tender advertised for Nov. 17, but the conditions have been modified.

Blackburn.—Tenders are invited for the various rubber cables required by the electricity and tramway departments during year ending March 25, 1903. Specifications, etc., may be obtained from Mr. Alfred S. Giles, engineer and general manager, Electricity Works, Blackburn. Tenders by 27th inst.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Stuart-street generating station and sub-stations of surface condensers, oil separators, and hot-well, cooling towers, and feed-water heaters. Tenders by Feb. 13. Details in our advertisement columns.

Blackburn.—Tenders are invited for supply of incandescent electric lamps required by the electricity and tramways departments during year ending March 25, 1903. Specifications, etc., may be obtained from Mr. Alfred S. Giles, engineer and general manager, Electricity Works, Blackburn. Tenders by 27th inst.

West Bromwich.—The Council invite tenders for the supply, delivery, and erection in their electricity works of boilers, feed pump and piping, steam dynamos and condenser, boosters, traction switchboard, and extension of lighting switchboard. Tenders by Jan. 29. Details in our advertisement columns.

General Post Office.—Tenders are invited for the purchase of about 25 tons of guttapercha, 60 tons of copper, 50 tons of lead, a quantity of other metals (brass, zinc, and iron), indiarubber-covered wire, limed hide pieces, electric glow lamp tops, tarpaulin, felt, jute serving, cabinet work, etc. Tenders by Feb. 12.

London, S.W.—The London County Council invite tenders for two lots of 50 double-decked double-bogie electric tramcars, equipped with a plough for working on a conduit system, and to be capable of seating about 68 persons. Specification and other particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by March 4.

Liverpool.—The Directors of the South Lancashire Electric Traction and Power Company, Limited, Liverpool, invite tenders for three-phase high-tension motor-generators, positive and negative boosters, battery-charging boosters, etc., and batteries of accumulators with accessories. Tenders by Jan. 29. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply of 10 double and 4 single deck car bodies and trucks, equipped with all electrical fittings for overhead trolley system, gauge 4ft. 8½in. Specification, etc., can be obtained on application to the borough electrical engineer, Mr. John F. C. Snell, A.M.I.C.E., Town Hall, Sunderland. Tenders by Feb 6.

Shipley (Yorks).—The Urban District Council invite tenders for the construction of new tramways and for the reconstruction of existing tramways (about 1½ miles double line). Specifications, etc., may be obtained on application to Mr. W. H. Dawson, surveyor to the Council, or to Mr. R. C. Quin, M.I.E.E., consulting electrical engineer, Electricity Works, Blackpool. Tenders by Jan. 27.

Madrid.—The Public Works Department invite tenders for an electric tramway from San Sebastion to Toloso, with power to work same for a maximum of 60 years, after which the undertaking becomes Government property without compensation. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m. Tenders by Jan. 27.

Wolverhampton.—The Tramways Committee invite tenders for the supply of the necessary materials and labour for the construction of tramway track and contingent works in the Dudley-road, from Snow-hill to the borough boundry. The length of the route is about 1½ mile, consisting of partly double and partly single track. Specifications, etc., can be obtained from the Borough Engineer's Office, Town Hall, Wolverhampton. Tenders by Feb. 4.

London.—The London County Council invite tenders for the supply of about (a) 3,250 tons of track rails; (b) 1,850 tons of slot rails; (c) 670 tons of conductor tee rails; together with (d) the fishplates bolts, nuts, etc., required in connection with the reconstruction of the London County Council tramways for electrical traction. Alternative tenders must be submitted for the supply of smaller quantities as follows of the articles above specified: (a) 2,280 tons; (b) 1,300 tons; and (c) 475 tons. with the necessary accessories. Specifications and other particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by Jan. 28.

Rockhampton (Queensland).—The Municipality invite applications from companies desirous of undertaking the construction and working

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a system of electric tramways under the Queensland Tramways Act of 1882 and the Amendment Act of 1890, within the municipality of Rockhampton aforesaid. Rockhampton, with a population of 15,461 is a rising town, and is situated on the Fitzroy River, about 40 miles from the sea coast, and is the second largest town in Queensland. Particulars of construction, maintenance, and working of tramways are contained in the Queensland Tramways Act of 1882 and the Amendment Act of 1890, copies of which may be seen at the office of this paper. Applications to be forwarded to Mr. H. W. Johnson, mayor, Municipal Chambers, Rockhampton, Queensland, Australia, by March 31.

RESULTS OF TENDERS.

Horsham.—The Urban District Council have accepted the tender of W. Prewett, at £37. 16s., for wiring and fitting the supply station in readiness for the electric light.

Dundee.—The Town Council have accepted the tender of Messrs. Macadam, of Aberdeen, for the laying of the line over the Constitution-road section. The contract price is stated to be over £11,000.

Harrogate.—The tender of the British Electrical Transformer Manufacturing Company for the supply of two large sized 50kw. transformers for use in transformer chambers, at £92. 10s. each, has been accepted by the Council.

Birkenhead.—The Corporation have accepted the tender of P. Tyson, Dryden-street, Liverpool, at £1,267, for the erection of battery-room, storeroom, and workshops at the electric lighting generating station, Bentinck-street, Birkenhead.

Stoke Newington.—The Borough Council have accepted the tender of the Edison and Swan United Electric Light Company, Limited, for the supply and erection of two switchboards in connection with the High-street electric lighting works, at £97.

Chester.—The Town Council have accepted the tender of the Erith Engineering Company, Limited, to supply and fix their patent underfeed stokers to boilers Nos. 5 and 6 at the electric light works, at £890, the work being so designed as to admit of extension to the remaining boilers.

Middleton (Lancs.).—The Corporation have received the following tenders for the electric wiring, etc., of the town hall: R. S. Blackburn, Hebden Bridge, (accepted); Parmiter, Hope, and Co., S. H. Heywood, Hayes, Wood, and Co., Lightfoot Bros., Laidlaw, Scholes, and Son, D. Firth and Son, Scholes and Son, R. Nicholson, W. P. Thermann and Co., Alliance Electrical Company—all of Manchester; A. Dickinson, Leeds; W. Wilson and Co., Middleton; F. W. Smith and Co., Southport; P. Dewhirst, Blackpool.

Oban (Scotland).—The Corporation have accepted the following tenders for the supply and erection of the three 60-kw. steam dynamos (vertical enclosed high-speed engines); two water-tube boilers with fittings; and economiser with dampers, etc. :—

J. Howden and Co., 195, Scotland-street, Glasgow, steam dynamos, with spare armature	£1,500	0	0
Babcock and Wilcox, Limited, Farringdon-street, London, water-tube boilers	1,340	0	0
Babcock and Wilcox, Limited, economiser.....	202	14	0

Walsall.—The following tenders have been accepted: T. Parker, Limited, for the supply and erection of the new transformer required at the tramway sub-station, together with the necessary switch gear, at £1,236, and for the supply and delivery of a spare armature required in connection with such transformer at £330, subject to the contractors undertaking to have the whole of the work except the spare armature ready for running by April 30, and also to have the spare armature ready for work by May 31 next; Callender's Cable and Construction Company, Limited, for the supply and laying of the high-tension cable and tramway feeder cables required for supplying the Bloxwich section of the tramways with current, at the schedule of prices set out in their tender, subject to the Board of Trade approving of the proposed mode of constructing the tramway to Bell-lane: T. Tildesley, Willenhall, for erecting a tramway transformer sub-station on the site in Hospital-street, in accordance with the plans, specification, and quantities prepared by the engineer, at £899.

BUSINESS NOTES.

TRACTION.

Huddersfield.—Cast-iron blocks are to be used in paving the electric tramways.

Chester.—The overhead system of electric traction is to be adopted throughout the town.

Moss Side.—The electric tramcars are expected to be running about November next.

Lancaster.—It is hoped to have the first electric car running in this place by June next.

Heaton Norris.—It is promised that the electric trams will be running through this district by May next.

Bacup.—Mr. Enright is advising the Council on the proposed construction of an electric tramway in the district.

Whitworth.—Mr. J. S. Enright is to make a report to the Urban District Council on electric tramways for the district.

Luton.—The Light Railway Commissioners will open an enquiry at this place on Feb. 5 concerning the light railway scheme.

Llandudno.—Formal opposition will be offered by the District Council to the Llandudno and Colwyn Bay light railway scheme.

Waterloo and City Railway Co.—The half-yearly meeting of this Company will be held at Waterloo Station on the 6th prox. at 2 p.m.

Cardiff.—Several new services of horse cars on routes which are being prepared for electric traction have been opened by the Corporation.

Underground Shallow Tramways.—The city of Westminster has petitioned agrinst the London County Council's Subways and Tramways Bill.

Grangetown.—Consideration of the Grangetown Tramways Bill by the Examiners of Private Bills of the House of Commons has been postponed till Feb. 10.

Mountain Ash.—Already there are a large number of dissenters to the tramways proposals here. About 200 frontagers and ratepayers are opposing the scheme.

Pemberton.—The Town Council have agreed to certain alterations in the plans of the South Lancashire Tramways Company as to passing places near the Hindley Green Mills.

Hampton.—The District Council have given their approval to the plans presented by the London United Tramways Company relating to the authorised tramways in this district.

Hounslow-Datchet Light Railway.—The official enquiry with reference to the Hounslow, Slough, and Datchet light railway scheme will be held at Windsor early next month.

Nottingham.—Work is proceeding in connection with the doubling of the tramway line in Milton-street, and putting in the junction with Lower Parliament-street and St. Ann's Well-road.

Hanley.—The Town Council have received information that the Potteries Electric Traction Company have under consideration extensions of the lines to Milton and Townsend (Bucknall).

Croydon.—The Addiscombe and Thornton Heath branches of the municipal tramways having been inspected by officials of the Board of Trade, the electric cars are now running on these routes.

Swindon.—The overhead system is to be adopted for the electric tramways at this place. As already reported, the Town Council will shortly apply for a provisional order to carry out the scheme.

Reading.—The National Telephone Company have been requested by the Corporation to substitute underground wires for overhead wires near the lines of the intended tramway routes in the borough.

Romford.—The poll on the proposal of the Urban District Council to promote a Bill in Parliament for the construction of electric tramways has resulted in a majority of 623 votes against the scheme.

Wolverhampton.—The Town Council have referred it to the General Purposes Committee to advertise for candidates for the appointment of manager of the new electric tramways at a salary of £250 per annum.

Beckenham.—Petitions against the Tramway Bill affecting this district have been presented by the borough of Croydon, the Croydon Rural District Council, the Beckenham Urban District Council, and the London County Council.

Exeter.—The Electric Traction Committee of the City Council having considered the proposals of the promoters of the Exeter and District Tramways Bill, have resolved to adhere to their decision to refuse their consent to the Bill.

Rowley.—An extraordinary meeting of the District Council has been held, at which it was decided to oppose the Bill promoted by the Birmingham and Midland Tramway Company, authorising the construction of tramways in this district.

Bradford.—An agreement has now been arrived at between the Corporation and the two tramway companies as to the hire by the latter of the rolling-stock from the Corporation to work the lines until they are converted for electric traction.

Greenwich.—It was agreed at the last meeting of the Borough Council not to contribute any sum towards the cost of widening Shooters' Hill-road in connection with the proposed construction of the London County Council tramway to the Herbert Hospital.

West Hartlepool.—Negotiations are proceeding with the tramway company for the fixing of one period for the determination of the several orders under which the undertaking is carried on, the improvement of the service, and the overhauling of lines and overhead wires.

Merton.—A special meeting of the Parish Council has agreed to generally oppose the proposals of the London United Tramways Company in their area. Special objection is taken to the projected line in High-street, where, it is thought, the tramway would be very inconvenient.

Swansea.—The draft of the Swansea and district light railways order, containing the amended provisions to meet the requirements of the Glamorgan County Council, has received the approval of the Swansea County Council.

Soothill Nether.—The District Council are in communication with the promoters of the Wakefield and district light railway scheme with reference to the construction of a line through the village. The scheme as at present drawn up does not include a line through Soothill.

Manchester and Salford Tramways.—A meeting has been held between the Tramways Committees of the Manchester and Salford Corporations in regard to the joint working of the tramways. The deliberations of the two committees are regarded as likely to lead to good results.

St. Pancras.—The Borough Council have resolved that while they cannot, on account of the narrowness of Tottenham Court-road, sanction tramways along the surface of that road, they would very willingly support any Bill for a shallow underground tramway along that thoroughfare.

Dudley.—The Corporation have issued a circular of hints for the guidance of the police and the public in case of accident to the overhead

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wires. The precautions to be taken in such an event are similar to those followed in other towns having electric tramways on the overhead trolley system.

Paisley.—Mr. Murphy hopes to have the through tramway from Hawkhead-road to Johnstone ready by September next. An estimate of the extra plant required at the generating station for traction purposes puts the cost at £30,000, and further borrowing powers to this extent are to be sought.

London United Tramways.—When the Bill promoted by the London United Tramways Company comes before the Examiners of Private Bills in the House of Commons on Feb. 10 there will be considerable opposition offered, there being no less than six allegations of non-compliance with the Standing Orders.

Newcastle.—Workmen's cars are to run in the morning from Byker to Elswick. It is also proposed to run through cars between the two places for general use throughout the day if the new service should prove successful. The total mileage run by the cars on all the routes last week was 22,990 and the total income £1,316.

Windsor and Maidenhead Light Railway.—A meeting of the inhabitants of Dedworth and Oakley Green has passed a resolution expressing "emphatic approval" of this scheme, and regretting the opposition which is being offered by some of the landed proprietors of the neighbourhood The public enquiry will be held at Windsor on Feb. 13.

Brownhills.—A letter was received at the last meeting of the Urban District Council stating that the Walsall Corporation would advertise during the present month for tenders for the laying down of the tramways on the Walsall Wood route. The tramlines would be laid as far as the Walsall Wood Bridge, and would be completed within 18 months of the signing of the contract.

Poole.—The Poole and District Electric Traction Company have submitted for the consideration of the Council certain proposed amendments to the by-laws made by the Council under the light railway order, and they have been referred to a sub-committee to consider and report thereon. We understand that the company intend to apply for an order for the extension of their light railway through Parkstone.

Central London Railway Co.—The directors of this Company announce dividends as follows: 4 per cent. per annum for the past half-year on the undivided ordinary stock; 4 per cent. per annum for the half-year on the preferred stock; and 4 per cent. per annum for the whole year on the deferred stock. The sum of £10,000 is transferred to the reserve fund, and the balance carried forward is £5,870.

Blackheath-to-Dudley Scheme.—The scheme formulated by the Dudley and Rowley Regis authorities for the construction of an electric tramway from Blackheath, Rowley, and Dudley has been abandoned, owing, it is stated, to the two authorities being unable to agree. Much satisfaction is expressed, however, that during the present year a tramway is likely to be constructed between Old Hill, Blackheath, and Birmingham.

Chiswick.—A petition signed by residents along the High-road, and complaining of the intolerable annoyance caused by the existing circumstances under which the tram service is maintained, was received at the last meeting of the Urban District Council. The petitioners complained of the noise and the inconvenience caused to shopkeepers by the dust occasioned by the tram service, which was too frequent. The matter was referred to a committee.

London "Tube" Schemes.—Further Bills have been deposited by the promoters of the Piccadilly and City and North-East London Railway schemes, with a view of so modifying their proposals as to meet the recommendations of the joint committee appointed last year. With a view to the safety of St. Paul's Cathedral, the promoters have undertaken to deviate under house property, and they do not now propose to interfere with any public building.

Tilbury and Southend Railway.—In the Bill which the London, Tilbury, and Southend Railway are promoting in the present session of Parliament they propose to work their system by electrical power, and to purchase or lease the Whitechapel Branch Railway and the Whitechapel (Mile End) Station of the Metropolitan District Railway. The new capital to be raised is £300,000 with the right to borrow a further £100,000 by the issue of debenture stock.

New South Wales.—Reuter's correspondent at Sydney says that the tramway revenue of New South Wales for the quarter ended Dec. 31 last amounted to £158,168, as compared with £131,835 in the corresponding period of 1900, while the expenditure was £137,504, as compared with £115,269 in the corresponding period of 1900. The increase in the expenditure is due largely to the augmenting of the rolling-stock and improvements in the permanent way.

Camberwell.—The Borough Council are recommended to oppose the Crystal Palace light railway order; the Victoria, Kennington, and Greenwich Railway Bill; the City and Crystal Palace Railway Bill; and the East London, City, and Peckham Railway Bill. The Council have already agreed to support the London County Council's Tramways and Improvements Bill, and to contribute one-third of the cost of the necessary street widenings, not exceeding the sum of £34,000.

Plymouth.—A permanent car-shed of sufficient capacity to accommodate 60 cars, and capable of extension so as to accommodate a maximum of 100 cars, is to be erected on land belonging to the Corporation at Prince Rock, and the borough surveyor has been instructed to prepare sketch plans and an estimate of the cost of the work. Sunday traffic at this place is proving quite as profitable as the weekday services, the profits being about the same in each case.

Pontypridd.—The District Council are applying to the Board of Trade for a provisional order for powers to enable them to construct tramways through the town, and to connect the centre of the town with the tramways which they have had power to lay to Cilfynydd and Treforest and the present tramways to Porth, which they have power to purchase next year. Considerable opposition is being offered to the scheme by the frontagers in Taff-street and Market-square.

Paris Metropolitan Railway.—Details of the scheme for the electric underground railway across Paris from north to south are to hand. The promoters undertake to complete the work within three years, and require no subsidy. They will pay the Municipality a portion of the receipts. The tunnel is to be driven so far below the surface that none of the sewers or foundations of the houses will be disturbed.

Scarborough.—The memorial presented by the Corporation against the Bill promoted by the Scarborough Tramways Company, and in opposition to its passing the Standing Orders stage, is confined to one allegation—viz., that the Bill is one that cannot proceed unless the Corporation give their assent to the proposed tramways, and this consent, the memorial points out, has not been obtained. They, therefore, request that until this assent has been given the Bill may not be allowed to proceed.

Smethwick.—Instructions have been given to the town clerk to endeavour to arrange with the tramways company to abandon their proposals as regards a portion of Rolfe-street and Rabone-lane, and to request the company to undertake to rebuild Cranford-street bridge and Rabone-lane bridge to the satisfaction of the Council, and to widen the several roads shown on the plans by the surveyor, and in the event of their refusing to do this to oppose the Bill to be promoted by them in Parliament.

Birmingham.—At the February meeting of the Town Council a report will be presented dealing with the introduction of electric traction on the Dudley-road. With regard to the Edgbaston and Harborne tramways, the committee recommend the Council not to include the scheme in the forthcoming Corporation Bill. They, however, propose to ask for the inclusion of the general tramway powers on similar lines to those upon which they made their appearance in the late omnibus Bill.

Metropolitan Railway Co.—The directors announce a dividend for the past half-year at the rate of 2¼ per cent. per annum, with £19,200 carried forward. The distribution on the surplus lands stock is at the rate of 2¾ per cent. per annum. A circular has been issued by the stockholders of the Metropolitan Railway Company and the holders of the surplus lands stock advocating a fusion with the District Company under conditions equitable to both companies. A request is made in the circular for proxies to support this course.

Paddington.—Two deputations attended at the meeting of the Borough Council on Tuesday and protested against the London United Tramway Company's projected Paddington and Bayswater scheme, and the London County Council's proposed tramway from the Marble Arch, along Edgware-road, to Cricklewood. The objection to the first scheme was that existing services were sufficient, and to the second that a tramline would depreciate property, and that a "tube" railway was the preferable scheme. The Council decided to oppose both projects.

Hull.—A very successful year is recorded for the tramway undertaking at Hull. No fewer than 20,710,239 passengers were carried on the various routes, bringing in a revenue of £86,292. Satisfactory progress is being made with the extension of the tramways from Prince's-avenue to the far end of Newland-avenue. The lines are now laid nearly half the length of Newland-avenue, and in Queen's-road the foundations have been put in. It is therefore safe to assume that before many months are over the electric trams will have penetrated to this part of the city.

Glasgow.—The chairman and several members of the Sheffield Corporation Tramways Committee, accompanied by the general manager and engineer, visited Glasgow last week, and inspected the tramway power station at Pinkston, with special reference to the coal-handling plant. It appears that engineers and others throughout the country are taking a great interest in this power station. There are almost daily visitors to it. On one day last week, for instance, there were no fewer than three parties inspecting it, one consisting of 70 members, and the other two of not less than 20.

The London-Brighton Electric Railway.—The Bill under which powers are asked to construct an electric railway from London to Brighton, at a cost of about seven millions sterling, came before Mr. Campion, one of the Examiners of Standing Order proofs in the House of Commons, on Saturday, on proof of compliance with the regulations of Parliament. There were eight memorials against the present stage of the Bill alleging non-compliance with Standing Orders. The examiner announced that for the convenience of the parties the consideration of the memorials would be postponed until Thursday, Feb. 6.

Walsall.—The Tramways Committee reported at the last meeting of the Town Council that agreements had been exchanged with the South Staffordshire Tramways (Lessee) Company, Limited, for carrying out the arrangement for the supply to them by the Corporation of current for working the Bloxwich section of the tramways, and for the working by the company of the proposed tramway extensions to Bell-lane. The electrical engineer has been instructed to apportion the actual cost of the work to be borne by the tramway and electrical departments respectively, the total expenditure being deemed to be for tramway purposes.

Private Bills in Parliament.—Among the Bills which came before the Examiners of Private Bills in the House of Commons on Tuesday for the investigation of Standing Order proofs were the Central London Railway new lines, the City and Brixton Railway, the Edgware and Hampstead Railway, and the Metropolitan District Railway. Proof of compliance with Standing Orders was given before the Examiners on Saturday in the case of the following Bills: The North-West Railway, Charing Cross, Euston and Hampstead Railway (No. 3), City and North-East Suburban, and the Brompton and Piccadilly-circus Railway (New Lines and Extensions).

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Leeds.—Mr. Wm. Wharam, who is about to retire from the position of general manager of the Leeds city tramways, was appointed secretary of the old Leeds Tramways Company 29 years ago. When the new Leeds Tramways Company started in 1873, there were only two routes open. The takings then amounted to between £4 and £5 per car per day, or to about £400 to £500 a week, as against over £4,000 a week at present with the magnificently equipped electrical service. When the company started the staff numbered 67 men all told; to-day, under the Corporation, 1,140 men are regularly employed. The men now work fewer hours and receive higher wages.

East London Railway Co.—Speaking at the half-yearly meeting of this Company, the Hon. A. E. Gathorne-Hardy (chairman) said proposals had been made for electrifying their system, but the matter was *sub judice*. There was no doubt whatever that the traffic could be better conveyed by electric traction, which was cleaner and better. This, however, was a matter which did not rest with this Company. Their line was directed and managed under the Act of 1882 by six companies, and he understood that the report of the managers favoured both means of traction on the East London Railway, and this report would come before the next meeting of the joint committee.

Lees.—The memorial of the Urban District Council complaining that the promoters of the Saddleworth, Springhead, and Lees Tramways Bill have failed to comply with the Standing Orders of Parliament, alleges that the deposited plans are inaccurate, and that the books of reference, except those deposited at the Private Bill Office, do not comply with the Standing Orders, as they contain several pages of numbers which are not shown on the plans. It is further alleged that the promoters have not obtained the memorialists' assent to the construction of the tramways through their district; and the memorial concludes by stating that the District Council "refuses, moreover, to give such consent."

Hammersmith.—A deputation representative of various church congregations has waited on the Borough Council and complained of the disturbance during the hours of public worship on Sundays by the running of the electric cars. The matter was referred to the Law and Parliamentary Committee. In order to obtain a *locus standi* the Law and Parliamentary and Works (Joint) Committee recommend that petitions be prepared and presented to Parliament, on behalf of the Borough Council, against the following Bills: the London United Tramways, the London County Council (Tramways and Improvements), the London United Electric Railway, the Central London Railway (New Lines), the Piccadilly and City Railway, and the Charing Cross, Hammersmith, and District Railway.

The Proposed "Tube" to the Crystal Palace.—The Bill promoted by the City and Crystal Palace Railway Company asks for powers to construct a line seven miles in length, from Queen-street, Cheapside, to the Penge entrance of the Crystal Palace. The proposed railway will be constructed on the principle of the "tube" railways, but the diameter of the tunnels is to be slightly larger. The generating station will be at Camberwell, abutting on the Peckham branch of the Surrey Canal. The proposed capital is £5,000,000. The promoters of the Bill are Mr. George Riley, Mr. Herman Gwinner, and Mr. Jamieson Ritchie, who, with two others, will be the first directors. The period required for the construction of the line is five years from the passing of the Act, and during this period power is sought to pay interest out of capital.

Tyneside Tramways.—The Examiners of the Standing Orders of the House of Commons had before them on Tuesday the Bill promoted by the Tyneside Tramways and Tramroads Company for the authorisation of new lines and extensions of their system. A memorial alleging non-compliance with the Standing Orders was lodged by Messrs. S. W. Whittlestone and C. H. Billing. The allegations were that the promoters had not specified their intention of taking parts only of certain lands, and that in several particulars the plans and sections were incorrectly drawn—that the gradients were incorrectly shown, and in some instances the surface of the ground was not shown. The latter allegation was not sustained. On the first allegation, Mr. Jeune, the examiner, said he would ascertain what was the settled practice, and report in accordance with it.

Torquay and Paignton Tramways.—A Bill has been deposited for promotion in this session under which power is sought to incorporate the Torquay and Paignton Tramways Company for the purpose of constructing nearly 12 miles of tramways in the borough of Torquay and the urban district of Paignton. The proposed tramways are to be constructed on a gauge of 3ft. 6in. and are to be worked by electricity, special provisions being made for the attachment of brackets to buildings with the consent of the owners. The capital of the company is fixed at £160,000. Since the Bill was deposited a memorial has been presented to the examiners by the Corporation of Torquay in opposition to the Torquay and Paignton Tramways Bill being allowed to pass the Standing Orders stage, alleging that the Corporation's consent, which has not been given, is essential.

South Shields and Sunderland Tramways.—In the memorial of the Corporation of South Shields against the Bill to authorise the British Electric Traction Company to construct tramways between South Shields and Sunderland, it is alleged that the promoters have failed to comply with the Standing Orders of Parliament in respect of the publication of street notices. It is also contended that the parliamentary notice was also defective, inasmuch as it did not state on what lands generating stations would be erected, nor did it state that tramways were to be laid along Dean-lane. Generally, it is also contended that the notice is misleading and faulty, and does not comply with the Standing Orders. The memorialists further point out that, as the road authority, their consent has not been obtained to the laying down of the proposed lines, which is required by the Standing Orders.

Farnworth.—From the opening of the tramways a week or two ago a regular service of electric cars has been maintained between Moses Gate and the town boundaries in Longcauseway and Worsley-road. The cars are being well patronised, and the children with their half-pennies are proving an excellent source of revenue. So far there has not been the slightest hitch in the running, and the only difficulty met with is due to the decision of the Tramways Committee to employ only Farnworth men. The new drivers are being rapidly trained in their work. When the Kearsley length is opened in a few weeks it is thought there may not be cars enough to meet emergencies, and it is probable that the present complement of eight will be increased. Arrangements have been made for carrying the Egerton-street line as far as the entrance to Moses Gate Station, with a loop on to the square that the present waiting at the top of Francis-street may be obviated, and this work will be commenced next week. The number of passengers carried and the receipts for the first week were 15,274 and £48. 19s. 7d. respectively.

Aberdeen.—The Great North of Scotland Railway Company will offer strong opposition to the granting of the provisional order promoted by the Aberdeen Suburban Tramways Company, on the ground that no justification can be shown for the granting of the proposed powers. The Town Council and County Council are also opposing the scheme in order to safeguard their interests. It has been remitted to the Tramways Committee to consider and report as to carrying out the extension of the tramway system to Ferryhill, according to the parliamentary plans, or in a modified form, and, if possible, along with the other tramway works sanctioned by the Council on 6th inst. A report by the burgh surveyor and electrical engineer in connection with the electrical equipment of the Rosemount circular route is before the Tramways Committee. The combined estimates amount to between £11,000 and £12,000. The electrical engineer proposes to place along the west side of Union-terrace poles with long arm brackets stretching out, and thereby obviating the necessity of having poles on the east side of the terrace, next the gardens. The burgh surveyor proposes to make a long passing place from the north end of Union-terrace to a point in Rosemount-viaduct. The rails will be renewed where necessary, and where there are steep gradients. It is hoped that permission will be got to have rosettes fixed on the buildings in Rosemount-place and Beechgrove-terrace, while it is also trusted that permission will be obtained to put the poles inside the gardens in Fountainhall-road.

Kensington.—The Works Committee report that they have had the following schemes before them for consideration: the Brompton and Piccadilly-circus Railway (new lines and extensions); the Central London Railway (new lines); the Metropolitan District Railway; the Charing Cross, Hammersmith, and District Electric Railway; the London United Electric Railways; the Piccadilly and City Railway (No. 2); and the London United Tramways. They have also considered the report which has been prepared by the borough engineer and surveyor upon the several schemes, and fully endorse the views and recommendations embodied therein as regards the construction of the tube electric railways. There are, however, other points to be considered, the first of which has reference to the ventilation of the railways. They consider that the air in the tunnels should be changed at such a rate as is required by the laws of hygiene, and that the change should be effected irrespective of the motion of the train. They also consider that it behoves the authorities to see that adequate provision is made for ensuring the safety from fire of the public travelling by the trains, and for providing safe egress from trains which may from any cause be delayed in the tunnels. It is further suggested that the lighting of the stations and trains should be required to be distinct from the power circuit. With regard to the scheme of the London United Tramways Company, the committee recommend that the Council's consent should be withheld from the proposed tramway along Holland-park-avenue and the High-street, Notting Hill, which in the opinion of the committee "is most objectionable."

London County Council.—It was unanimously agreed at the reassembling of this body at Spring-gardens on Tuesday after the Christmas vacation to purchase the lines of the South-Eastern Metropolitan Tramways Company, who have agreed to sell for £50,000. The tramways are about 2½ miles in length, of which a little over half a mile is double, while the remainder is single track; and, starting within a very few yards from the London County Council tramways in Greenwich-road, their route is along South-street, Greenwich, Lewisham-road and High-street, Lewisham, to the terminus at Rushey-green. Thus it will be seen that they can easily, by means of a short junction line, be made to form part of and be worked with the Council's system of tramways. The company's profits for the last completed year were £5,000, and it is estimated that if the employés are placed on a better footing and fares readjusted, the Council will make a profit of £3,500 annually, sufficient to meet interest and sinking fund and to wipe out the debt of £51,000, including legal expenses, within 25 years. In regard to the London United Tramways Company's application for an order to construct a light railway through a part of the London county, the Highways Committee pointed out in their report that in the order the local authorities have power to purchase as a going concern after 25 years. The commitee did not think these terms advantageous enough, and further showed that the order does not make sufficient provision for workmen's cars. It was, therefore, decided to oppose the order, as well as another sought by the Crystal Palace Light Railways Company, on the ground that it seeks to make a line from Lordship-lane to the Crystal Palace, almost wholly in the county of London, and along a route which the County Council intend to extend their tramlines.

Light Railways Bill.—On Wednesday the President of the Board of Trade received in his private room at the House of Commons a deputation of members of the council of the Roads Improvement Association with reference to the proposed Light Railways Bill of the present session. The deputation supported the following proposals: "(1) That it should be made possible for promoters to obtain power to take a long strip of land compulsorily for the purposes of building a new road, on which the light railway is to be laid, and to obtain

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exemption from the operation of Clause 92 of the Lands Clauses Act, full compensation to be paid, however, to the owners of property for any depreciation sustained by severance. In estimating this compensation, any betterment to the property resulting from the construction of the railway and the road should also be taken into consideration. (2) That promoters should also be able to obtain power to acquire the frontages on both sides of the new road, and to sell or let them for building purposes. (3) That they should also be able to obtain power to make roadways suitable for other classes of traffic, and to arrange with the local authority for a contribution towards the cost of the same. (4) That they should be able to obtain power to tunnel under the roadway in and near the neighbourhood of large towns. (5) That it should be provided that the Board of Trade shall pass no scheme for laying a light railway on a public highway until they have satisfied themselves, on the consideration of the report of one of their inspectors (as well as any evidence which may be offered by the promoters or opponents), either that the highway is already wide enough for the light railway and the present and prospective ordinary traffic, or that sufficient provision is made in the scheme for widening it within a reasonable time, and that such provision may be made either by way of a capital charge, or by annual payments. (6) That further provisions shall be inserted to secure the efficient upkeep of the surfaces of the roads upon which light railways have been laid."

LIGHTING AND GENERAL.

Brechin.—The Angus Electric Light and Power Company, Limited, are pushing forward the duplication of their plant.

Kenilworth.—The District Council are not taking any action with regard to the Warwickshire and Leicestershire Electric Power Bill.

Llanelly Dock.—The Llanelly Harbour Commissioners have received 13 tenders for an electric light installation for the new dock.

Salford.—The new electric lamps in Blackfriars-street and Chapel-street, Salford, were lighted for the first time on Thursday last week.

Partick.—It is expected that the electric light will be switched on by the end of the month, and the opening ceremony will take place early in February.

Broadstairs and St. Peter's.—The positions of the proposed electric arc lamps on the sea-front and in the main road leading from Broadstairs to St. Peter's have been fixed.

H.M.S. "Warspite."—It has been decided that the "Warspite" shall be lighted in future by the electric light, and the installation is being proceeded with as rapidly as possible.

Taunton.—The new 250-kw. alternator has been supplied and erected at the works. The connections to the mains during the past quarter were equivalent to 535·8-c.p. lamps.

Portishead.—The District Council have asked the Bristol Town Council to insert into the Corporation's Electric Lighting Bill certain clauses to protect the interests of Portishead.

King's Lynn.—The Electric Lighting Committee have entered into an agreement with the Guardians to wire the workhouse for £148, and to supply a current at 4½d. per Board of Trade unit.

Longford.—The governors of the county infirmary are discussing the lighting of the institution. It appears that the institution is very badly lighted, and electric light is also required for the X-rays.

Hamilton.—In view of possible proposals from electric lighting and power corporations, the Electric Lighting Committee have been asked to negotiate for tenders to work the burgh's electric lighting power order.

Leigh.—A suggestion by Mr. Fred Taylor, that he should make a survey of the district and ascertain the probable annual cost of working an electric lighting order, is before the Urban District Council in committee.

Trowbridge.—The Urban District Council have decided to abandon their proposal for an electricity supply scheme, as the borrowing powers of the Council will not for some time permit of a sufficient loan being raised.

The "Rochdale Observer."—We are informed with reference to a note on the extension of the premises of the *Rochdale Observer* in our last issue, that the supply for the installation described is taken from the Corporation mains at 440 volts.

Ilford.—The electric light is to be extended to the new hospital, the approximate cost of the extension being £425. The engineer has been asked to prepare an alternative estimate of the cost by taking the cables to the hospital through Little Heath.

Colchester.—A writer in the *Essex Telegraph*, commenting on municipal telephones, says "if Colchester had its own system as Guernsey has, and used it in the same proportion, there would be 840 houses in connection with the exchange.

Spennymoor.—The Callender Cable Company have been busy for some time in laying down the cables for the electric light in the principal streets, shops, etc., and every effort is being made to complete the work in a very short period.

Swansea.—The Electric Lighting Committee's last report states that the expenditure in connection with electric lighting to Dec. 31, 1901, on capital account was £50,509. 19s. 3d., and on revenue account £2,649, making a total of £53,159.

Portsmouth.—The Telephone Committee have formally decided to offer the position of engineer and manager to Mr. Gardner, who ably pioneered the municipal exchange at Tunbridge Wells, and who still occupies a similar position under that Corporation.

Scarborough.—The Municipal Telephone Sub-Committee have decided to engage Mr. A. R. Bennett in connection with the proposal to establish a municipal telephonic system, and to write to the Postmaster-General for a map of the local telephone area.

Copper.—Chiefly on account of the fall in price of high-conductivity copper, the London Electric Wire Company, Limited, Golden-lane, E.C., have made a further discount of 10 per cent. on their listed prices of wires and cables for electric lighting and power.

Dictionary.—Ulrico Hoepli, Milan, has published a second edition of E. Webber's technical dictionary in Italian, German, French, and English. The corresponding volume of the 1892 edition has 409 pages, while in the present edition they reach above 550.

Stroud.—A committee (consisting of the chairman, vice-chairman, Messrs. E. P. Little, S. J. Newman, J. Lapage Norris, Chas. Curtis, and J. Dudbridge) has been appointed, with power to consult an expert, with regard to the Gloucestershire Electric Power Bill.

Gorton.—At a recent special meeting the Electric Lighting Committee discussed with Mr. J. S. Enright, the consulting engineer, the offers received from the Manchester Corporation and the Lancashire Electric Power Company to introduce electric light into the district.

Pemberton.—The formal inauguration of electric lighting in the district and the opening of new electric works by the District Council took place last week, the ceremony of turning on the electric light being performed by Mrs. W. Sharrock, wife of the chairman of the Council.

Plymouth.—The successful annual dinner and smoking concert of the afloat section of the Devonport Dockyard electricians and their co-workers was held on Saturday at Sleeman's Restaurant, Old Town-street, Plymouth. Covers were laid for about 50. Mr. W. Prout presided.

Dover Telephones.—The Corporation have decided not to apply for a municipal telephone license. They were advised that a municipal system would entail a cost of nearly £30,000, for which there would not be an adequate return in competition with the National Telephone Company.

Technical Terms.—In the present number (4) of the *Revista Maritima Brazileira*, published by the Government printer, Rio de Janeiro, there is commenced a list of technical terms in Portuguese, French, and English, which may be found useful to intending contractors.

Horsham.—The Postmaster-General has informed the Urban District Council that he would not be justified in placing underground the wires which he was desirous of erecting along Wimblehurst-road. The town hall will be wired for electric light at an estimated cost of £41. 10s.

St. James's and Pall Mall Electric Light Co.—The directors recommend a dividend for the half-year ended Dec. 31 of 7s. 6d., together with a bonus of 2s. per share on the ordinary shares, making, with the interim, a dividend of 12½ per cent. and a bonus of 2 per cent. for the year 1901.

City of London.—The Streets Committee are discussing a letter from the City of London Electric Lighting Company reiterating the request that the Corporation would decide without delay whether the company should continue the lighting of the main thoroughfares in the western and central districts.

Lectures.—On Wednesday the Rev. John M. Bacon read a paper on "Scientific Observations at High Altitudes" at the Society of Arts. Mr. E. R. P. Moon, M.P., presided at the first lecture of a course of ten on "Electric Power and Lighting," by Mr. E. Halford Strange, at the William Ellis Schools, Kentish Town.

Fleetwood and District Electric Light and Power Syndicate. The income of the Company for the last quarter is reported at over £600, and the expenditure averages about £250 per quarter, so that there should be some little margin left either for distribution as dividend or for expending on new machinery.

Greenock.—In a recent issue we made a note on a short leet for the post of electrical engineer for this town, but we have now ascertained that the report must have been forwarded to us by someone suffering under a curious misapprehension, as no such vacancy exists, of which fact we hasten to apprise intending applicants.

Aberdeen.—An electric installation which has been introduced in Rubislaw parish church, Aberdeen, through the generosity of Mr. Harvey Hall was switched on for the first time at public service last Sunday. The work has been executed by the Aberdeen Electrical Engineering Company, Limited, Belmont-street.

Lewisham.—The Borough Council have assented to the Camberwell Borough Council's application to the Board of Trade for a provisional order under the Electric Lighting Acts to supply electricity in the parts of the parish of Lewisham transferred to the borough of Camberwell under the Local Government Act, 1899.

Hull.—The Property and the Baths Committees are conferring about using the site of the Trippett Baths, which show gradually diminishing receipts, for the proposed municipal telephone exchange. Colonel A. J. Hepper has held an enquiry into the application of the Corporation for sanction to borrow £47,900 for purposes of electric lighting.

Tiverton.—With regard to the electric lighting scheme prepared by Mr. W. P. Adams for lighting Tiverton with electricity from the Exe at Washfield Mills, two miles distant, to which we referred some months ago, the Town Council have now decided to submit the same to the highest hydraulic and electrical expert for his opinion.

Personal.—Mr. E. T. Williams was recently presented by the members of the Belfast electricity department with a handsome case of razors and shaving tackle on the occasion of his leaving to take up a position as engineer-in-charge at the new Corporation electricity works, Salford. Mr. Williams held a similar position at Belfast.

Norwich.—The Town Council on Tuesday confirmed the resolution of the Council to promote a Bill to empower the Corporation to acquire the undertaking of the Norwich Electricity Company, Limited, to carry on, extend, and improve the undertaking, and to make further provision in regard to the issue of stock and the borrowing of money.

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Penge.—The electric light company have informed the Council that negotiations are now proceeding by which it is expected that the supply of electricity will shortly be available. It appears that the company will be unable to arrange for the supply except under terms of the provisional order so far as the maximum price for private consumers is concerned.

Huddersfield.—It appears that in a very short time the principal streets will be pulled up for conversion of the steam tramway lines to electrical traction, and the Town Council are now approaching the National Telephone Company to ascertain what terms they would be prepared to offer in order to obtain a license to lay their wires underground at the same time.

United States Metallic Packing.—We have received from the United States Metallic Packing Company, of Soho Works, Bradford, some interesting information in connection with their well-known engine packings. These were used largely on the 5,000-h.p. Musgrave engines in the Glasgow tramway station, and are also employed by other prominent engine builders in this country.

Newton Abbot.—The Urban District Council have adopted the Board of Trade's regulations relative to the proposed installation of electric light. At their last meeting it was pointed out that the local company was under a bond of £500 to supply them with light within two years of the passing of the Act, and a resolution was passed to the effect that they be called on to forfeit their bond.

Hastings.—A number of tenders have been accepted, and extensions of the electric light mains and incandescent light will be substituted for the present burners in the whole of the lamps in Old London-road from the top of High-street to Christ Church, St. Helens. Application will also be made to the Local Government Board for sanction to a loan of £52. 10s. for another extension.

Llandudno.—The charges for electricity will be reduced from 6d. to 5d. per unit where the current is supplied on the flat rate. Where it is supplied on the maximum demand system the charge is to be 7d. per hour for the first hour, as before, but afterwards 2d. per hour will be charged instead of 3½d. The Urban District Council have decided to allow the electrical engineer to take a pupil.

Mansfield.—A sub-committee of the Electric Lighting Committee has arranged terms with Messrs. Sanderson and Robinson to supply electricity to their new works. Mr. Tonge has been appointed clerk of the works of the new electricity working at a salary of £3. 13s. 6d. per week. The Telephone Sub-Committee have retained the services of Mr. A. R. Bennett, M.I.E.E., as consulting engineer.

Ham.—The District Council will ask Mr. Skewes-Cox to support any action that might be taken in Parliament in pursuance of the action of the recent telephone conference. Permission has been granted for the laying of the Kingston municipal electric lighting cable to four houses to be built in the grounds of the Albany Club, on condition that the Kingston Corporation undertake to withdraw the cable when required.

Manchester.—The foundation stone of a new electricity generating station to be erected by the Corporation was laid on the 16th inst. The building will cover an area of over eight acres, and with its sub-stations will rank as one of the largest establishments of its kind in Europe. The estimated cost, when 27,000 h.p. has been provided, is nearly £1,000,000. The plant will eventually be laid to produce 70,000 h.p.

Wireless Telegraphy.—The Marquis of Graham, addressing the London Chamber of Commerce on the subject of wireless telegraphy on Sunday, according to an Exchange Company's telegram, said the Cape Government had made liberal provision for its adoption by an agreement with Lloyd's. Bird Island and Dassen Island would be connected with the mainland, and this would be invaluable both in peace and in war.

Newcastle.—At a meeting of the City Lighting Committee on Wednesday, it was reported that the Tramway Committee would furnish 200 electric lamps instead of the 24 at present in use, to be placed in different parts along the tramway route. Arrangements will be made to have a joint meeting of the two committees when the electric lights are ready. The estimates for extra electric lighting will involve an additional cost of nearly £3,000 for the year.

Electrical Exhibition.—The Twentieth Century Electrical Exhibition, which is now drawing to a close, has been well visited. The management are carrying out an exceedingly good programme, bristling with novelties, at the World's Show, in the centre of the hall, which tends to attract many for whom electricity alone would, perhaps, not be a sufficient inducement. Mr. Lynd continues his lucid explanations and demonstrations of wireless telegraphy and Tesla coils.

Books Received.—"Graduated Exercises in Elementary Practical Physics," by Clement J. Leaper, principal of and lecturer on physics and electrical engineering at the Taunton Municipal Technical Institute. Illustrated; price, 2s. 6d. Biggs and Co., 139-140, Salisbury-court, Fleet-street, E.C. "Practical Exercises in Magnetism and Electricity," being a laboratory course for schools of science, by H. E. Hadley, B.Sc. (Lond.) Price, 2s. 6d. Macmillan and Co., Limited.

Henbury.—In the Bristol Corporation Bill it is proposed that a portion of the parish should be included within the city boundary, and that the whole of the parish should be included within the area for the supply of electrical energy for all purposes. As the Barton Regis Rural District Council are promoting a provisional order from the Board of Trade under the Electric Lighting Acts, the Parish Council consider it undesirable to take any individual action in the matter at present.

Hampstead.—The Borough Council have adopted a report of the Lighting Committee, stating that they had carefully considered the question of putting in further steam alternating plant at the station for the winter of 1903 and had received a report from the engineer on the subject, and had given instructions for a copy of it to be forwarded to each member of the Council. The committee recommended that tenders be invited for the erection of an 800-kw. non-condensing (1,000-kw. condensing) plant at the station.

Accident.—An accident occurred on Thursday last week in the wagon-building works of Messrs. Hurst, Nelson, and Co. at Motherwell, resulting in damage which is estimated at £1,000. The accident appears to have been due to the bursting of a flywheel. Two valuable dynamos and a large Tangye steam-engine for driving the same were completely wrecked. Only the spokes of the flywheel were left. The roof of the electric station was blown off, and various parts of the buildings and outhouses were more or less damaged.

Dundee Telephones.—In answer to the proposal to establish a municipal telephone system in the city already more than 1,000 replies have been received, and in almost every case intimation has been made that an instrument would be taken. The promoters of the scheme considered at the outset that were 1,000 subscribers obtained they would be justified in proceeding, and as that number has already been secured, while many more are yet confidently expected, the Town Council will be asked shortly to apply to the Postmaster-General for a license.

Boston.—Having considered Mr. Adrian Collins's report on electric lighting, the Town Council have decided to invite three or four firms to submit schemes of public lighting and electric traction and supply of motive power, with estimates, the said firms to give alternative estimates showing terms upon which they would work the scheme put forward for a period of years, and the terms upon which the Corporation could then acquire the concern. The selection of the firms to be invited has been placed in the hands of the Mayor and Mr. Councillor Gane.

Luton.—The electrical engineer's last report states that since Dec. 6, 1901, 8,476 units have been generated, 206 8-c.p. lamps connected, making a total of 53 customers with an aggregate of 3,975 8-c.p. lamps and three motors, and that at the present time premises are being wired equal to 290 8-c.p. lamps. The well at the electricity works is completed, and there will be a plentiful supply of water for condensing purposes. The pump and motor will now be obtained. A switchboard attendant is to be engaged at wages not exceeding £1. 5s. per week.

Halifax.—The representatives of the Town Council, the Chamber of Commerce, and the Drapers' and Hosiers' Association have, after considering a letter of the National Company offering new conditions for the working of the telephones in Halifax, unanimously declined the terms offered by the company. The new Bill which the Halifax Corporation are promoting in Parliament provides for the establishment of a municipal telephone exchange, and recently the town clerk was instructed to apply to the Postmaster-General for a license to enable the Corporation to construct and work such an exchange.

Mangotsfield.—The Corporation of Bristol propose in their Bill this session to take powers to supply electrical energy for all purposes within the parishes of Mangotsfield, Kingswood, and Hanham. The Parish Council have written to the County Council as follows: "This Council is opposed to the Bill as it stands, and it would like your Council to insist upon the insertion of clauses which will prevent them from supplying our district except in bulk to us, and then at a price which will enable us to retail it to our ratepayers at the same price as that charged in Bristol."

Folkestone.—As already noted by us, the Corporation are considering the question of applying for a license to establish and work a system of municipal telephones, and they are advised that the Postmaster-General will only grant a license for the existing exchange area, which includes Dover, Sandgate, Hythe, Cheriton, and certain places within the rural districts of Ewell and Elham. How far the recent action of Dover Corporation not to proceed with their scheme will affect Folkestone cannot be determined at the present moment. In the meantime the local authorities of the places named are considering the matter.

Kingstown.—At the last Urban District Council meeting a vote of thanks was accorded Mr. Wallace for his services as chairman of the Electricity Committee. A protest was entered against the statement that had been made to the effect that the Kingstown electric lighting provisional order had cost £2,000, while Blackrock had paid only £70 for a similar order. It was stated that the order had only cost £250, and at the time that the order was sought and granted, the conditions were quite different from what they now were. The £2,000 had been spent in preparing the plans and making everything ready up to the point at which the work would be entered upon.

West Hartlepool.—At the last meeting of the Town Council the electrical engineer was instructed to prepare specifications for additional plant at the electric lighting station. The Chairman of the Electric Lighting Committee commented on the progress and financial position of the undertaking, and remarked that if he had been in the better paid position of chairman of a private company having control of the concern, he would have been able to recommend a dividend of 3 or 4 per cent. at the end of the first financial year. He hoped at the end of the financial year to not only indicate some small benefit to the ratepayers, but also a reduction in the maximum charge to consumers.

London Gazette.—The partnership existing between A. E. Pemberton and W. Rodger, carrying on business as the Sale Electrical Company at Tatton-building, School-road, Sale, has been dissolved by mutual consent. The partnership existing between W. B. Carrick and J. Anderson, electric light and power engineers and consulting electricians, trading as W. B. Carrick and Co., at 46, High West-street Gateshead, has been dissolved by mutual consent. The last day for receiving proofs in the estate of W. V. Scott, electrical engineer, lately residing at 1, Shaftesbury-road East, Hammersmith, is Feb. 5.

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Mr. A. H. Wildy, official receiver, Bankruptcy-buildings, Carey-street, W.C., is trustee.

Electric Contractors.—At a meeting of the northern section of the National Association of Electrical Contractors at the Grosvenor Hotel, Manchester, on Saturday, Mr. H. Bland (Newcastle-on-Tyne) presided, and in the course of his address adversely criticised the general extension of municipal trading. The following resolution was carried: "That the National Association of Electrical Contractors be requested to take action, in conjunction with all kindred associations, for the purpose of defining the limits of legitimate municipal enterprise as regards electrical work, and of strengthening the hands of those who are unfairly exposed to competition by municipal and other authorities trading under parliamentary powers."

Cardiff Telephones.—At the annual staff dinner of the Cardiff district of the National Telephone Company on Saturday evening, Mr. Horatio Bell, district manager, mentioned that the staff, which numbered 245 members, dealt on an average with 34,740 calls per diem at the 42 exchanges in the district. He deplored the unwillingness of the Cardiff Corporation to grant the company those facilities vested in them by Act of Parliament, and said so long as the Corporation refused them so long must the subscribers be content with an indifferent service. He said if the storm which recently raged in the Midlands had visited Cardiff with its overhead system, the town would have been without a telephone service for two months.

Poplar.—The Borough Council have adopted the following report of the Electricity Committee: "We have considered the report of the electrical engineer showing that in view of the growing demand for the supply of electric current to the neighbourhood, and in order to balance the load between the two feeding points at either end of Glengall-road, it is necessary that an additional network cable be provided on the south side of Glengall-road, Isle of Dogs. A trench has to be opened for laying a main along the route of the proposed cable, and if the two works are carried out together a saving of £221 will be effected. We recommend (*a*) that an additional network cable be provided on the south side of Glengall-road for a distance of 1,200 yards, at an estimated cost of £993."

Rochdale.—At the annual meeting of the Rochdale Merchants' and Tradesmen's Association on Wednesday last week, the following proposition was discussed: "That we, the members of the Rochdale Merchants' and Tradesmen's Association, regret the action taken by the Town Council in deferring the telephone question for 12 months, and request that all information possible be obtained during that time, and, if necessary, the question be reopened before the expiration of the time for which it was adjourned." On a show of hands being taken the resolution was defeated, the votes being five for and nine against. A number of those present remained neutral, there being a strong feeling that it would be unwise to do anything which would have the appearance of censuring the Corporation.

Exeter.—The Electric Lighting Committee have recommended to the Town Council that application be made for sanction to borrow £70,000 for electric lighting, principally for the erection and equipment of the new electricity station. The chief items are: land, etc., £2,000; buildings, £13,905; contingencies, including condensing water-pipes from basin, £1,390; railway siding, £600; equipment as per Westinghouse tender, £29,707; boiler, feed pump, and weigh-bridge, £1,264; main feeders from new station, £3,500; and extensions of mains, including services for 400 consumers, and making good roads and pavements, £9,030. Mr. Robert Hammond is to be engaged to act as expert to examine and report on the specification and conditions for equipment of the new works.

Camberwell.—In view of similar resolutions passed by the Westminster City Council the London County Council are to be informed that the Borough Council have decided to support the London County Council in obtaining powers to control the breaking up of streets by the water, gas, electric light, and other companies, provided that such powers are placed in the hands of the local authorities. Taking into consideration the varying circumstances and necessities of the different boroughs, the Borough Council consider it must be provided that the making of regulations and by-laws should also be in the hands of the local authorities; and that the Board of Trade should be constituted the appeal authority in cases of dispute between the city or borough councils, and any of the companies.

The Borough Theatre, Stratford.—Several interesting and novel electrical effects have been introduced into the pantomime now running at this theatre. This is especially so in the "Alphabet" scene, in which, on the appearance of the letter E (which, according to the book, stands for electricity), a very powerful incandescent lamp is switched on, effectively lighting up the whole stage while the gas and limes are lowered. At the end of the scene the whole of the letters of the alphabet are shown electrically illuminated, and then the words "God save the King" are formed at the front of the footlights while the remainder of the house is in darkness. Another electrical effect is to be found in the large Christmas tree carried by Santa Claus, which alternately lights up in white, red, or blue, or in a combination of the whole. A visit to the Borough Theatre to see the merry "Babes in the Wood"—which, by the way, is capitally played and staged—will amply pay for the trouble of going to Stratford.

Ipswich.—The Roads and Bridges Committee of the East Suffolk County Council on Tuesday adopted a report of the sub-committee appointed to consider Messrs. Barber and Croft's application to erect poles and wires for electric lighting purposes at Oulton Broad, in which the sub-committee stated that apart from any question of right to grant a wayleave for posts for an electric cable, the road was not sufficiently wide to admit of posts being erected without causing an obstruction to users of the highway. The Clerk stated he had received a letter from the Mutford and Lothingland District Council upon the matter, intimating that they themselves had received an application of this nature from the Lowestoft Town Council, who desired consent to supply electricity in parts of the district. The District Council had considered the advisability of applying for a provisional order, and accordingly asked that the County Council should defer coming to a decision until the District Council had had an opportunity of expressing their views on the matter.

Cardiff.—The Electric Lighting Committee propose to approach the Cardiff Railway Company for permission to lay a main for the distribution of electric light and power to property in the docks districts within the borough. This step has become necessary in consequence of the proposed competition of the South Wales Electrical Supply Company, Limited, which might be able to lay a main along the private property of the railway company inside the borough boundary. The last report of the electrical engineer (Mr. Ellis) states that during the past 12 months there had been a satisfactory increase in business, the number of consumers now totalling 530. The total number of 8-c.p. lamps connected during the past 12 months was 15,250, or an increase of 50 per cent. upon the number connected during the previous year. The maximum load showed an increase of 30 per cent., and the units generated an increase of 44 per cent. Notwithstanding this large increase the wages showed an increase of only a little over ½ per cent.

Coventry.—The following accounts for the quarter ending Dec. 31, were laid before the Electricity Committee at their last meeting: Station charges, £1,338; interest and sinking fund, £947—total costs, £2,285; revenue, £2,005—net deficit, £280. Quarter ending Dec. 31, 1901: station charges, £1,017; interest and sinking fund, £981—£1,998; revenue, £2,334; total costs, £1,998—net profit, £336. Station charges for December quarter, 1900, 2·55d. per unit; station charges for December quarter, 1901, 1·64d. per unit. December quarter, 1900—coal used, 1,167 tons; units sold, 125,000; December quarter, 1901—coal used, 989 tons; units sold, 148,000. December quarter, 1900, 23lb. coal used per unit sold; December quarter, 1901, 14·9lb. coal used per unit sold. Under the new scale the Corporation will make the following charges for current supplied for lighting: 6d. for the first hour, 3d. for the second, and 1d. for the third and subsequent hours. The Council has also decided to reduce the price of electrical energy for motive power to a flat rate of 1½d. per Board of Trade unit.

Stock Exchange.—The Stock Exchange Committee have appointed 29th inst. a special settling day for Marconi's Wireless Telegraph Company, Limited, further issue of 12,736 shares of £1 each, fully paid, Nos. 137,084 to 149,819; and Feb. 5 for British Electric Traction Company, Limited, further issue of 37,926 ordinary shares of £10 each, fully paid, Nos. 122,075 to 160,000, and 10,000 6 per cent. cumulative preference shares of £10 each, fully paid, Nos. 190,001 to 200,000. The committee have ordered the undermentioned securities to be quoted in the official list: British Electric Traction Company, Limited, further issue of 37,926 ordinary shares of £10 each, fully paid, Nos. 122,075 to 160,000, and 10,000 6 per cent. cumulative preference shares of £10 each, fully paid, Nos. 190,001 to 200,000; also Commercial Cable Company's further issue of £100,180 sterling 500-year 4 per cent. debenture stock (redeemable). The committee have been asked to allow to be quoted in the official list National Telephone Company's further issue of £100,000 4 per cent. debenture stock (redeemable).

Radnor Asylum.—Messrs. Austin and T. Bernard Graham, of Church-street, Middlesbrough, have obtained from the County Councils for Radnorshire and Breconshire the contract for a complete electric light installation at their new joint asylum now building at Talgarth at £4,000. There were in all 26 schemes submitted. There will be approximately 1,300 lights throughout the main asylum buildings. The plant comprises three Galloway boilers, which are already installed, Messrs. Graham supplying the following: three high-speed enclosed engines, coupled to direct-driven dynamos, a storage battery capable of maintaining all lights required throughout the night, motors to the capacity of 30 b.h.p. for working the laundry machinery, booster for charging storage battery flarye, main switch-board, fitted with most modern and improved switch gear. The plan of lighting is so arranged that the medical superintendent will be able to make a complete tour of the building, lighting himself through at one door, and switching lights off at the other end as he leaves the dormitory or corridor, whichever it may be.

Pocket-Book.—Foster's "Electrical Engineer's Pocket-Book" is described on the title page as a handbook of useful data for electricians and electrical engineers, by Horatio A. Foster, M.A.I.E.E. and M.A.S.M.E., with the collaboration of eminent specialists. The book is published by Messrs. E. and F. N. Spon, Limited, London, and the D. Van Nostrand Company in New York, and is intended for people with large pockets in more senses than one. It costs one guinea, and it is in the form of a small crown 8vo. of just 1,000 pages. Its character may best be described by quoting from the preface as follows: The book is not an encyclopædia, nor is it intended for a text-book, but it is hoped that as a compendium of useful data it may assist the practising electrician and engineer. The matter included is representative of American practice, and no effort has been made to include any other, except in special cases. No excuse is offered for the very considerable amount of matter taken from trade publications of the larger electrical manufacturers, as in this country (there is no address given at the bottom of the preface, but we presume the United States of America are meant) the engineers retained by such works are specialists.

Maidenhead.—At the last meeting of the Town Council the Mayor read a long letter from Councillor J. E. Pearce, dated from Johannesburg, Dec. 15, 1901, which acknowledged his gratitude to the Town Council for keeping his seat open during his absence in South Africa, and also expressed his pleasure at the progress made with the electric lighting scheme. He suggested that householders should have their houses wired and connected when the mains were run, and recom-

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mended a reduction in the charge for service wires and meter connections from mains to consumers' terminals. The letter concluded with an interesting account of the writer's work and experience in connection with the volunteer company of Electrical Engineers, in which he is a lieutenant. It was resolved to enter the letter on the minutes.

Walsall.—According to the last report to the Corporation by the Electric Lighting Committee, the total number of consumers supplied on Dec. 31 last was 210. During the past month the total units generated at the station were 61,948. The total output from the main generators was 59,867 units. The total units from the transformers were 46,629 (estimated). The total units registered on the meters were 42,404. The machinery was run for 525 hours. The wages paid amounted to £93. A deputation representing the places of worship in the borough in which electric light is used having presented a memorial asking for a reduction in the charge for current for lighting places of worship, the engineer has been instructed to obtain information on the subject from the towns where such reduced charge is made, and report thereon to the committee.

Carlisle.—The Electricity Committee have decided to grant an application to extend the electric lighting cable to St. James's Church at a cost of £370. The Public Lighting Committee have decided to improve the lighting of a number of streets by the erection of additional lamps, and the conversion of gas lamps into incandescent electric lamps. At a meeting of the Electricity Committee on Jan. 7 the Engineer reported that since the previous meeting he had received eight applications for new lights, equal to 352 8-c.p. lamps. The Electricity Committee have agreed to a proposal by the Gas Committee, who desire to erect a pump and stand-pipe on the premises occupied by the Electricity Committee, to pump the oil required at the gas-works from the oil wagons and delivered it forward by an underground pipe. The pump will be driven by electricity.

Huddersfield.—Mr. M. K. North has held an enquiry into an application of the County Borough Council for power to borrow £100,000 for the Corporation's electricity undertaking. Mr. F. C. Lloyd, the town clerk, said the money was required for machinery, mains, and other purposes. The electricity undertaking was a flourishing one, and last year there was a surplus balance of £3,358. 0s. 9d. on the year's trading. Mr. A. B. Mountain, the borough electrical engineer, gave particulars of the works which were required, and said that the present application included a sum of £10,814. 10s. 2d., which had been spent in excess of the £100,000 which had been previously authorised in order to lay down mains (instead of spending the money on buildings), so great was the demand for the electric light; and it was expected that there would be a great demand for light in places which had not yet been tapped when they got additional plant.

Alloa.—The formal inauguration of the electric lighting of the principal streets of the town took place on the 16th inst. Amongst those present were the Earl of Mar and Kellie, the provost, magistrates, and councillors of the town, Mr. Stewart, chairman of the British Electric Plant Company, and several directors, etc. The party first of all visited the works of the company to the west of the town and were shown over the establishment by Mr. Spence, the managing director. Afterwards the first of the engines connected with the dynamos was started by Mrs. Landor, wife of one of the directors; the second was started by Mrs. Stewart, wife of the chairman of the company; while the arc and other lamps throughout the works were switched on by Mrs. Arrol, wife of Bailie Arrol. The machines and appliances for the manufacture of electric plant, the overhead travelling cranes, etc., aroused considerable interest. What was described as a cake and wine banquet followed, when a long toast list was gone through.

Chailey.—At the meeting of the Council last Friday a letter was read from the East Sussex County Council, stating that the Brighton Corporation had been granted a license by the Postmaster-General for the establishment of telephonic communication over an area which comprised not only the boroughs of Brighton and Hove, and the urban districts of Portslade, Southwick, New Shoreham, and Burgess Hill, but also portions of the Chailey, Newhaven, Cuckfield, and East and West Steyning rural districts. The letter also stated that the County Council had given their consent in an agreement, which provided, among other things, that Brighton should pay a wayleave of 5s. per mile to the road authority for the use of the main and district roads within the area, that the poles should be of such description as the road authority's surveyor approved, and that the charges for use of telephones to subscribers in East Sussex should not exceed those made for similar services to subscribers within the borough of Brighton. The matter was allowed to stand over until information had been obtained on various points, especially whether the Brighton Corporation are under any liability to connect subscribers up in the rural districts, or whether they will be able to refuse if they consider the distance is too great.

Salford.—Mr. M. K. North has held an enquiry into an application of the Corporation for permission to borrow £25,000 for purposes of electric lighting and £5,000 for the provision of electrical motors to be let out on hire. Mr. W. W. Greenhalgh, of the town clerk's department, and Mr. C. D. Taite, the borough electrical engineer, gave evidence. The larger sum is required in order to carry out certain extensions at the existing works, and thus to increase the supply of power for lighting and motor purposes. It is proposed also to obtain 100 motors, ranging from ⅛ h.p. to 25 h.p., all of which will be let out on hire. The motors will cost £4,700 and £300 is allowed for the cost of testing and fixing the motors. Mr. Greenhalgh remarked that in Salford there were many small factories and workshops where these motors would be of great service, and it was expected that there would be a great demand for them. In reply to the inspector, Mr. Greenhalgh stated that the electrical undertaking had not hitherto been a paying concern. Between 1897 and 1899, he said, the concern began to pay its way, but since the erection of the last new generating station there had been such a large sum paid in interest and sinking fund that the return in the last few months had been practically nil. Now that the department was engaged in providing the current for the electric tramways, and in view of a probable increase in the number of customers, it was hoped that in a year or two's time a profit would be made.

Private Bills.—The Examiners of Private Bills, Messrs. Campion and Jeune, on Tuesday certified to seven Bills dealing with London tube railways, which were before the Special Committee in the House of Lords last year, as being the same measures as those deposited last session. In addition to these Bills the following were also found to have complied with the Standing Orders, and were ordered for first reading—namely: Great Northern and City Railway, Metropolitan Railway, Baker-street and Waterloo Railway, Finchley Improvement, Charing Cross, Hammersmith and District Electric Railway. Only nine memorials alleging non-compliance with the Standing Orders on the part of the promoters of seven Bills has been received by Mr. Frere. There was one memorial by the Westminster Borough Council deposited against the London County Council (Subways and Tramways) Bill; three by the Brighton, Hove, and Worthing Corporations against the Hove, Worthing, and District Tramways Bill; against the East London, City, and Peckham Railway Bill; and against the Great Northern Railway, West Ham Corporation, and Swansea and Birmingham Bills. Mr. Campion on Wednesday passed the Piccadilly and City Railway (No. 2) Bill and the North-East London (No. 2) Bill. The following Bills were also advanced a stage—namely: Kent Electric Power, London County Council (Electric Supply), and London United Electric Railways (which was marked opposed, but which passed unopposed). The East London, City, and Peckham Railway and the Romford Urban District Tramways Bills were marked "dead."

London County Council.—The Council resumed their sittings on Tuesday. Upon the recommendation of the Finance Committee it was agreed to lend the Islington Borough Council £1,700, £4,125, and £2,595 for electric light installation. The Council have issued a circular calling attention to the difficulty of compelling electric lighting companies to charge to their revenue account amounts which, in the opinion of the auditor, should be charged to that account, and not to capital account, a matter of importance to local authorities in view of the probable purchase by them of the companies' undertakings, and to the consumers in connection with the periodical revision of the maximum charges for current. Messrs. T. P. Gunyon, A. E. Rossiter, H. W. Ridley, A. Champion, and W. T. Hodgson have been appointed to be electric inspectors under the Electric Lighting Acts and orders applying to the county of London. The following notices under Electric Lighting Acts and orders were approved: from the Woolwich District Electric Light Company, for the approval of the Council to the construction of a brick culvert under Globe-lane, from the corner of Rodney-street to the company's premises; also from the Blackheath and Greenwich District Electric Light Company, under the Blackheath and Greenwich District Order, 1897, of intention to lay low-tension mains along Glenluce-road; the Brompton and Kensington Electricity Supply Company, under the House-to-House Order, 1889, to lay mains of high and low tension along portions of Eardley-crescent and Richmond-road, along portions of Redcliffe gardens and Cathcart-road, and Abingdon-road and Kensington-crescent; the City of London Electric Lighting Company, under the Southwark Order, 1891, to lay mains along a portion of Hatfield-street; the Westminster Electric Supply Corporation, under the Westminster Order, 1889, to lay mains along and across Kensington-place; the St. Pancras Borough Council, under the St. Pancras (Middlesex) Order, 1883, to lay mains along portions of Ossulston-street, Albany-street, Grafton-road, and Warden-road, and along and across King-street; the County of London and Brush Provincial Electric Lighting Company, under the County of London (North) Order, 1892, to lay power and low-tension mains across Old-street and along a portion of Helmet-row, and to construct two transformer boxes in Helmet-row and Red Lion-street, and under the Wandsworth Order, 1892, lay mains of high and low tension along a portion of Putney Park-lane, and to construct a transformer box in that thoroughfare; the Woolwich District Electric Light Company, under the Woolwich District Order, 1891, to lay mains along Glass-yard. Notices under orders granted to local authorities, under which the Council has no power of approval or disapproval of works, were received as follows: the Hampstead Borough Council, under the Hampstead Order, 1893, of intention to lay mains along portions of Winchester-road and Belsize-avenue; from the Islington Borough Council, under the Islington Order, 1893, to lay mains along portions of New North-road and Shepperton-road; and from the Stepney Borough Council, under the Whitechapel District Order, 1892, to lay mains along portions of East Mount-street and Oxford-street.

Fulham.—At a special meeting of the Council on Wednesday it was proposed to rescind the following resolutions adopted by the late Fulham Vestry on Oct. 11, 1899—viz.: "(*d*) We have adopted the following report from our permanent sub-committee—viz., 'We beg to report that we have had submitted to us information obtained by the clerk and consulting engineer from the various electric light undertakings in the Metropolis, and after full and careful consideration we recommend that for the present the charge per Board of Trade unit for current for lighting purposes be 5d. per unit, inclusive of the use of meters, and that 2½d. per unit be the charge for current for power or heating purposes,'" and of Oct. 17, 1900—viz.: (*d*) "We have further considered the consulting engineer's report, as set forth on pages 609 and 610 of the Vestry's minutes with reference to the adoption of a graduated scale of charges for consumers of electric current, and recommend that no alteration be made at present in the charge of 5d. per Board of Trade unit for current for lighting purposes." The Council also considered the following report of the Establishment Committee: "In accordance with the resolution of the Council of Oct. 30, 1901, we have carefully considered the question of making a reduced charge for the supply of electrical energy for lighting purposes to large or

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or profitable consumers, having first ascertained the practice adopted in various metropolitan boroughs, and we recommend that the following rate of charge for the supply of electrical energy for lighting purposes, be adopted—viz.: (*a*) 5d. per unit for an average consumption of 12 units per 8-c.p. lamp per annum; (*b*) 4d per unit for an average consumption of between 12 and 24 units per 8-c.p. lamp per annum; and (*c*) 2d. per unit for all units consumed over and above an average of 24 units per 8-c.p. lamp per annum; (*d*) that the discounts be deducted in each case during the last quarter of the year."

Brighton.—It has been decided that Mr. W. R. Galbraith be engaged as consulting engineer in connection with the electric power-house works now in progress at Southwick under Messrs. Pedrette and Co.'s contract, the Corporation to pay, in addition, the wages of an inspector, to be recommended by Mr. Galbraith. A number of additional public street lamps are about to be erected. The Telephones Committee have received the following letter from Mr. A. R. Bennett, of 65, Renfield-street, Glasgow, relative to telephone specifications: "In drawing these for goods to be supplied only (no work to be done in Brighton), I am puzzled by the clauses in your general conditions (electricity meters) which require the contractors to pay the same rate of wages and work the same hours as in Brighton. I fear this will operate to our disadvantage. Many of the things required (copper wire, bronze wire, ironwork, telephone instruments, etc.) are not and cannot be made in Brighton. How, then, can the Brighton wages and hours of work apply? Clearly they cannot, and it is not to be expected that the important North of England and foreign firms on whom we must rely for some of our chief supplies will consent to alter their practice in order to conform with conditions inapplicable to their industries. I know that at least some of them would not tender at all or bother themselves in the least in the face of such restrictions, and the telephone enterprise might suffer very seriously in consequence by excluding the best supplies from the contracts. I am well advanced with the specifications, and on hearing from you on this point and also with regard to the printing in Brighton or Glasgow, I can complete them rapidly." The clause in question will now be varied for the telephone contracts, and the contractors will be required to pay the standard rate of wages in force in the district in which the work contracted for is carried out, and to observe the recognised hours of labour usual in such district.

Finchley.—The Urban District Council have received a report upon the points contained in the Improvement Bill by the Council's parliamentary agents, from which we extract as follows: "The Council are authorised by the Finchley Electric Lighting Order, 1899, to supply electricity, and have already appointed a resident electrical engineer, and have received the sanction of the Local Government Board to the loan for the purpose of the site for the generating station. If the Council had not been promoting a Bill in Parliament, they would have applied to the Local Government Board in the ordinary way for sanction to borrow the necessary capital—about £40,000—for the undertaking. Having regard to the promotion of the Bill, the Council felt it desirable to include in it the power to borrow the capital for the undertaking, as by so doing they hope to secure 30 years instead of 25 years for the repayment of the loan, thus reducing the amount of the annual interest and sinking fund by about 12s. 6d. per annum on every £100 borrowed, or on the total sum asked a saving of £550 per annum. The scheme contemplated by the expenditure of £40,000, above referred to, would, in the opinion of the Council, soon have become inadequate to supply the needs of the district, and the Council therefore thought it well to provide a sufficient sum by the Bill to cover future extensions. The sum proposed to be borrowed under the Bill would cover the capital requirements of years, and will be borrowed gradually, as the undertaking becomes ripe for such capital expenditure. The repayment of the interest and principal will be met out of the revenue of the undertaking, and will not fall upon the rates. The Bill will also empower the Council to supply electric fittings. Householders of moderate means find it convenient to have their houses wired on terms of paying a small annual sum, or an addition to the charge for current, instead of defraying at once the cost of wiring and fittings. This system greatly encourages the use of electric light, and thus prevents the undertaking being a burden upon the ratepayers during the earlier years. The Bill also gives the Council various minor but important powers in connection with the electricity undertaking, which has been obtained by other local authorities, and which certainly should not be denied to a local authority competing with an unauthorised company, unless it is desired that the Council's electricity undertaking should not get a fair chance."

Indiarubber.—The Paris correspondent of the *Standard* gives some particulars of the campaign carried on by two English firms—Messrs. John Holt and Co. and Messrs. Hatton and Cookson—on the Upper Ogowe, and the comments of the *Temps* with regard to the judgment of the Appeal Court of Libreville, just published in the *Dépêche Coloniale* of Jan. 2. By that judgment the Court rejected the demand of Messrs. Holt and Co., who had sought to obtain possession of a certain quantity of indiarubber bought by them and deposited in the stations of Loango, Mayumba, and Nyanga, and the possession of which was claimed by the Compagnie Française du Congo Occidental in virtue of its concession. These three stations, and the concession of the French company of the Western Congo itself, are situated well within the conventional basin of the Congo. That being the case, the French Ministerial organ frankly admits that the English merchants are in no way wrong in invoking the Berlin deed for their defence. Though it is quite natural that private individuals who have only to think of their own private interests should, in their desire to crush their adversary, have recourse to all the legal means at their disposal, the *Temps* points out that the French Colonial Administration, which in its sphere is responsible for the good relations of France with the other Powers, would commit a grave fault in allowing itself to give way to irritation. Satisfaction of *amour propre* are, it contends, nothing compared with the need felt by the French nation to be able to continue in peace that trial of great companies now being made in the French Congo. This journal is, therefore, not astonished that the English firms should complain loudly, and adds: "Under similar conditions French firms would not act otherwise. What we must admit is that it is not true that common law tribunals can mete out justice in such a matter, because it is not a question of common law, but of international law. If we allow the affair to be carried before the only jurisdiction which can settle it definitively, it will end by being brought before a tribunal of arbitration, which will have to decide which is the right interpretation of the Act of Berlin, that of the French Government or that of the British Government. Any case may be lost. If we were to lose ours, the 40 concessions of the French Congo would be at once quashed by it. Anyone who may reflect coolly on that eventuality cannot fail to apprehend the consequences of such an adventure. That is why we persist in believing that it would be prudent to come to an arrangement with the two English firms."

Battersea.—The electrical engineer has reported that up to Dec. 31 the number of applications for the supply of electricity, including the Council buildings, amounted to 138, with an aggregate equivalent to 12,285 8-c.p. lamps, the number of actual consumers being 119, with an aggregate equivalent to 9,627 8-c.p. lamps. Applications for motive power equivalent to 48¾ h.p. had been received, and motive power equivalent to 7¼ h.p. was being actually used. On Wednesday the erection of suction and delivery pump-houses at the central electric generating station was recommended at an estimated cost of £2,177. 13s. 7d. Application is also to be made to the London County Council for sanction to, and the advance of, £3,200 for additional mains, meters, etc., in connection with the electric lighting of the borough. The Lighting Committee has reported upon an application with reference to the supply of electrical energy in St. James's-road by the Council or by the County of London and Brush Provincial Electric Lighting Company, Limited, under the Wandsworth electric lighting order, as follows: "At the present time only a portion of the premises are within the area of supply under the Battersea electric lighting order, the remaining (major) portion being in the area of supply of the Wandsworth electric lighting order, but under the scheme of the London Government Act, 1899, the whole of the premises have been transferred to Battersea borough, and legislation is being promoted by the Board of Trade providing for the alteration and readjustment of the electric lighting areas in London so as to make them as far as possible co-terminous with the areas of the new boroughs. The premises in question are situated about half a mile from the Council's existing electric mains, but the mains of the company are very near. In the special circumstances of the case, we recommend that permission be given to the company to supply electrical energy to the premises in question until such time as the Council are in a position to supply themselves (subject to the company agreeing to enter into an agreement upon those terms)." The committee further recommended that the charge for meter rent be abolished where the account for the quarter exceeds 15s., and that the scale of charges for electrical energy used be revised as follows, to take effect immediately after March 31: For lighting—ordinary purposes, 4½d. per Board of Trade unit; residential premises and premises in which business is carried on after 10 p.m., for five days a week, 4d. per Board of Trade unit—subject to rebates as previously. For motive power—2d. per Board of Trade unit, subject to rebates as previously, or in the case of consumers of a quantity exceeding 10,000 units per annum, such special terms as may be agreed upon between the Council and the consumers.

PROVISIONAL PATENTS, 1902.

JAN. 13.

868. **An improved fitting and reflector for carrying electric and other lamps and lights.** Clarence Metcalf Stead, 30, Park-row, Leeds.

873. **Improvements in electrical railways of the conduit or enclosed supply system.** John Milnes, 15, Water-street, Liverpool.

914. **An improved electric arc lamp for light-cure purposes.** Robert Otto, 40, Chancery-lane, London. (Complete specification.)

918. **Improvements in or relating to electrical measuring instruments.** Robert Stewart Whipple, 111, Hatton-garden, London.

943. **Improvements in portable electrically-driven rotary apparatus suitable for use as a rotary hair or other brush, and for grinding, polishing, cutting, and like purposes.** John A. Cole, 46, Lincoln's-inn-fields, London.

JAN. 14.

947. **An apparatus to give alarm by means of an electric bell in the event of a locomotive running past a signal at danger.** B. J. Chubb, 74, Queen's-road, Buckland, Portsmouth.

952. **Improvements in means for upholding broken electrically-charged or "live" wires.** William Barnes, 5, John Dalton-street, Manchester.

993. **Improvements in or relating to telegraph and telephone wires.** James Womersley and George William Womersley, 8, Quality-court, Chancery-lane, London.

999. **Improvements in electrically-controlled railway switches.** Ernest de Pass, 78, Fleet-street, London. (The Cheatham Electric Switching Device Company, United States.) (Complete specification.)

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1021. Improvements in electric switches. William Howard Chipperfield and Edward Samuel Cook, 4, Danes-inn, Strand, London.

1027. Improvements in and relating to electric railways. Ed. Wilson Farnham, 18, Buckingham-street, Strand, London. (Complete specification.)

1028. Improvements in and relating to electric railways. Ed. Wilson Farnham, 18, Buckingham-street, Strand, London. (Complete specification.)

1057. Improvements in and relating to electric signal lamps and the like. Herbert Dudley Barlow, 18, Southampton-buildings, Chancery-lane, London.

1061. Improvements in or relating to telegraphic apparatus. Frederick George Creed and William Arthur Coulson, 46, Lincoln's-inn-fields, London.

JAN. 15.

1077. Improvements in a process and apparatus for the manufacture of white lead from pig lead by electro-chemical fusion. Ernest Bailey and Arthur Crowther, Barstow-square, Wakefield.

1078. Improvements in electrical railway signalling. Edward Wilford and George William Taylor, the Nottingham Electroplating Works, Sherwood-street, Nottingham.

1104. Improvements in or relating to dynamo-electric machinery. Arthur Burgess Soar, 111, Hatton-garden, London.

1126. Improvements in methods of generating electrical energy. Alexandre Wassilieff, 46, Lincoln's-inn-fields, London.

1136. Improvements in lighting carbons. Aktien-Gesellschaft Siemens Bros. and Co. and H. Viertel, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

1139. Improvements in the manufacture and production of electric batteries of the kind known as dry batteries. Herbert William Butler, 47, Lincoln's-inn-fields, London.

1142. Improved means for enabling a number of electric circuits at a distance to be made and broken periodically as required, the invention being applicable to the operation of multi-rate or ordinary meters, arc or incandescence lamps, transformers, demand indicators, and other apparatus. Ernest Schattner, 55, Chancery-lane, London.

JAN. 16.

1161. Improvements in and relating to electric signalling and telephonic [communication with railway trains, electric lighting, and railway couplings. John Day, 156, Penn-road, Wolverhampton.

1224. An electromagnetic engine governor. Albert Schmid, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

1229. Improvements in telegraphs. Willie Dickson Kilroy, 1, Queen Victoria-street, London.

1237. Improvements in valves for air compressors. The British Westinghouse Electric and Manufacturing Company, Limited, Westinghouse Building, Norfolk-street, Strand, London. (Cyrus Robinson, United States.)

1238. Improved collector rings for electrical machines. The British Westinghouse Electric and Manufacturing Company, Limited, Westinghouse Building, Norfolk-street, Strand, London. (The Westinghouse Electric and Manufacturing Company, United States.)

1239. Electric fan for use in theatres and other places. Hussein Agha, 53, Chancery-lane, London.

1241. Improvements in means for regulating the voltage in installations worked by alternating currents. Louis Georges Chevrier, 47, Lincoln's-inn-fields, London.

1251. Improvements in and relating to electricity meters. William Morris Mordey and Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

JAN. 17.

1267. An invention for insulating metal covers for electric switches to prevent short-circuits. George Henry Bricknell, The Hawthorns, Quinton, Worcestershire.

1274. Improvements in electrical transmitters and receivers. Thomas Duncan Dundas, Sunnymede, Queen's-road, Coventry.

1313. Improvements in and relating to surface-contact systems for electric traction. August Rast, 8, Princess May-road, Stoke Newington, London.

1322. Combination door-knocker and electric alarm. John Griffiths, 138, Salisbury-road, Everton, Liverpool.

1325. A new or improved method and apparatus for the production of tele-photographs. Arthur Korn, 18, Buckingham-street, Strand, London. (Complete specification.)

1343. Improvements in electric fuses. Callender's Cable and Construction Company, Limited, and Harold Hastings, 24, Southampton-buildings, Chancery-lane, London.

1344. An electric switch. George Higginson, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

1351. An improved process for purifying and bleaching liquids, more specially saccharine liquids, by electric dialysis in conjunction with a halogen (chlorine). Otto Spillern-Spitzer, 19, Holborn-viaduct, London.

1355. Improvements in the construction of conduits for underground, more especially intended for use in systems of underground electric traction. Thomas Easton Devonshire, 47, Lincoln's-inn-fields, London.

JAN. 18.

1402. Improvements in apparatus for operating the points of overhead electric tram wires. Henry Collins and Charles William Collins, 55, Market-street, Manchester.

1417. A new or improved electric meter. Frank Wyatt, 50, Melgund-road, Highbury-crescent West, London.

1435. Improved coupling joint or connection for electric wires and fittings. Max Railing and George Henry Ide, 165, Queen Victoria-street, London.

1441. Improvements in or relating to the means for adjusting or regulating the shades, reflectors, or screens employed in connection with adjustable or other electric lights, gas lights, and others for the purpose of concentrating and diffusing the light therefrom in any desired or required direction for the purpose of facilitating photography, and apparatus therefor. Nathan Smedley Kay, 8, Quality-court, Chancery-lane London.

1446. Improvements in automatically signalling by electricity between trains on railways, and braking, and apparatus for that purpose. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Hubert Pfirmann and Max Wendorf, Germany.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Feb. 6.

1900.

23461. New method of impregnation and isolation of protecting pipes, tubes, or cylinders to lay underground cables, electric wires, and other conductors, and the like. Wayss and Freytag.

1901.

969. Electrolytic electricity meters. Bastian.

1017. Electric transformers. British Thomson-Houston Company, Limited. (Moody and Emmet.)

1049. Regulating devices for induction electric motors. British Thomson-Houston Company, Limited, and Meyer.

1103. Telephonic and other switchboard apparatus. Francis.

2428. Electric motor starting switches. Cowan and Still.

3398. Overhead trolley wires for electric traction, overhead electric cables, telephone, telegraph wires, or the like. Hancock, Leighton, and Hacking.

4123. Slack-cable safety gears for electrically-operated lifts, elevators, and the like. Hildred, and R. Waygood and Co., Limited.

4290. Mica insulation for electric apparatus. British Thomson-Houston Company, Limited. (Peterson.)

4575. Electric power distribution. Lake. (Compagnie de l'Industrie Electrique.)

5487. Electric heating and cooking apparatus. Schindler.

6617. Means for supplying electric energy at stations applicable for charging electromobiles. British Thomson-Houston Company, Limited. (Haskins.)

6629. Drying electric cables and other goods, and apparatus therefor. Heyl-Dia.

6898. Electric racecourse for recreation. King. (Pozzo.)

7196. Electromagnetic devices for controlling the rotation of shafts. Johnson. (Avril and Soc. Marinier Navoite and Jeanson.)

9311. Fusehead for electric blasting. Render.

11992. Means for accentuating electrical contacts. British Thomson-Houston Company, Limited. (Thomson.)

15196. Systems of control for electrically-propelled trains. British Thomson-Houston Company, Limited. (Case.)

16351. Submarine boats. Hardingham. (Electric Boat Company.)

16423. Magnetic devices to restore and aid the hearing. Payn.

17026. Electric circuit breakers. British Thomson-Houston Company, Limited. (Hewlett.)

17028. Electric brakes for electric railway vehicles. British Thomson-Houston Company, Limited. (Barry.)

17030. Electric insulating material, and the application of the same in the construction of commutators for dynamo-electric machines. British Thomson-Houston Company, Limited. (Emmet.)

17031. Friction clutches. British Thomson-Houston Company, Limited. (Everest.)

18027. Dynamo-electrical machines and motors. Guy.

18428. Systems of electric motor control. British Thomson-Houston Company, Limited. (Farnsworth.)

19229. Governors for steam-engines. British Thomson-Houston Company, Limited. (Emmet.)

19231. Automatic electric circuit breakers. British Thomson-Houston Company, Limited. (Haskins.)

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22543. Systems of electric circuits for controlling electric motors. British Thomson-Houston Company, Limited. (Case.)

24808. Coupling devices for electric conductors. British Thomson-Houston Company, Limited. (Case.)

25171. Electric telephone systems. Cardwell.

25266. Electric arc lamps. British Thomson-Houston Company, Limited. (Thomson.)

25496. Telautographs. Ritchie.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	Jan. 18	586	575	+ 11	—	—
Birmingham Tramways	—	—	—	—	—	—
Blackburn Corporation	,, 17	625	552	+ 73	1,574	1,368
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 18	156	127	+ 29	—	—
Bolton Corporation	,, 19	1,346	1,194	+ 152	—	—
Bradford Corporation	,, 19	1,061	701	+ 359	2,939	2,174
Bristol Tramways Company	,, 17	3,913	3,747	+ 166	—	—
Carlisle Tramways Company	,, 18	109	112	- 3	346	306
Central London Railway	,, 18	6,808	5,982	+ 826	19,580	17,505
City and South London Railway	,, 19	2,937	2,002	+ 935	9,147	6,073
Cork E. T. and L. Company	,, 16	379	347	+ 32	897	833
Darwen Corporation	,, 17	202	154	+ 48	457	407
Dover Corporation	,, 18	165	163	+ 2	478	465
Dublin & Lucan Electric Railway	,, 19	93	69	+ 24	255	206
Dublin U. T., electric cars	,, 17	3,332	3,254	+ 78	—	—
Dublin S. District, Electric	,, 17	678	686	- 8	—	—
Dundee Tramways Company	,, 15	615	439	+ 176	—	—
Glasgow Corporation	,, 18	10,111	8,494	+ 1,617	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 18	1,591	1,535	+ 56	—	—
Liverpool Corporation	,, 11	9,037	7,661	+ 1,376	18,545	16,091
Liverpool Overhead Railway	,, 19	1,397	1,482	- 85	4,252	4,537
Newcastle-on-Tyne Corporation	,, 18	1,316	—	—	—	—
Portsmouth Corporation	,, 18	921	609	+ 312	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 19	3,573	—	—	—	—
Southampton Corporation	,, 16	749	624	+ 125	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £601 decrease.
Barcelona Ensanche y Gracia, £12 increase. Barcelona, £607 increase.
Brisbane, £214 increase (month of Dec., £1,322 increase).
Buenos Ayres and Belgrano Electric, £125 decrease.
Calcutta, £20 decrease.
Cape Town (month of Dec.), receipts, £16,925; expenditure, £6,792.
La Capital Traction and Electric, Buenos Ayres (month of Nov.), £1,973 increase.
Mexico Electric (month of Dec.), receipts, £18,250; expenditure, £10,750.
Perth Electric, £149 increase.
Port Elizabeth (month of Dec.), receipts, £3,898; expenditure, £1,898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Tramways.—	£	£
Anglo-Argentine, 1-260,007	5 ..	3¼-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	123-126
Blackpool and Fleetwood Tramroad	10 ..	12¼-13¼
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2¾-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	101-103
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6¾-7¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9-9¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	14-15
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12¼-12¾
—— 5 per cent. Perpetual Debenture Stock	100 ..	126-129
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1¾-2
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5¾
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2-2¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22¼
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	102-104
New General Traction, Ordinary	5 ..	2¼-3¼
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	10s. ..	¼
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	50 p.c...	50 p.c.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅞-1
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅞-1
—— Ordinary, 1-125,000	1 ..	⅞-1
British Insulated Wire, Ord., 1-70,000	5 ..	9¼-10¼
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¾-6¼ xd
—— 5 per cent. Mortgage Debentures	100 ..	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5¼-6
Brush Electrical Engineering, Ordinary	2 ..	1⅞-1⅞
—— Nos. 90,001-105,731	2 ..	1⅞-1⅞
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	97-100
Callender's Cable, Debentures	100 ..	110-114
—— Ordinary	5 ..	16¼-17½
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	3-3½ xd
—— 5 per cent. Debentures	— ..	99-104 p.c.
Edison and Swan United, Ordinary	3 ..	2-2⅛
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	78-83
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	84-89
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1⅞-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	98-101 xd
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16¼-17½
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	112-116
India Rubber, Gutta Percha, and Telegraph Works	10 ..	20-21
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15¼-16¼
Telegraph Construction and Maintenance	12 ..	35-38
—— 5 per cent. Bonds	100 ..	102-104
Telegraph Manufacturing, Ordinary	5 ..	10¼-11¼
—— 5 per cent. Cum. Pref.	5 ..	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	9¼-10¼
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	103-105
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅞-1
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	97-102
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9¼-10¼
—— Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	8¾-9¼
—— 7 per cent. Preference	5 ..	8¾-9¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7¼-8¼
—— Nos. 20,001-30,000	5 ..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, ,, £10 Ord.	6 ..	10¾ xd
Charing Cross and Strand	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5-5¼
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	103-105
Chelsea Electricity Supply	5 ..	5¼-6
—— 40,501-50,936	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	108-111
City of London, Ordinary	10 ..	9-10
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	121-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	105-108
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5¼-6 xd
—— 6 per cent. Cum. Pref.	5 ..	5¼-6
—— 4½ per cent. First Mort. Deb.	100 ..	105-108 xd
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-4¾
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5¾
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	103-106
Kensington and Knightsbridge and Notting Hill	100 ..	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1¾
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	95-100
Metropolitan, Ordinary	10 ..	14¼-15¼
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6¾
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1¼-1¾
—— £5 Shares	5 ..	7¼-8
—— £4½ Shares, New	4½ ..	6¾-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-2¼
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15¼-16¼
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	12-13
Electric Railways.—		
Central London, Ordinary	100 ..	105-108
—— 4 per cent. Pref.	100 ..	105-108
—— ,, deferred	100 ..	106-109
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	114-117 xd
City and South London, Consolidated Ordinary	100 ..	65-67
—— Ordinary	10 ..	6¼-6¾
—— Nos. 60,001-70,000	10 ..	6¼-6¾
—— 4 per cent. Debenture Stock	100 ..	112-116
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Telephones.—		
National Telephone, Ordinary	5 ..	3⅜-3⅝
—— 6 per cent. Cum. First Pref.	10 ..	11-13
—— 6 per cent. Cum. Second Pref.	10 ..	11-13
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-5
—— 4 per cent. Deb. Stock, Red.	100 ..	94-97
—— 3½ per cent. Deb. Stock, Red.	100 ..	101-105
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

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NOTES.

The Acetylene Association.—We have to acknowledge the receipt of a preliminary copy of the memorandum and articles of association of the above institution, which has for its object "the advancement of acetylene gas engineering and manufacture."

Wireless Telegraphy.—The Withernsea wireless telegraph station of the Marconi Company is being considerably enlarged. So far Withernsea is the most northern station of its kind in England, and it is hoped that with the increased installation communication with Norway, a distance of over 300 miles, will be obtained. More land has been acquired, and a new pole 150ft. high is to be put up, in addition to the 80ft. pole erected last year. A house for the operator has been taken, and another office is also to be built for the instruments.

Greetings from America. — A complimentary telegram was read at the ordinary meeting of the Institution last week from the American Institute of Electrical Engineers. The message ran as follows: "The American Institute of Electrical Engineers on the occasion of their annual dinner, with Guglielmo Marconi as their guest, send to their sister society their compliments and fraternal greetings." The president announced that this telegram had been acknowledged in the usual way, returning the American Institute thanks for their kindly greetings.

Wool-Pulling by Electricity.—Mr. S. L. Johnson gave a lecture before the members of the Bradford Textile Society last Monday evening on the subject of wool-pulling by electricity. The apparatus of the Electrical Wool-Pulling Syndicate, of Bradford, was explained by the lecturer. This apparatus, which has been described previously in our columns, is now said to be so far developed that it can de-wool skins at the rate of 3½ minutes each. The lecturer also claimed that both the wool and the hide were less damaged by this process than by the ordinary course of fellmongering.

Large Power Schemes.—It will be remembered that when the large power distribution scheme on the Tyne was inaugurated last year we commented favourably on the fact that the engineers had not only provided duplicate cables to the various parts of the district supplied, but also had taken care wherever possible to secure that these cables should go along duplicate routes, so that an accident in one would not in any way interfere with the supply through another. The need for this is exemplified by an accident in connection with the St. Helens Corporation's mains. It seems that a colliery known as Broad Oak, near St. Helens, derives all its light and power from the Corporation's station, and owing to a burn-out of a feeder on Friday night the colliery was deprived of current for three hours. This not only prevented the winding machinery from being worked, but also extinguished all the lights in the colliery. The accident, which kept a number of men three hours in the pit without light, would have been prevented had the duplicate system of cables and cable routes been adopted.

The American Philippine Cable.—We note that the Bill to authorise the laying of a submarine cable between California, Hawaii, and the Philippines has secured the approval of the Committee on Commerce in the House of Representatives at Washington. The measure has been subjected to a little amendment, and as now framed it provides that the cable shall be of American make if it can be supplied according to the highest standard, and at a cost not exceeding 10 per cent. above that of foreign manufacturers. We do not think it likely, however, that the manufacturers of cables in the United States will be found to be able to comply with these conditions. As we noted a week or two ago, the American manufacturers on their own showing are not able to turn out a cable within about 50 per cent. of the cost of one of English make, and then it is a question whether it comes up to the required standard. There seems every probability, therefore, that the remaining contracts for the Philippine cable—the order for the first section has already been given to the Silvertown Company—will not be placed in America.

The New York Explosion.—From the news reaching this country of the explosion which occurred on Monday in connection with the construction of the underground shallow tramways or railroads in New York to form part of the Manhattan rapid transit system, it appears that the accident, which occurred in the heart of the city, was caused through the explosion of a large quantity of dynamite used for excavating through the rocky soil. According to the newspaper reports, several lives were lost, and an enormous amount of damage done to buildings immediately in the neighbourhood of the explosion. It will be remembered that the London County Council are going to construct an underground shallow tramway under the new street from the Strand to Holborn on the same lines as those in course of construction in New York. Any fear of a similar catastrophe taking place in this case from the same cause may, however, be dispelled from the fact that the use of dynamite or other explosives will not be required in the tunnelling operations, which for the most part will be through clay.

Small Three-Phase Motors.—Three-phase induction motors of small capacity, and with a short-circuited armature, have generally too great an angular speed for most applications, and also a small starting torque. *L'Industrie Electrique* recently described a motor made by Prinetti and Stucchi, of Milan, in which these disadvantages are claimed to be avoided. From an abstract in the *Electrical World* we gather that to reduce the angular velocity to 100 or 200 revolutions per minute, this firm use a large number of poles of the inductor. To obtain a sufficient starting torque the inductor is not fixed on the ground, but is mounted on the armature axle, around which it can turn, but a long pendulum, ending in a heavy disc keeps it in a vertical position when the motor is at rest. When the motor is started the pendulum is deviated in the direction of the rotation of the armature. The angle of deviation enables one to find the power given out by the motor; it is equal to the product of angular velocity, the weight of the pendulum, its theoretical length, and the sine of the angle which the pendulum makes with the vertical direction. As the power of the motor is thus always evident, overloads are at once apparent, and the arrangement may be made that for a certain overload the circuit is automatically broken by the pendulum. The motors are especially adapted to drive spinning and weaving looms.

Single-Phase Motors at West Ham.—The West Ham Corporation, under the advice of their electrical engineer, are extensively taking up electrical driving for their numerous workshops and Corporation depôts. In this respect they are to be strongly commended, as there is nothing like a good Corporation lead in the introduction of electric motors generally throughout the district. In the case of West Ham, single-phase alternating currents at 50 frequency are employed for the lighting, and the same, of course, are available for motor work. Following, therefore, on the lead of Frankfort, a large number of single-phase motors are being installed. We gather that the last placed on order are being obtained from Messrs. Witting Bros., and are of the Heyland type. Some time

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ago the same firm completed a similar installation for the Corporation—viz., the conversion of the chaff-cutting and other machines used at the large Corporation stables from gas-engines to electric driving. The Heyland single-phase type of motor is also used fairly extensively in the West Ham district for driving private installations, one of the first put down by Messrs. Witting being a motor of 15 b.h.p. direct coupled to an Isler deep-well pump. In this case the motor starts directly on the pump, there being no clutches or similar devices required, and we understand that no trouble has been experienced in operating the motor under these conditions.

Prompt Release of Starting Resistances.—Mr. H. C. Heidrich, in the *Electrical Review* of New York, describes a simple device for the prompt release of starting switch levers. It is customary for switchboard men to reset breakers quickly, which, as the writer points out, frequently results in a hard "plug" for the motor armatures, and often opens the auxiliary breaker or blows fuses. To obviate this feature and to prevent the passage of abnormal currents, a very simple and inexpensive device can be employed. It consists of an ordinary relay, the bobbin of which is placed in series with the line, being wound with comparatively few turns, and of sufficient cross-section to carry the total current of the motor. The purpose of the relay is to short-circuit the release magnet, making its action simultaneous with the line interruption. It will be understood that at no load there must be sufficient ampere-turns on the relay magnet to separate its contacts, otherwise the release magnet being short-circuited could not retain the starting lever at the running position. The proper winding for the relay can readily be determined by one or two trials, or a comparatively high-resistance winding and shunt may be used, as a very light spring on the relay armature will allow sufficient adjustment to cover a very wide fluctuation of current to the motor. The action is practically instantaneous, and it is impossible to break and reclose the main circuit, however rapidly, without the necessary and desired action of the relay and the consequent prompt protection to the apparatus through the opening of the armature circuit.

Hardening Steel by Electricity.—A process of hardening iron and steel plates employing electrical means has been devised by Cleland Davis, a lieutenant in the United States navy. The face of the iron or steel plate is first subjected to the action of heavy electric currents passing either from carbon electrodes or through a mass of carbon, which may be in a granulated form. In this way the face of the plate is soon brought to a high heat, and is impregnated to a greater or less depth with particles of carbon carried either from the electrodes or from the arms of granular carbon placed over the face of the plate The depth to which the carbon will be carried, and the consequent hardening which will occur, will vary with the electric current and with the time that the treatment lasts. Where it is desired to harden to a considerable depth below the surface, the treatment may be prolonged; but where it is desired to harden only to a slight depth, the treatment will be shorter. Since it would be ordinarily difficult to secure current enough to treat the entire face of a large armour plate at one time, it may be preferable to treat portions of the plate progressively, which may be done either by moving the electrodes over the plate, or by moving the plate under the electrodes, or by shifting the current from one group of electrodes to another, in the meantime keeping the plate and the electrodes in the initial position. In the same way, where rails or plates are to be treated the electrodes can be moved along the rail or the rail moved under the electrodes, as may be preferred. Where portions of the plate are treated progressively, the conductivity of the metal will ordinarily speedily produce the desired chilling effect, or this may be supplemented by means of a spray of water or other chilling agent. The invention, however, is said to be more particularly adapted to the manufacture of hard-faced armour plate.

Students' Premiums.—President Langdon, at the meeting of the Institution of Electrical Engineers on the 23rd inst., announced the names of students to whom premiums have been awarded for reports rendered at the suggestion of the Council with reference to some of the exhibits at the Glasgow Exhibition last year. The object the Council had in view in offering these premiums was to induce students to concentrate their attention upon the various electrical exhibits at Glasgow, and then to devote themselves to reporting on the subjects which should be selected for them. The premiums are worth £5 each, and have been awarded to the 10 students whose reports have been selected from those sent in as being of most merit. The following are the names of the successful students, together with the subjects dealt with: Mr. A F. T. Atchison, for his report on "Gas and Oil Engines Suitable for Electric Generators"; Mr T. A. Davies, "Special Features in the Exhibition on Electrical Generators and Transformers"; Mr. J. Griffin, "Materials Used in Primary and Secondary Batteries"; Mr. J. B. Langford, "Electrical Measuring Apparatus": Mr. P. Laubach, "Special Features in the Exhibition on Electrical Generators and Transformers"; Mr. H. L. Persey, "Special Fittings for Electrical Cars and Electrical Traction Generally"; Mr. A. Raworth, "Steam-Engines for Driving Generators"; Mr. D. Reid, "Special Fittings for Electrical Cars and Electrical Traction Generally"; Mr. F. E. Robinson, "Labour-Saving Apparatus and Machine Tools Worked by Electrical Energy"; and Mr. J. C. Smail, for his report on "Electric Cranes."

Street-Lighting.—The December number of the *Transactions* of the American Institute of Electrical Engineers has reached us, and we again find that it contains advance copies of papers to be read this month. Amongst these is one on "Street Illumination and Units of Light," by Mr. W. D. A. Ryan. This article contains a vast amount of research work on street-lighting by open and enclosed arcs, from which the author draws the conclusion that while the open arcs give a higher maximum candle-power than the enclosed for a given consumption of electrical energy, this maximum candle-power is in an undesirable direction. He also finds that the fluctuations of light through the arc travelling round the carbons are much more serious with the open than the enclosed type. This causes him to pronounce judgment in favour of the enclosed arc for street-lighting. He finds that with either direct or alternating currents this enclosed arc is superior to the open types, but qualifies this conclusion by the statement that if the European practice is followed of installing lamps at short intervals, say from 80ft. to 175ft. apart, and using more accurate control with high-grade carbons, the advantage of the enclosed arc disappears. This is almost what we had expected to hear, and it shows that in America they have been comparing the best types of enclosed arcs with older types of open arc lamps using inferior carbons. Another question taken up by the author is that of incandescent lamps for street-lighting. His view is that it is not enough to light the street surface, but that one requires to light the buildings at either side, and he thinks that this can be done by means of incandescent lamps. This conclusion, of course, depends on the problems taken, and in England it is usually considered that to light the footways and

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carriageways is really what is required. This can be done with incandescent lamps, and an equal distribution of light obtained by suitably arranged reflectors.

A Year's Work in the States. — Prof. Elihu Thomson, in the New Year's number of the *Western Electrician*, contributes a concise review of the electrical progress in the United States during the past year. He regards the technical and commercial progress in that period as having been fairly general, and a growth upon what has been done in preceding years—that is to say, there has been more plant installed, more electrical energy used, and a large increase in the number of consumers. A subject which has attracted great attention has been the long-distance high-potential transmissions of power. Unprecedented potentials, larger units, and greater distances are involved in the past year's work, and he predicts that the coming year will doubtless see the work pushed almost to the limit of its possibilities as a matter of electrical engineering. In the commercial sense there is as yet no limit to be seen to the growth in this direction. Of arc lamps, the enclosed type is now made in the States almost to the exclusion of any other, and alternating enclosed arcs have come largely into use in series street-lighting during the past year. The Nernst lamp made its first appearance in public in America at the Pan-American Exhibition, but Prof. Thomson regards the present time as too early to predict what effect it may have upon the future of electric lighting. The incandescent lamp is still the only lamp for small units of light, and it remains for the future discoverer to provide its more economical rival. Commenting on the steady and rapid growth of electric traction in America, he remarks that the direct-current motor has practically all this field, and for sufficient reasons. There has been a very rapid extension of the use of small and medium-sized motors for stationary work, besides the installation of three-phase motors in larger units in connection with power transmission. He also alludes to the failure of the electric cab in the past year. The ordinary lead batteries are none too good for service in an automobile, and he relies upon the new Edison battery proving of sufficient merit to redeem the electric vehicle.

Charge of Electrical Machinery in the Navy.— The care and maintenance of hydraulic and electrical machinery in warships must always be a matter of high responsibility, and this has hitherto devolved on the engineer officers in the navy, who have been required "to undertake the charge of and to be responsible for the maintenance in a state of efficient working" of all such machinery. This, of course, includes all electric light engines and dynamos. It has also been a special instruction to the captains of ships in regard to torpedoes that "the dynamos and engines for driving them are in charge of the engineer officer, who is responsible for their mechanical and electrical efficiency." A "Naval Correspondent" to the *Times* points out that this arrangement has not always been happy, and has been somewhat conducive to friction, making, as it did, one man responsible for the effective working of a machine and another for its efficient use. By the new regulations which the Admiralty have decided to introduce, all this is to be altered. In future, the gunnery lieutenant is to take charge of all the hydraulic machinery, while the torpedo lieutenant is to be responsible for the dynamos, motors, torpedoes, and all the fittings which have to do with the torpedo armament. Thus the engineer officer will be relieved of any responsibility for the efficient working of this machinery, and will simply be required to provide steam to work the dynamos and hydraulic engines. By the change the authorities would seem to have succeeded in pleasing all parties, for while the engineer officers have long complained of being upon to perform what they term "military duties," the gunnery and torpedo lieutenants have always desired to take this burden upon themselves. Moreover, it seems to us it is only as it should be that those officers who have to undergo a special course of gunnery and torpedo instruction before they can attain to the rank of gunnery or torpedo lieutenant, should take the whole of the responsibility arising from the use of such machinery in warships. We gather that it is intended that the new rating of electrician in the navy shall assist the torpedo lieutenant, and it is probable that some similar rating will be introduced to assist the officer charged with the care of the hydraulic machinery.

Insulation Failures.—In last week's issue of the *Lancet* there is a long editorial article on the failure of insulation and its perils. It is without doubt out of the scope of the journal in question to give editorial notes on the design of electrical apparatus, and yet we think that before such an article as that in question is written the editor might make himself conversant with the means adopted by electrical engineers at the present time to avoid the dangers to which he draws attention. For instance, in the article the following passage occurs: "Until, however, some better guarantee is forthcoming than has hitherto been the case that the most effective measures are taken to prevent short-circuiting, or to obviate any serious consequences when it is established, travelling on an electric railway, and especially in the 'tubes,' in which there is practically only room for the train, means running a risk of a nature never heard of before in connection with railways. The accidents arising from short-circuiting in Liverpool, New York, and on two of the London 'tubes' are cases in point." This subject has been commented on so recently in the electrical Press that the editor of the *Lancet* should know now that accidents such as at Liverpool can hardly occur on the more modern electrical railways. Perhaps, however, as the article goes on to point out the dangers in connection with electric lighting, it would be well to recall the Board of Trade regulations for the protection of power circuits using more than 250 volts. Under these regulations all the conductors are required to be encased in continuous metal conduits, which are effectively earthed. The frames of the motors also have to be earthed. The object of these regulations is that in the event of any failure of insulation a direct short-circuit shall be established, which can be relied upon to operate the circuit breakers or fuses. These precautions are now adopted in all the better classes of installations where the wood casing gives place to metallic tubing. We may, therefore, conclude that electrical engineers fully recognise the importance of so arranging their apparatus that the leakage of electricity through a path of considerable resistance shall be avoided. This latter is much more dangerous than a direct short-circuit, as perhaps our contemporary can hardly believe. With the modern appliances the risk is reduced to a negligible quantity.

Electric Signalling on Railways. — We have frequently commented on the fact that the present system of signalling, with its interlocking of the signals with the points, is admirably designed to protect the signalmen against error, and yet offers no security whatever against engine drivers over-running signals which are against them. It is true that on the train both the engine-driver and the stoker are supposed to be on the look out for the signals as soon as any important crossing is in view, and yet there frequently arise accidents through this over-running of signals when extra traffic is running. What seems to be

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so much required is some means of communicating with the driver of a train which will give an audible signal in the event of his infringing the regulations of the line. Such a device we have recently seen described in the daily Press as having been introduced by an Austrian inventor, and also a similar device by a Mr. Butt, of Wolverhampton. In each case it is proposed to have a contact-rail alongside the train opposite each signal or crossing point, and a skate on the train to make connection with the same. By this means a bell could be rung on the engine in the event of the driver neglecting to observe a signal at danger. We recently had a conversation with an expert signal engineer on the subject, and he was most strongly in favour of an actual mechanical obstruction. According to the Board of Trade regulations, all signals to be erected in future have to be directly over the line which they are to control. He suggested accordingly that a light board should be lowered in front of the engine when the signal was at danger, so that it would strike the smoke stack if the driver attempted to pass on. There is much to be said in favour of this mechanical signalling as against the electrical signalling arrangement, which would only be used in cases of emergency, and hence might not then be in order. While on this subject, we notice that the North-Eastern Railway Company are proposing to make an extensive installation of the Hall electric signalling arrangement on their main line. The original intention, as announced in this journal, was to equip first a small portion of the main line near York with the system as an experiment, but it is now stated that the directors of the railway are contemplating a much larger installation. Accordingly the Hall Company have been asked to suspend operations on the initial order awaiting the decision of the Railway Board in the matter.

The Future of Locomotion.—Sir Alexander Binnie was present at the annual dinner of the Institution of Junior Engineers on Saturday evening, and gave the toast of "Improvements in Passenger Transit." In his opening remarks he admitted that what with the congested traffic of large towns and the necessity for some means of locomotion throughout the country less costly and more facile than ordinary steam transit, we were entering on a period which, if it meant anything, meant the abolition of the horse. Passing to a consideration of the modes of locomotion, Sir Alexander Binnie pointed out that the narrowness of our thoroughfares forbade the continuation of overhead electric traction. But in London, blessed by a substratum of clay, we had growing up deep-seated modes of communication at comparatively high speeds. The one or two examples in existence had so far succeeded as to prove electric traction to be one of the cheapest and most facile means of transit over comparatively long distances. When they considered the order book of the House of Commons they saw a large number of such projects, but it was perfectly certain they could not all go on. He had had occasion to tell a joint committee of both Houses that the proposed capital of tube railways in London amounted to 48½ millions, and it was quite clear from the knowledge which professional men had of the cost of constructing railways that all these proposed lines could never return to the investor a proper source of revenue. Sir Alexander thought that at present we were proposing to go a little too quickly, and to do more than the public purse could stand. But it was bound to come. While he spoke in these high terms of electric traction, there was another method rapidly coming to the front. He referred to the motorcar, which he prophesied had come to stay. It was a splendid mode of locomotion, but it was the duty of engineers to make it more sightly and less of a nuisance. But though it needed improvement, still more it needed to be released from the trammels placed upon it by short-sighted legislation. He went on to discuss the question of the storage of electrical energy. For the fuller development of the possibilities of electrical science, some economical mode of storing current when generated was required. There were many sources of nature which were continually, though intermittently, pouring out stores of energy, which, were it possible to catch and convert them into power, would be a great national gain. He concluded by saying he had every hope for the future with regard to the development of these new powers for the purpose of locomotion.

The Telephone Agreement.—On Monday last, on the motion of the Lord Mayor (Sir Joseph Dimsdale), the question of the agreement which the Postmaster-General has made with the National Telephone Company was fully discussed. Sir Joseph Dimsdale's speech was to the effect that the agreement gave practically no advantage to the telephone users in London, and that it did not fulfil the promises made when the money for the purpose was voted in 1899. Mr. Austen Chamberlain, in his reply, took practically the same lines as those followed by Lord Londonderry when answering, first, the London County Council deputation, and afterwards the letter from the telephone conference. As we reported both answers at length, there is no need again to go over the whole ground. A new point was raised, however, on the comparison which has so often been put forward of the price at which the London County Council were prepared to give an unlimited service—*i.e.*, £10 per annum. Mr. Chamberlain pointed out that the London County Council estimate was for 15,000 subscribers only in an area only one-fifth the size of that about to be supplied by the Post Office. Also that as some 30,000 subcribers are being arranged for, the cost is naturally considerably more. Another point which was brought out was that to avoid the rebreaking-up of the streets, the Postmaster-General has at once laid down the ducts required for this number of subscribers, and hence the capital charges at first will be unduly heavy. He accordingly argued that it was a good policy to rent these underground facilities to the National Telephone Company, as had been arranged under the agreement. It was also urged that an enquiry now into the rates to be charged would be useless, because no information had been obtained as to the working of the message-rate system. It was promised, however, that annual reports would be made to the House of Commons of the working of the system, and an adequate enquiry held in 1905. An estimate was brought forward by Mr. Chamberlain that the average receipts from a subscriber in London was likely to be about £8 per annum, as the Post Office were getting 12 subscribers on the message-rate system for every one who agreed to pay £17 per annum for unlimited user. The argument was freely used by other supporters of the agreement, including Mr. Hanbury, that the opposition was fighting for a reduction to the wealthy users of the telephone, which reduction would prevent a cheap service being given to the poorer classes, who only require a limited use. The amendment for an enquiry, which Sir Joseph Dimsdale was not allowed to withdraw, was defeated by a majority of 88. In connection with the contract which the subscribers to the Post Office London telephone system have to sign, we have again to call attention to the saving clause, which was not clearly understood when considered at the last telephone conference. Under the second provision of the fourth clause of the conditions the subscriber agrees to indemnify the Postmaster-General against any claim for damages done on the subscriber's premises due

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to high-potential currents being conveyed to the same by means of the exchange line. In view of the fact that the Postmaster-General is providing fuses at either end to disconnect the wires in case of high-potential currents entering them, and also that all the conductors are underground, this risk is exceedingly slight, and it is not correct, as was previously reported, that the subscribers have to indemnify against damage done in the exchange.

Sodium from Fused Nitrates.—The January issue of the *Journal* of the Franklin Institute discloses the fact that the John Scott legacy premium and medal have been awarded to Mr James D. Darling for his inventions in connection with the electrolytic production of metals and nitric acids from fused nitrates. A committee of the Franklin Institute have thoroughly looked into Mr. Darling's inventions, and their report is of great interest as showing the actual progress made by the inventor in overcoming the serious difficulties in the electrolisation of fused nitrates. The committee remark that when going over the plant, which is now in working operation, they were able to see from the remains of former types the energy which Mr. Darling has shown in following up his invention. In the same number of the *Journal* this inventor gives a full description of his latest apparatus. He found after experimenting that it was necessary to have a complete separation between the fused nitrates and sodium ions. In order that this could be done, he introduced into his apparatus a porous diaphragm, which is able to stand the destructive fluxing action of the electrolyte. This he makes of a mass of vitrified magnesium oxide confined between two walls of perforated sheet iron. The porous cup thus made is 30in. in height and 16in. outside diameter, and has walls 4in. thick, which leaves the inside diameter of the cup 8in. The rest of the furnace consists of a cast-iron pot which holds the fused nitrates and acts as anode. The inside of the porous cup is filled with fused sodium hydroxide. In starting up the furnace the pots have to be heated until the nitrates are fused, but after that the heat generated by the passage of the current is sufficient to keep the solution in a liquid state. Hydrogen dioxide and oxygen are liberated as gases at the positive electrodes, and are collected and made into nitric acid in the usual way. The first sodium liberated is absorbed to a certain extent by the sodium hydroxide, hydrogen gas being evolved and sodium monoxide probably formed. After some time, however, sodium rises to the top of the electrolyte, and is skimmed off with a spoon about once an hour. In order to prevent the perforated iron walls of the porous cup being eaten away, about 5 per cent. of the current is shunted through them so as to make them positive. This plan has reduced the local action between the electrolytes and this iron and increased its life about 10 times. Each furnace as now constructed takes about 400 amperes at 15 volts, and the life of the cups is from 425 to 450 hours. The committee in their report allude to the fact that the high resistance of the porous diaphragm makes the process somewhat expensive as regards electrical energy. It will be seen that 15 volts is required, which is much higher than the decomposing voltage of the sodium nitrate. We are pleased to note that Mr. Darling is working on a commercial scale, as the process is one which will be of great value where water power is cheap.

The Management of the "Underground."—The official circulars issued by the Metropolitan Railway Company and the Metropolitan District Railway Company with regard to a possible fusion of the two Boards do not tend to carry matters much beyond the controversial stage. Both companies declare their willingness to come to an arrangement which would place the two concerns under one management, but neither has any further proposals to make to the attainment of this end. The first matter which the circular of the Metropolitan Company discusses is the offer of the Metropolitan District Electric Traction Company to lease their Metropolitan undertaking, with a guarantee of 3½ per cent. on the ordinary stock. This proposal, it will be remembered, the Metropolitan Company have for a long time refused to entertain. They contend that the terms and conditions of the offer are of such a character as no man of business would think of accepting, and, moreover, they consider that in the ordinary course of railway development there is no reason why the Metropolitan lines should not be paying a 4 or 4½ per cent. dividend before long. The circular which the District Railway directors have issued is not so much concerned with this matter as the statement in the half-yearly report of the Metropolitan Company that "an American syndicate has obtained control of the District Railway." As regards this, the directors remark that the interest of the traction company, though very large, is by no means large enough to control the policy of the District Railway or even secure a majority without the support of the British shareholders in the company. In spite of this statement, however, it cannot be denied that these American financiers, with Mr. Yerkes at their head, are the leading spirits in the District Company's affairs, in co-operation with the large English shareholders associated with the present chairman. It is obvious, therefore, that the company's policy is more or less directed by Mr. Yerkes through Mr. Perks, but however this may be, we do not think it is a matter which should be allowed to stand in the way of an amicable working arrangement between the Metropolitan and the Metropolitan District Companies. No broad-minded man can deny the value of the co-operation of the American investors, who, as the District Company point out, have unrivalled practical experience in electrical traction, and command large financial resources. Another matter on which the two Boards cannot agree is with regard to the supply of electrical energy for the working of the lines. As our readers know, the District Company, who are building a power station at Chelsea, wish to supply the whole of the current for their own lines and those of the Metropolitan Company, and they have offered either to sell to that company current "by meter at a reasonable price," or, in the alternative, to let the Metropolitan Company become part owners of the power-house at Chelsea. The Metropolitan Company have declined both these offers, and decided to build a power-house of their own at Neasden. This course would seem to be justifiable if the statement be correct which occurs in the Metropolitan's circular, to the effect that "the Metropolitan Company's consumption will be so large that, with the advantages of the Neasden site and of the favourable contracts they are now able to make, this company can supply themselves with the current required, and effect a saving, as compared with the offer of the traction company, approaching the large total of £100,000 per annum, which alone is equivalent to a dividend of 1¾ per cent. on the ordinary stock." Thus, it would appear that a fusion of the two Boards is as far off as ever it was, but it is encouraging to learn that while the Metropolitan directors are anxious for a "complete and friendly understanding with the District Company," the directors of the District Company will "persevere" in the direction of harmonious working. Considerable interest centres in the general meeting of the Metropolitan Company, which is timed for 12 o'clock to-day, and it remains to be seen whether the directors have any fresh proposals to make with a view to the two companies being ultimately united under one management.

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THE LIGHT AND POWER PLANT OF THE MAZAWATTEE TEA COMPANY.

In equipping large factories with complete systems of electrical distribution of power, many advantages have frequently to be sacrificed in consequence of the previously existing arrangements for older systems of driving. This is not the case in the new works of the Mazawattee Tea Company at New Cross, as from their first inception it was arranged that they should be lighted throughout by electricity, and also have electric motors everywhere for the driving of the numerous machines in the great many departments into which the works are divided. These works, which were designed throughout by Messrs. Stott and Sons, the well-known architects and consulting engineers, of Manchester, are situated on some acres of ground lying in between the South-Eastern and London and Brighton Railways at New Cross. The northern boundary of the site is the Surrey Canal, which can also be used as a means of transport to and from the London Docks. Through the courtesy of the directors of the Mazawattee Tea Company we have been allowed to inspect in detail their electrical equipment, both for generating the energy and for utilising it in the works. The various departments are all contained in one-storey buildings, and these have the usual saw-tooth roofs, with north lights, with a result that good, airy, and light buildings are obtained. The arrangement, however, involves the use of a much larger area than if three or four storeyed buildings had been erected, and the conditions are in consequence exceedingly favourable to electrical driving as compared with older systems. We propose in the first place to describe the generating plant, and afterwards to give a few brief references to the special uses to which electricity is put in the departments themselves.

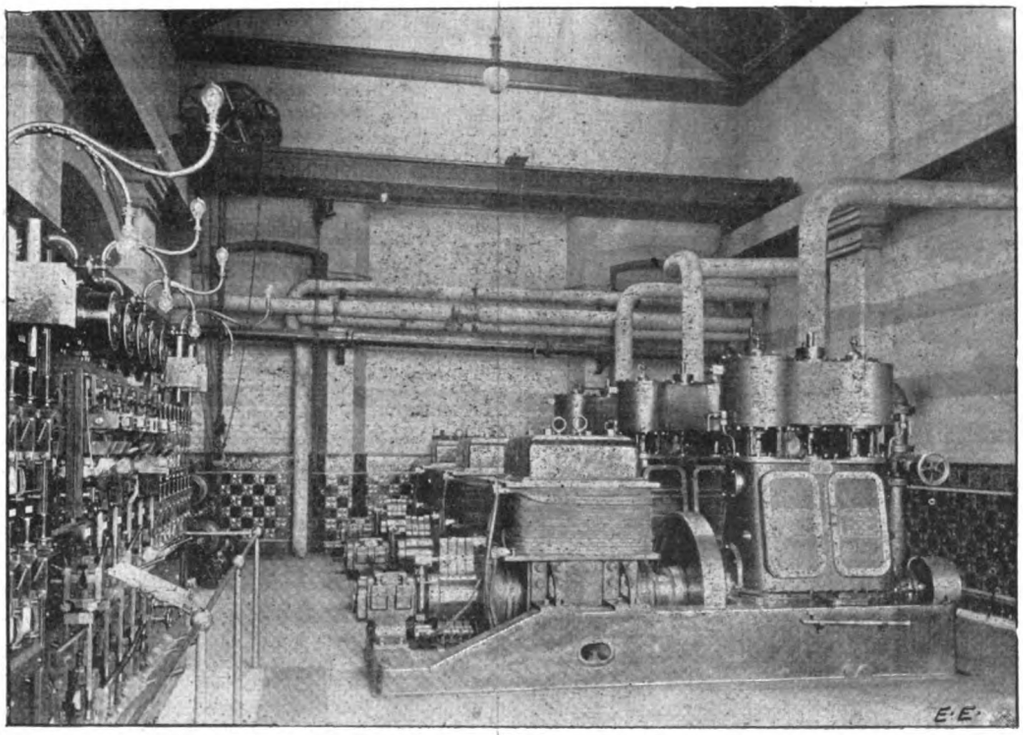

FIG. 2.—General View of the Generating Plant at the Mazawattee Works.

The contract for the generating plant and for the motors was placed with Messrs. J. H. Holmes and Co., of Newcastle-on-Tyne. The generators (Fig. 1) consist of three Castle dynamos, each direct coupled to compound engines of the Belliss type. The output of these machines is 425 amperes at 230 volts when running at a speed of 400 revolutions per minute. They are wound with compounding coils, and work well in parallel. The switchboard arrangements for this will be described later on. In addition to these three machines there is a fourth dynamo, of the same output, which can be rope-driven from a Davey-Paxman horizontal engine. This engine drives, by means of gear wheels, the lead-rolling plant with which the company prepare from ingot lead the vast quantity of tin-covered lead sheets used for wrapping up their tea. The output of the Davey-Paxman engine is more than sufficient to drive these rolls, and hence could supply a certain amount of power to the rope-driven dynamo above mentioned. Conversely, if the engine is being overhauled, the dynamo can be used as a motor to drive the lead rolls The steam for the generating plant, which frequently has to deal with an output of 1,100 amperes, is obtained from three Lancashire boilers 8ft. diameter by 30ft. long, working at 160lb. steam pressure. Two of these are equipped with Meldrum mechanical stokers, and eventually it is proposed to add a coal elevating and conveying plant to deliver coal into these stoker hoppers. It is when we come to the auxiliary plant in the pump-room that the first use of electric motors for driving is met with. The Belliss steam-engines above mentioned are worked condensing, and as the water supply is not unlimited, a Klein cooler is employed to cool the circulating water. The first auxiliary plant calling for notice is illustrated in Fig. 2, where there can be seen the two motor-driven circulating pumps working on the same shaft. These pumps are of the Gwynne type, the one being capable of delivering 150 gallons and the other 350 gallons per minute into the 7in. pipe. To the left of this circulating pump is the motor-driven air-pump of the Edwards type. A slow-speed Lundell motor of the multipolar pattern drives the pump shaft by a single-reduction gear with a raw-hide pinion working into a cut gear-wheel. The armature of the motor is double-wound, and a series-parallel controller enables the pump shaft to be worked conveniently at four different speeds—*i.e.*, 75, 100, 150, and 200 revs. per minute. At this highest speed the motor is running at 730 revolutions. The Edwards air-pump is of the three-throw type, and its construction, as is well known, avoids the use of foot valves. At the end of the air-pump shaft is coupled a smaller pump, also of the Edwards type, used to feed the boilers. It is interesting to remember that this combination of air and feed pumps is theoretically correct, because as the output increases more feed water is required, and at the same time the air-pump has to deal with more exhaust products. The feed pump provides 1,200 gallons per hour at 200 revolutions per minute.

The water used on the works is obtained from an artesian well which is sunk in the centre of the pump-room. This well goes down 460ft. into the chalk, and the normal water-

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level in it is 20ft. below the floor of the pump-room. In order to get the water up into a tank above the same, an electrically-driven air-compressor, also worked by a single-reduction gearing from a Lundell motor, forces air down a subsidiary tube in the artesian well. The mixture of air and water then rises up to the level desired, and 4,000 gallons per hour is regularly drawn from the well. In Fig. 3 we show a service pump, which is used to lift this artesian well water into a service tank after it has been softened by the Archbutt-Deeley plant, supplied by Messrs. Mather and Platt, of Manchester. Two of these service pumps have been installed, the other dealing with the make-up water for the circulating-water reservoir under the Klein cooler. As the two plants with their automatic control are identical, a description of the one will suffice. It will be seen that a double reduction of speed between the motor and the pump axle is obtained by means of a countershaft. The transmission is effected by Hans Renold chains working into toothed shrouded wheels on the shafts. Interest centres on the automatic device seen on the wall for starting the motor when the water-level in the tank falls to a certain point, and stopping the same when it has risen up to the top of the tank. It will be seen that in this instance there are two charging pipes brought down from the tank to the small cylinders to the right and left respectively of the starting switch lever. Assuming the motor to be stopped, and the switch over to the left, if now the water-level in the tank falls to a predetermined point, a ball tap at the top of the left-hand pipe admits tank water into it. The pressure in the left-hand cylinder is quite sufficient to move over the switch, gradually starting the motor, which forces water up into the tank. The ball valve shuts off as soon as the level

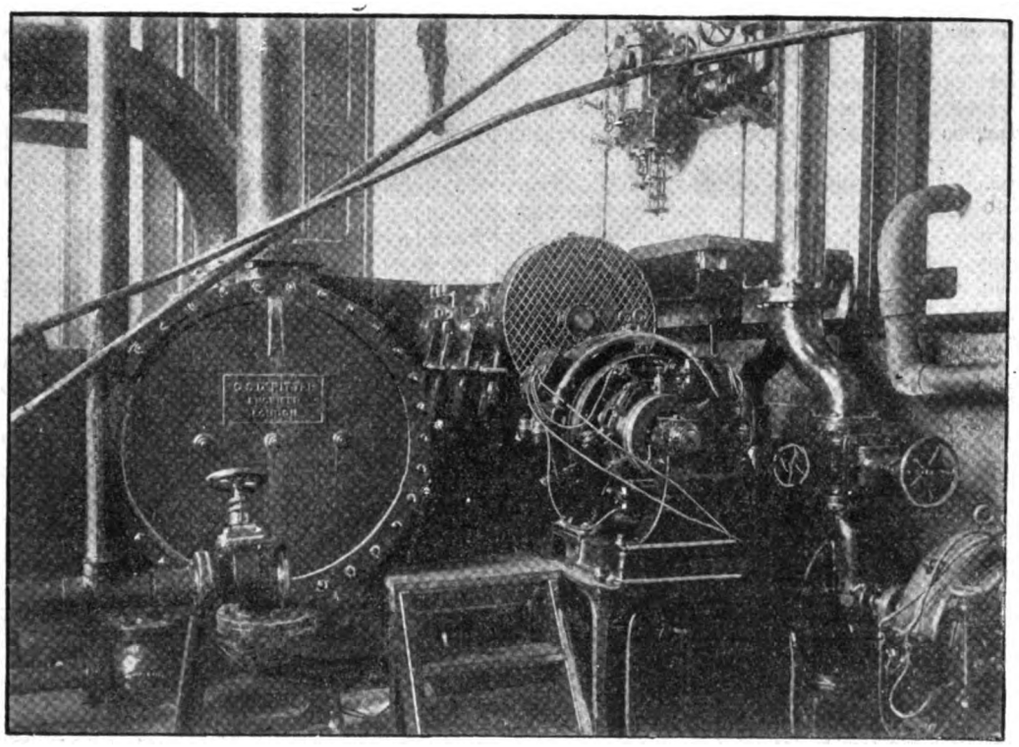

FIG. 2.—A Corner in the Pump-Room, showing Electric Circulating and Air Pumps.

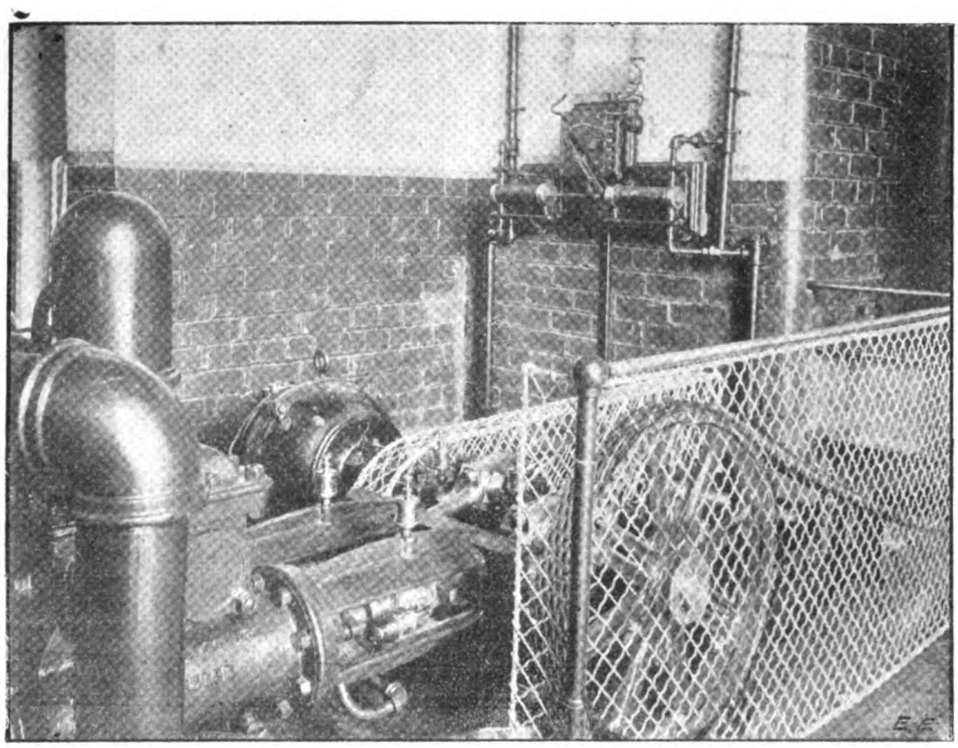

FIG. 3.—View of a Service Pump, showing Automatic Starting and Stopping Gear worked by Hydraulic Pressure.

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rises. When then the water has risen up to the top of the tank, it flows into the pipe shown at the right-hand side of the switch. The water pressure then enters the right-hand cylinder and switches off the motor. The subsidiary action of the drain pipes for emptying the cylinders and the charging pipes after each operation cannot clearly be explained without a drawing, which the makers of the apparatus (Messrs. Mather and Platt) have been unable to furnish us with at the present time. The service water-tank, which is over this subsidiary pump-room, is used to supply the whole works with softened water, as well as providing feed water for the boilers.

Coming now to the switchboard, we think a full description of the generator switch gear for coupling the compound dynamos in parallel will be of interest. Compound machines were selected in this instance because of the wide variation in load which occurs without warning in a factory like that of the Mazawattee Tea Company, owing to the heavy plant which has to be driven in certain of the

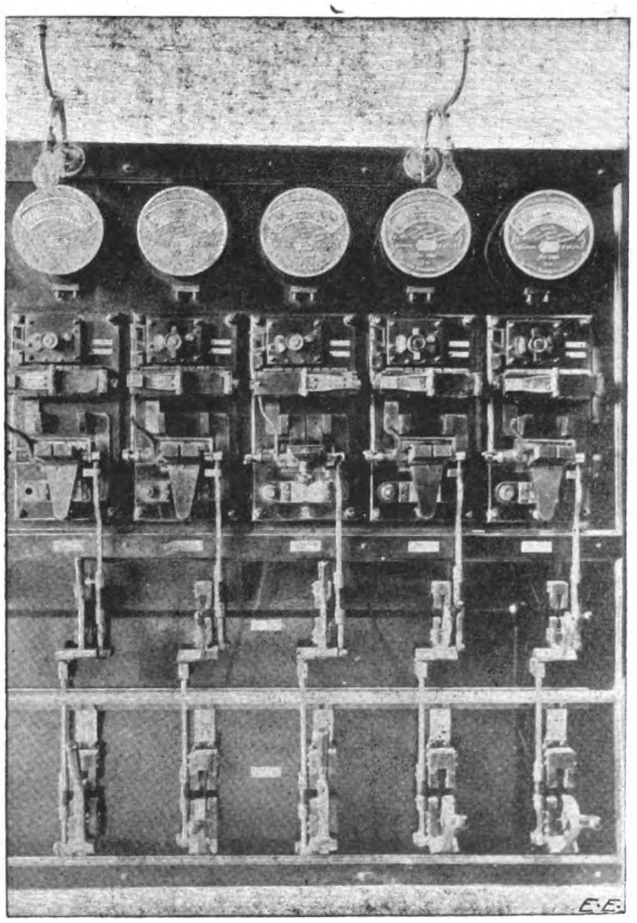

FIG. 4.—The Switch Gear for Coupling the Compound Dynamos in Parallel.

departments. This is especially the case in the cocoa department, where motors up to 40 h.p. are required. When we were inspecting the works we witnessed a sudden increase of load, which necessitated the quick starting-up of another generating set. It was noticeable, however, that practically no regulation of the shunts was required to keep the voltage constant. The switch gear for paralleling these generators is shown in Fig. 4. It will be seen that there are three distinct switches for each machine placed one above the other on the switchboard. The lowest of these switches connects the negative terminal of the machine on to the negative 'bus bar of the switchboard. In bringing the machine into parallel this switch is always closed first; the next switch above this connects on to the equalising bar the brush terminals which feed the series coils of the incoming machine; the third switch closes the positive side. To ensure, however, that the incoming machine shall be of the same voltage as the 'bus bars, it is excited from them, and adjustment is made with the shunt resistance until this is the case. The machines, however, are not run on load with their shunt connected on to the 'bus bars. In order to change over, therefore, the small two-way switch seen above the automatic switch is used. When this stands on the upper right-hand contact, the machine is excited from the 'bus bars. A small connecting rod, working from the axle of the automatic switch, moves this shunt connection on to the lower right-hand contact when the automatic switch is closed, and then the machine is excited from its own armature. The larger connecting rods between the three large switches prevent them being closed except in order described above, and also lock the lower two switches in the "on position" until the automatic switch is first opened. In the general view of the engine-room (Fig. 1) these switches can also be seen. From the positive and negative panels, placed one on either side of the generator panel, 16 feeders go out to various departments in the works. Thus each department has a separate feeder for supplying its motors, and another one for the lights. A single-pole switch and fuse are placed in both the positive and negative feeder.

Coming now to the electrical equipment in the works, there are some 40 motors used, varying in output from 3 h.p. up to 40 h.p. The motors are all of the Lundell

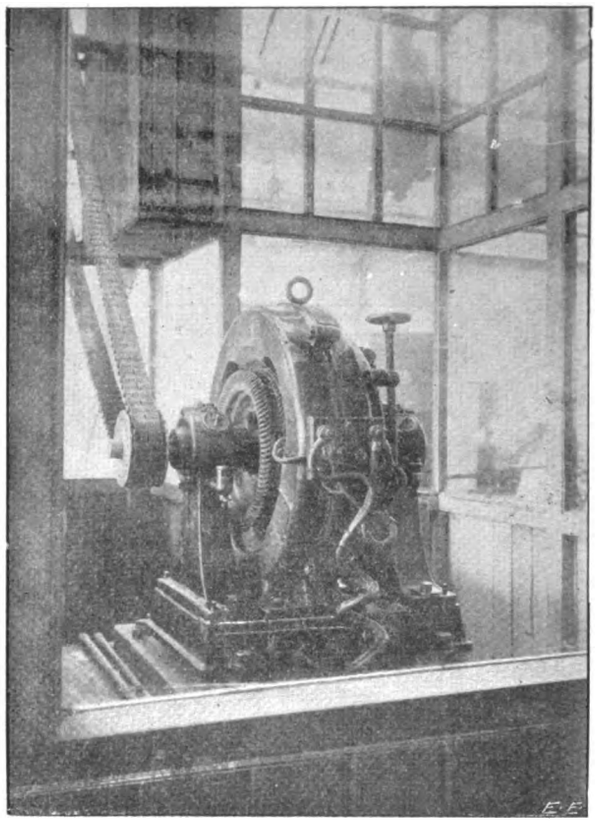

FIG. 5.—Motor Driving by Hans Renolds Chain.

type, supplied by Messrs. J. H. Holmes and Co., and most of them are compound wound to secure constant speed at all loads. They drive as a rule on to short lengths of countershafting by means of Hans Renolds chains. These chains seem to be giving good results. In other cases, as in the printing department, motors direct coupled on to the machine or working by gearing are employed. In Fig 5 we show a typical case of a Hans Renolds drive. This photograph is taken in the tea cleaning and blending department, where there is a considerable amount of dust. The motors are accordingly completely enclosed in glazed partitions, which to a large extent keeps this dust out of the working parts. In this department we were much interested to see the very successful way in which electromagnets were being used to take nails and other pieces of iron from the tea as it passed along a travelling belt.

In the next department, where the tea is made up into packets, after having been blended, all the weighing is done electrically. As these electrical weighing machines are worked at 100 volts, a rotary transformer is introduced to reduce the voltage of the supply mains from 230 to that required by the machine. The accuracy with which these

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small weighing machines portion out the ½lb. of tea is combined with very considerable rapidity, and the company have also some interesting machines for making-up the packets themselves. This portion of the plant, however, is somewhat outside the scope of this article.

Before leaving the electrical power distribution, we must refer to the careful way in which the company have guarded against any disorganisation. Thus in a rack in the engine-room are to be seen one spare armature for each size of motor in use, and in this way, should any small defect arise, the machine affected would only be laid on one side for the short period needed for changing the armature. In this respect the careful standardisation practised by Messrs. J. H. Holmes and Co. in the manufacture of these Lundell motors is to be highly commended.

The wiring of the building was done by Messrs. Drake and Gorham, the wires being laid in Simplex tubing, carried in a subway which runs the full length of the building. This subway, which is 180 yards long, forms a convenient channel for the wires on their way to the main distributing boards for lighting and power in each depart-

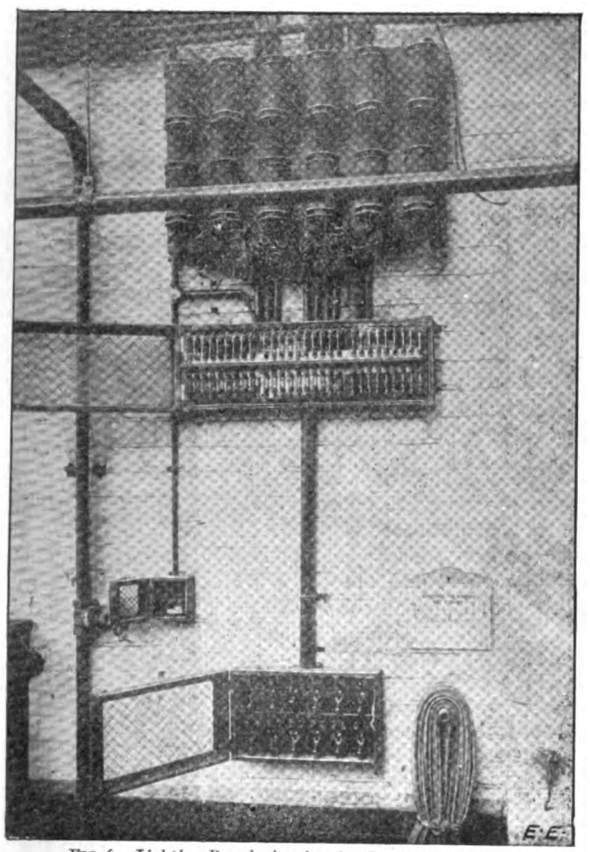

FIG. 6.—Lighting Board, showing Arc Lamp Resistances.

ment. We gather that in one department alone the motor power board is constructed to carry 948 amperes. This board is divided into three sections, fed by three pairs of $^{37}/_{12}$ cables. We may mention in passing that this is in the chocolate department, where the heaviest machinery is required. The bulk of the lighting is done by the Jandus type of enclosed arc lamp, with self-registering inner globes. The external resistances for each lamp are collected together over the switchboard, as seen in Fig. 6. The lamps are designed to take four amperes and are arranged two in series at 230 volts across the mains, and some 228 of them have been supplied. Besides these, some 275 incandescent lamps are in use in the offices and other special parts of the works. This plant is under the charge of the superintendent engineer for the works, who kindly showed us round when we inspected the same. From his accounts we see that the company are obtaining their light and power at an exceedingly low rate, as is perhaps only to be expected in view of the large output. In fact, the Board of Trade units generated per annum are more than are turned out at many corporation electricity works for towns. It would not, however, be fair to the staff at the present time to give the actual figures of costs, as the works have only been going for some six or eight months, but we hope at some later time to be allowed to do so, and to show how the low costs now obtained have still further been reduced.

In conclusion, we have to congratulate the Mazawattee Tea Company on the up-to-date and efficient lighting and power plant which they possess, and which must conduce to the economical running of their enormous factory.

BERMONDSEY COMBINED REFUSE DESTRUCTOR AND ELECTRICITY SUPPLY WORKS.

(Concluded from page 124.)

MAIN STEAM AND EXHAUST PIPING.

The main steam-pipes are arranged, as shown in Fig. 3, on what may be termed a modified ring system, with valves inserted so as to provide for cutting out any section for the purpose of executing repairs without interfering with the supply of steam to the other sections. The pipes are constructed of lap-welded mild-steel tubes with wrought-steel flanges shrunk on and riveted through the collar, and turned on their edges and faced with a socket and spigot. The joints between the flanges are made with corrugated copper rings. The steam separators are made of mild steel with pressed steel inlets and outlets riveted to body. The bends connecting to the engines from the steam header are of inverted U shape, so as to allow for expansion and contraction. In the main between the boilers a large bend is provided for a similar purpose. The exhaust from each engine is taken into a common main exhaust placed in a trench below the engine-house floor, this main being carried through a baffle chamber and then to the atmosphere through the chimney shaft. The pipes in the engine-house are of cast iron, with flanged joints, those outside the buildings having spigot and faucet joints. Gangways are provided over boilers for access to valves, and a gangway is also provided for access to the main header. The pipe work was carried out to the specification of Messrs. Kincaid, Waller, and Manville by Messrs. John Spencer, Limited, of Wednesbury.

ENGINES AND DYNAMOS.

In deciding the system of distribution most applicable to the borough of Bermondsey, the engineers had under consideration the fact that the district is an extremely congested one, and also filled with factories and workshops of various descriptions, a most favourable opportunity occurring, therefore, for supplying electricity during the daytime for motive power purposes. Under these circumstances it was considered that the continuous-current system of supply was the most suitable. The plant at present installed in the generating station consists of three multipolar generators, by the Thames Ironworks Shipbuilding and Engineering Company, coupled to Willans engines. Two of the sets each have an output of 150 kw. at 480 to 520 volts, the third set having an output of 75 kw. at 480 to 520 volts. A view of the generating plant is shown in Fig. 16, while in Fig. 17 the design of one of the larger dynamos is seen. It is satisfactory to note that the manufacturers of the generating plant have earned a bonus on the steam consumption, which has been found, by tests made by the engineers, to be better than the figures guaranteed. It should be mentioned that two of the engines are of the three-crank compound type (size 3 H's), capable of giving 215 b.h.p. at 380 revolutions with 150lb. steam pressure; cylinders, 12in. and 17in.; stroke, 8in. The other engine has two cranks, and gives out 110 b.h.p. at 450 revolutions; cylinders, 280mm. (11in.) and 440mm. (17·3in.); stroke, 150mm. (5·9in.). In each instance a complete engine is arranged tandem-wise over each crank, and the sets in all respects conform to the standard practice adopted by Messrs. Willans and Robinson, Limited. There are also installed in the engine-house a balancer and battery-charging motor-booster. The balancer consists of two separate machines directly coupled together, either of which will run as a motor or generator according to the balance of load. The combination is capable of giving

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an output of 15 kw. at any pressure between 240 and 260 volts, and runs at a speed of 800 revolutions per minute. The battery-charging booster consists of three separate machines, two generators, and one motor, the three machines being direct coupled together and mounted on a combination bed-plate. The booster or generator

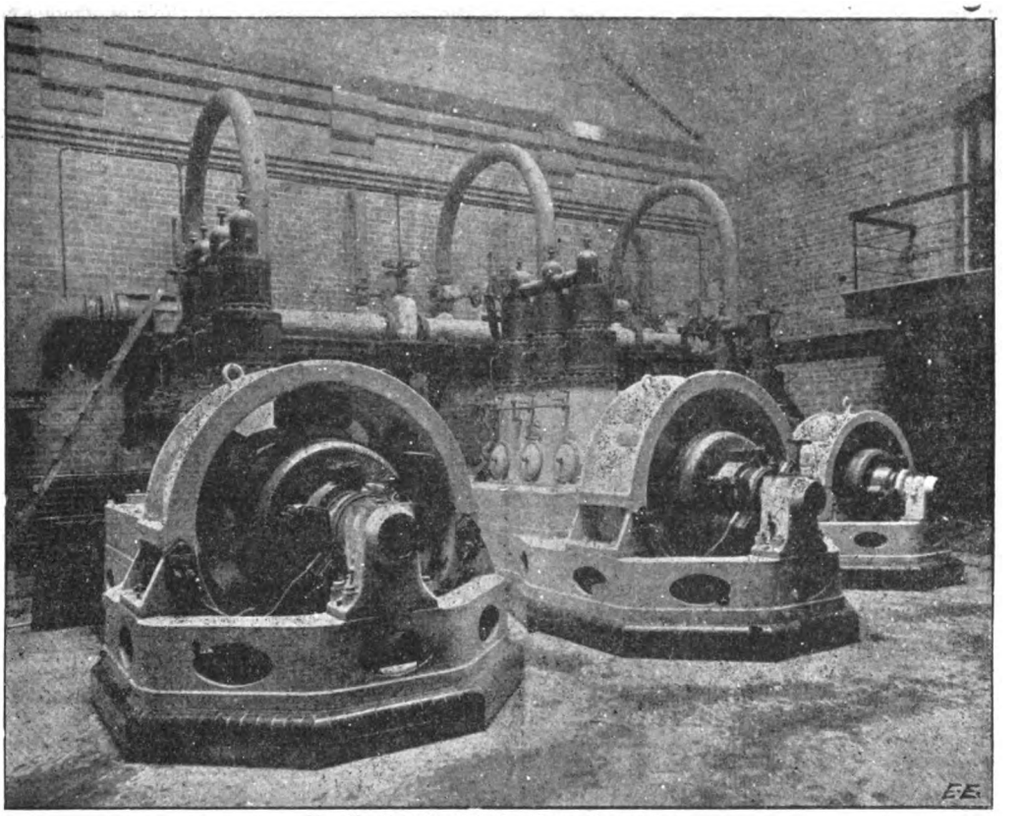

FIG. 16.—Interior of Engine-House, Bermondsey.

armatures are each capable of giving an output of 80 amperes at any pressure varying between 10 and 100 volts, and the set runs at a speed of 800 revolutions per minute. In addition to being used for battery-charging purposes, the booster may be placed in series with the battery when discharging, when it will give the output stated above at

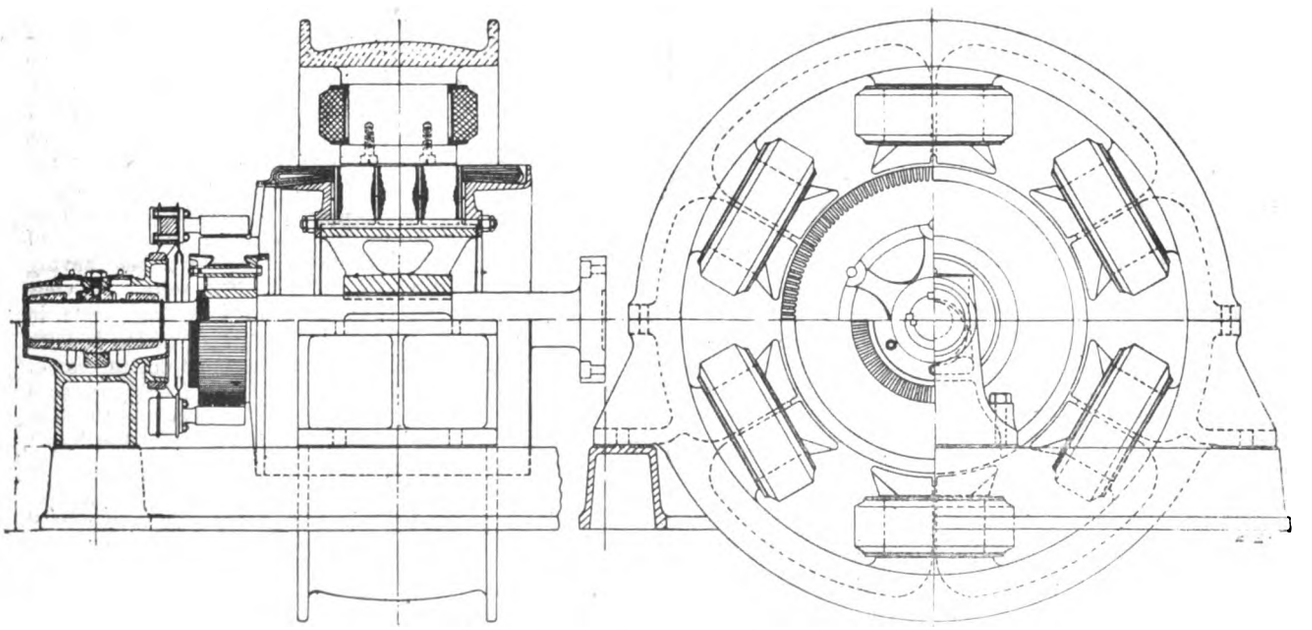

FIG. 17.—Details of 150-kw. Dynamo, Bermondsey.

an E.M.F. in the reverse direction, the reversal being effected by reversing the shunt connections.

ACCUMULATORS.

The battery of accumulators consists of 280 cells of the Tudor Company's L.B. 11 type in glass boxes. Each cell contains 11 plates—five positives and six negatives—the size of the positive plates being 14in. by 12in. by $\frac{1}{2}$in., and that of the negative plates 14in. by 12in. by $\frac{3}{8}$in. The weight of each positive plate is 22$\frac{1}{2}$lb. and negative 16$\frac{1}{2}$lb., the total weight of a cell complete with acid being 400lb. The plates are suspended from the sides of the boxes, a free space of 4in. being left beneath the plates for the accumulation of deposit, while the plates are free to expand in all directions. The boxes are supported on wooden trays containing sawdust carried on the glass oil insulators. The specified capacity of the battery is 500 ampere-hours at a six-hour rate, and 435 ampere-hours at a three-hour rate, with a terminal pressure of 510 volts. The cells are arranged in two tiers, one tier forming the positive side and the other the negative side of the battery. The connections from the cells to the switchboard are indiarubber and lead covered. For the purpose of charging individual cells, a portable booster with regulating resistance is provided, which does away with the inconvenience attaching to the use of "milking" cells set apart for a like purpose.

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SWITCHBOARD.

The switchboard, which is mounted in a wrought-iron frame, consists of panels of polished black enamelled slate 1½in. in thickness. The board has been designed to control three dynamos, six feeder circuits, eight arc circuits, the town hall, depot, and station lighting and power circuits, the storage battery, balancer, and the battery-charging motor-booster. The connections to the switchboard are also each provided with a paralleling voltmeter, a double-pole field breaking and discharge switch interlocked with the double-pole main dynamo switch, and a field-regulating switch. The accumulator panel, which is placed next to the generator panels, contains the connections from the positive and negative batteries. Each battery is provided with a 16-way regulating switch connected to those cells numbering from the middle wire, two Thomson-Houston

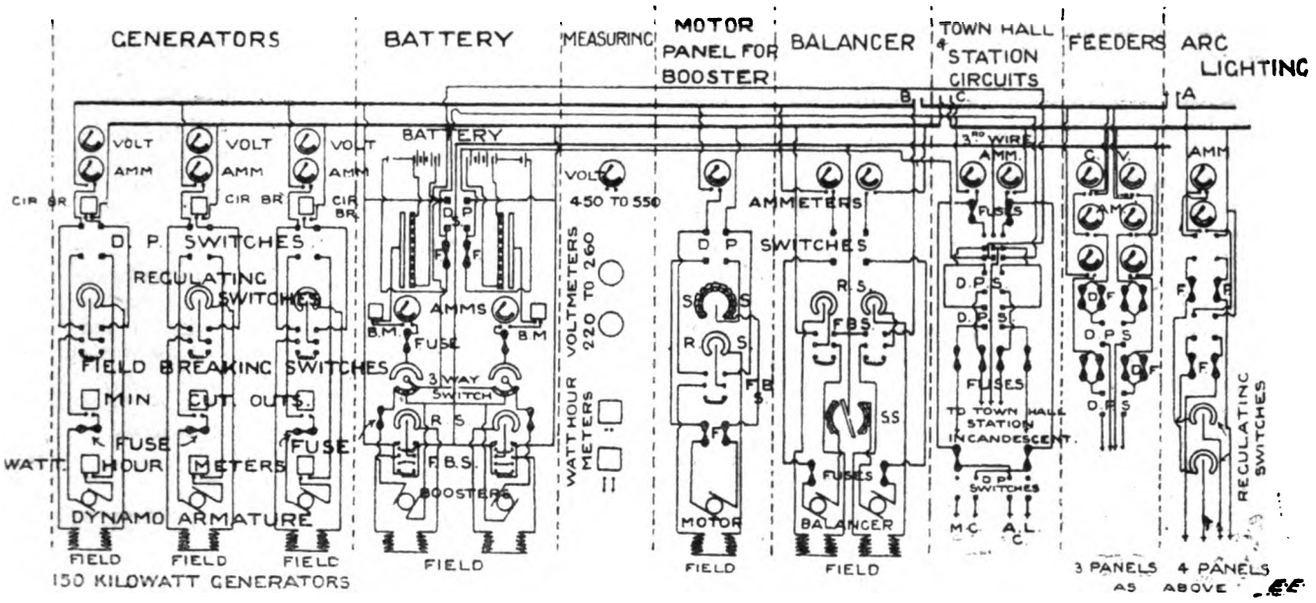

Fig. 18.—Diagram of Switchboard Connections, Bermondsey.

shown diagrammatically in Fig. 18. Positive, negative, and middle wire 'bus bars of ample section are carried at the back of the board, and in circuit with them are arranged watt-hour meters of the British Thomson-Houston type, connected in such manner as to measure the energy delivered to the feeder circuits and the public lighting circuits respectively. These meters are fixed on the measuring instrument panel, and provided with short-circuiting plugs. Three

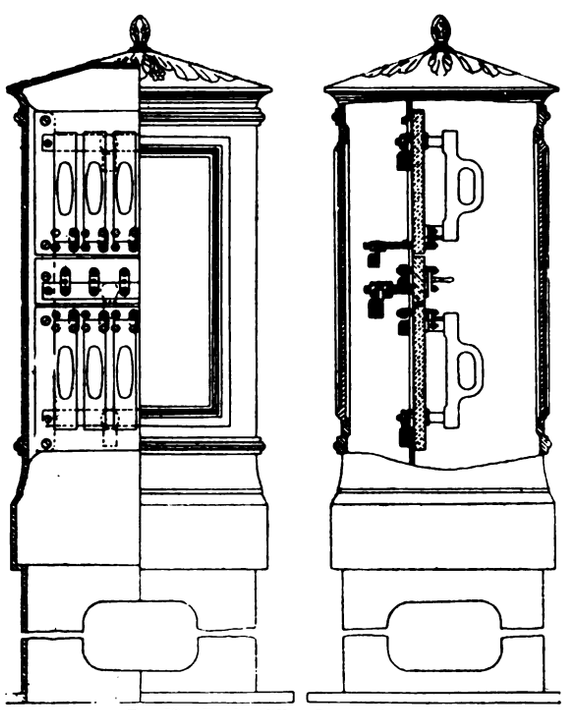

Fig. 19.—Feeder Pillar, Bermondsey.

Weston voltmeters, with illuminated dials, are also fixed on this panel connected across the outer and neutral and outer 'bus bars. The connections from each generator to the 'bus bars are made through a British Thomson-Houston magnetic circuit breaker and wattmeter and a Siemens automatic minimum cut-out, and each circuit is also carried through an ammeter, showing the output of the generator, and a double-pole main switch. The three generator panels are wattmeters for measuring the charge and discharge of the battery respectively, a central zero ammeter for indicating the charge and discharge current of the battery, and a three-way switch. One way of this latter is used for putting the booster in circuit with the battery for charging or discharging as the case may be, the second way for cutting the booster out of circuit which directly connects to the 'bus bars, the third way for connecting the battery directly on to the town hall and station lighting and power panel. A double-pole switch and cut-out are provided, which are connected to the outer connections of the battery, to the 'bus bars for isolating and protecting the battery respectively. Also, mounted on the battery panel for each booster, is a field break switch with connections for reversing the direction of the current to the fields when the booster is in the charge or discharge of the battery, discharge resistance, and field-regulating switch. The booster-motor panel is provided with a starting switch fitted with field break-and-make contacts, double-pole cut-out and switch, field-regulating switch, and ammeter for indicating the current taken by the motor. The balancer panel has mounted upon it a double-pole starting switch fitted with field break-and-make contacts, and in circuit with each machine is arranged a central zero ammeter for indicating the current when used as a motor or generator respectively, a fusible cut-out, and field-regulating switch. The town hall and station lighting and power panel is in the usual way connected to the 'bus bars, but as a further source of supply may be connected direct to the battery through the three-way switch before mentioned in the battery panel. In order to effect the change-over a triple-pole change-over switch is provided. In circuit with each outer connection from the 'bus bars is arranged an ammeter indicating the current delivered, and a regulating switch and resistance for reducing the pressure of the current in the 'bus bars to the normal supply pressure. Each of the feeder panels has provision for two feeders. On each of the outer conductors of the feeders is placed in circuit an ammeter indicating the outgoing current, and a duplex cut-out, so that, in the event of a fuse failing, the remaining one can be instantly switched in to take its place. A compensating voltmeter is placed across the outer conductor, and a double-pole main switch is provided for disconnecting the feeder from the board. On each of the arc lighting panels, arrangements are made for four arc circuits, each provided with regulating switch and

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resistance for maintaining a constant current to the lamps, an ammeter for indicating the current taken by the lamps, and a double-pole cut-out and switch. Messrs. Crompton and Co., Limited, supplied and erected the switchboard.

System of Mains.

As will have been gathered from the foregoing, the three-wire system of distribution has been adopted in the borough. The feeder mains are at present four in number, three of ·125 square inch section triple-concentric, and one of ·25 square inch triple-concentric. A fifth feeding point is provided adjacent to the generating station. Each feeder is approximately three-fifths of a mile long, and terminates in a feeder pillar (Fig. 19) containing an oil-insulated slate base, on which are mounted three triple-pole switch cut-outs. To these cut-outs are connected the triple-concentric distributors. By this arrangement any particular distributor may be very easily isolated for the purpose of localising a fault, and, moreover, as provision is made for connecting an indicator to either distributor, the maximum demand on that particular distributor can be readily ascertained. Both the feeder and distributor cables are insulated with diatrine paper and lead covered. It being undesirable in streets with a large amount of traffic over them, such as those in Bermondsey, that a burying-in system should be used, involving as it does the taking up of the roads when additional mains are required, it was decided to use a drawing-in system, and earthenware conduits, made by Messrs. Doulton and Co., Limited, have been used throughout, with the exception of the distributors, which are laid in earthenware troughing filled in with pitch The conduits are both two, three, and four ,way, and the ways 3in.. and 4in. square. It should be mentioned that the mains have been supplied throughout by Messrs. W. T. Glover and Co., Limited. The mains already laid may be traced on the accompanying map (Fig. 1), which also shows the position of the public arcs and feeding points.

Public Lighting.

The public lighting, as at present arranged, consists of 71 standards of artistic design, supporting 10-ampere double-carbon Crompton arc lamps, replaced by incandescent lamps after midnight. The arc lamps are arranged in circuits of 10 in series running off the outer 'bus bars. The standards supporting the arc lamps are also provided with two brackets supporting the two 16-c.p. incandescent lamps referred to. Each lamp-post is fitted with an isolating switch, and with one of Messrs. Glover and Co.'s "Edmunds" patent automatic switches for controlling the lighting of the incandescent lamps. These switches are so arranged that during the time of running the arc lamps, should any one arc lamp or the whole circuit be accidentally extinguished, the incandescent lamps are automatically connected up to the low-tension network, whilst immediately the lamp in question or the series are relighted, the incandescent lamps are at once extinguished. At 12 o'clock, when the arc lamps are permanently turned out, the incandescent lamps are lighted automatically by these switches, and remain so until the morning, when, by momentarily switching on the current to the arc circuit, these automatic switches extinguish the incandescent lamps for the daytime. Immediately the arc lamps are lighted again the next evening, the switch is automatically put in position to light the incandescent lamps again should any of the arc lamps be extinguished.

Flag-making Plant.

This description would be incomplete without reference to the electrically-driven hydraulic plant which has been put down in connection with the refuse destructor for the manufacture of flags from a portion of the clinker residuum. This plant has been constructed by Messrs. C. and A. Musker, of Liverpool, and will turn out flags at the rate of 25 per hour. A motor of the Bruce Peebles type provides the motive power for driving the hydraulic plant and mill.

Prospects of the Supply.

Bermondsey has a population of 130,486, spread over an area of 1,736 acres, and a ratable value of £847,365. The gas supply is in the hands of a company, the price charged being at the rate of 2s. 8d. per 1,000 cubic feet to the consumer. So far as the electricity supply is concerned, the Wright system of charging has been adopted for lighting, the price charged per unit being 6d. for the first hour and 3d. afterwards. For power, a flat rate of 2½d. per unit is to be charged. The equivalent of 5,000 8-c.p. lamps has been fixed up to date, not reckoning the public arc lighting. The prospects of a good motor load are excellent, there being numerous leather and other works within the limits of the borough.

In conclusion, we have to thank Messrs. Kincaid, Waller, and Manville for the facilities accorded us in connection with the preparation of the above description, and for the loan of most of the accompanying drawings; also Mr. W. H. Vincent, the borough electrical engineer, for his courtesy in showing us over the works.

Commemorative Banquet.

The opening ceremony having been duly performed on Thursday, the 23rd inst., as reported in our last issue, a commemorative banquet, given by the engineers and contractors concerned in carrying out the works, was subsequently held at the Trocadero Restaurant, Piccadiily-circus, W. Mr. E. Manville was in the chair, and the proceedings throughout were marked with conspicuous success.

SOUTH SHIELDS CORPORATION ELECTRICITY WORKS.*

BY JOSEPH A. JECKELL, A.I.E.E.

(Continued from page 17.)

The cables used at first were entirely rubber covered; rubber concentric for the high tension and rubber single for the low-tension, the low-tension mains being laid on the two-wire system. With the aforesaid exceptions, these rubber cables have been found very satisfactory. All these cables were laid in cast-iron pipes. The high-tension cables were laid in 3in. cast-iron pipes, which were large enough to allow of other cables being drawn into the same pipes. The low-tension cables were

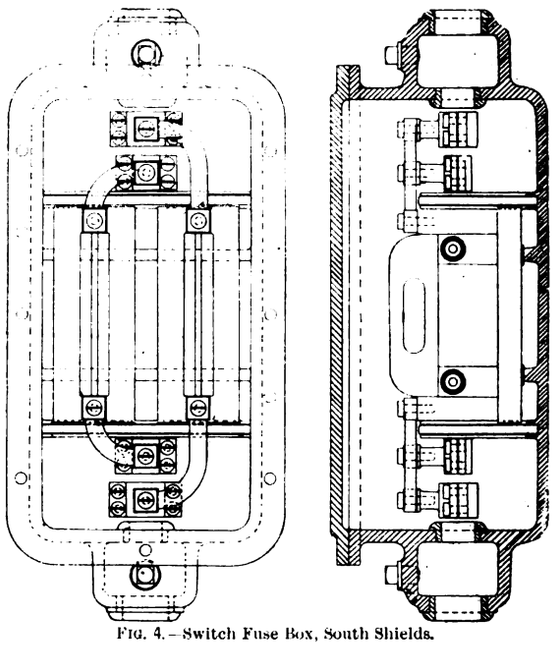

Fig. 4.—Switch Fuse Box, South Shields.

drawn into pipes only just large enough for them. The arrangements in the case of the low-tension cables were that when it became necessary to put on a service the cast-iron pipe was cut. This was done in far less time than it takes to cut the armour of the armoured cable, two minutes being quite sufficient time to cut the piece out of the pipe. A cast-iron box was then bolted on, and couplings were put on to the cable and the box (Fig. 5) filled with compound. The advantages of this system were found to be as follows: Seeing that the cables were drawn into a cast-iron pipe, there was absolutely no fear of mechanical damage being occasioned to the cable by workmen putting a pick into them. When the cast-iron pipes were laid, quite a small gang could lay them, and it was not necessary to take up a long length of street. By this means the full work per man per day could be obtained. When the length of pipes had been laid, the cable

* Abstract of paper read before the Newcastle Local Section of the Institution of Electrical Engineers.

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which, as before mentioned, was single cable, but in extensions concentric cable was used, would be drawn into the pipes by means of a large gang. As the pipes had been laid, the large gang would not be required except for a short time. Thus it became possible to lay cables on this system at a cost of very little, if any, above the cost of laying armoured cable. Should a fault occur on the cable, it is in any case necessary to open the house service boxes on each side of the fault. In the case of the aforesaid system, should the fault be found between the house services, a length of main could be withdrawn and another substituted without taking up the pavement between the boxes. It should be carefully noted that the pipes to contain the low-tension mains should be only just large enough to hold the low-tension mains, it never being intended to draw in another main on the top of the existing one. It will be seen from this that concentric cable was more convenient for this purpose than two single cables. The coupling

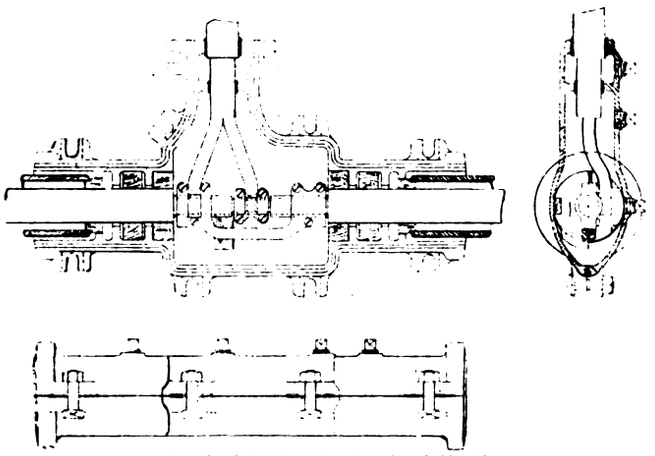

FIG. 5.—2½in. Junction Box, South Shields.

which it has been found most convenient to use is shown in Fig. 5, and tinfoil is wound round the conductor, and the couplings clamped on. It is convenient if the outer coupling has a bar on the top and bottom half of the coupling, as appears in the drawing. When it became necessary to lay larger cables, paper-insulated cables were used and have in every way proved satisfactory. As the demand for current increased, it was found necessary to put down sub-stations in place of street transformers. The position of these sub-stations are shown on the plan. It will be seen that the district was rather a convenient one in which to put sub-stations, because it enabled the cables to be, if necessary, ringed.

Sub-Stations.—The principle that the author has adopted with regard to the sub-stations is: firstly, to have them all equipped exactly alike; secondly, to have each sub-station fed by a separate high-tension main from the generating station, and at the same time to have led into the sub-station and pass through it two other high-tension mains. Each sub-station is designed to hold six 30-kw. transformers, five to be working and one spare. The high-tension feeders are ·15 square inch section. Each low-tension distributing board is arranged to deal with 10 circuits, but, as all the connections are in duplicate, more circuits can be put on if necessary. Under normal

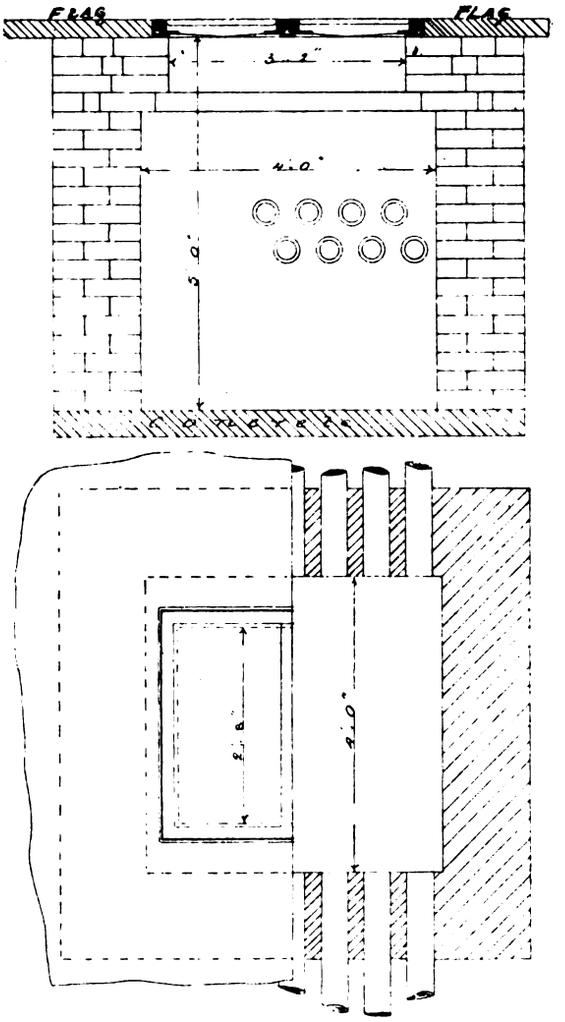

FIG. 6.—Draw-in Box, South Shields

conditions, when the sub-station is fully equipped, the feeder will be working at 500 amperes per square inch. Each of the sub-stations will be of the same capacity ultimately, therefore each of the feeders will be of the same size. Should any sub-station break down, the

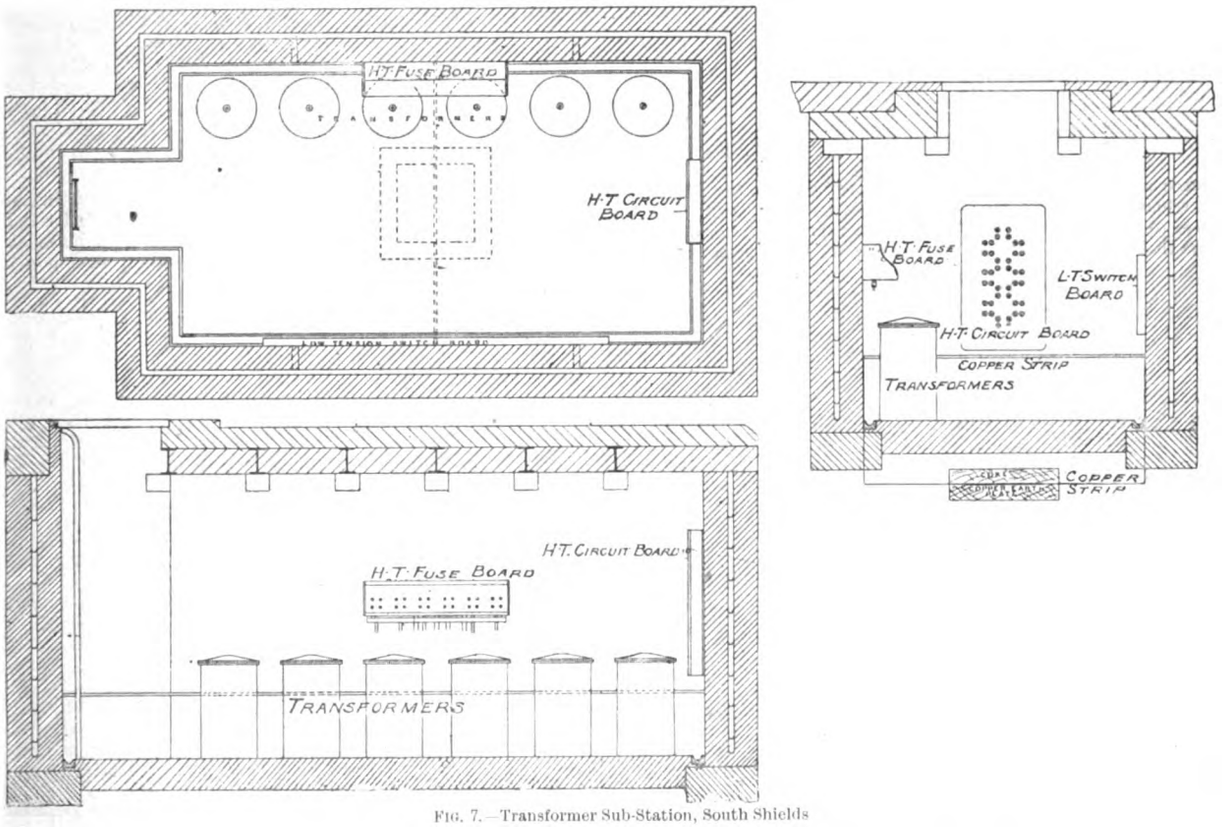

FIG. 7.—Transformer Sub-Station, South Shields

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circuit board will be divided, and half of the sub-station fed off each of the high-tension mains which pass through. Even supposing that each of these high-tension mains was doing its full capacity—viz., 500 amperes per square inch—the extra load placed on them, owing to the breakdown of the feeder to the sub-station, would only mean that each of these two feeders passing through would have 750 amperes per square inch passing through them. Each sub-station feeds its own low-tension network, which, under normal conditions, is not connected to any other low-tension network, but there are connecting boxes, so that the low-tension network in any of the sub-stations could be connected to the low-tension network served by a neighbouring sub-station. Thus, if a fault occurs, it means that only a small portion of the town is affected. Each sub-station is, moreover, connected to the neighbouring sub-station by means of intercommunicators which act as feeders to the low-tension network; therefore, if it were necessary to disconnect the high-tension network in any sub-station altogether, it would be comparatively easy to feed that sub-station network from the neighbouring sub-station. These sub-stations are 17ft. long, 9ft. wide, and 9ft. high, with a recess 3ft. square at one end for entrance, as shown in Fig. 7. The walls of the sub-stations are double, the outer being 9in. thick, with a cavity of 3in., and then 9in. inside. The interior of the sub-station is lined with white glazed bricks throughout; there are weep holes at the bottom of the walls connected with the cavity, and a porcelain channel runs all round the sub-station, communicating with the drain; thus the walls in the sub-stations are kept perfectly dry, and there is no fear of water oozing through on to any of the apparatus, since if any water gets through the outer wall it will run down the cavity, out of

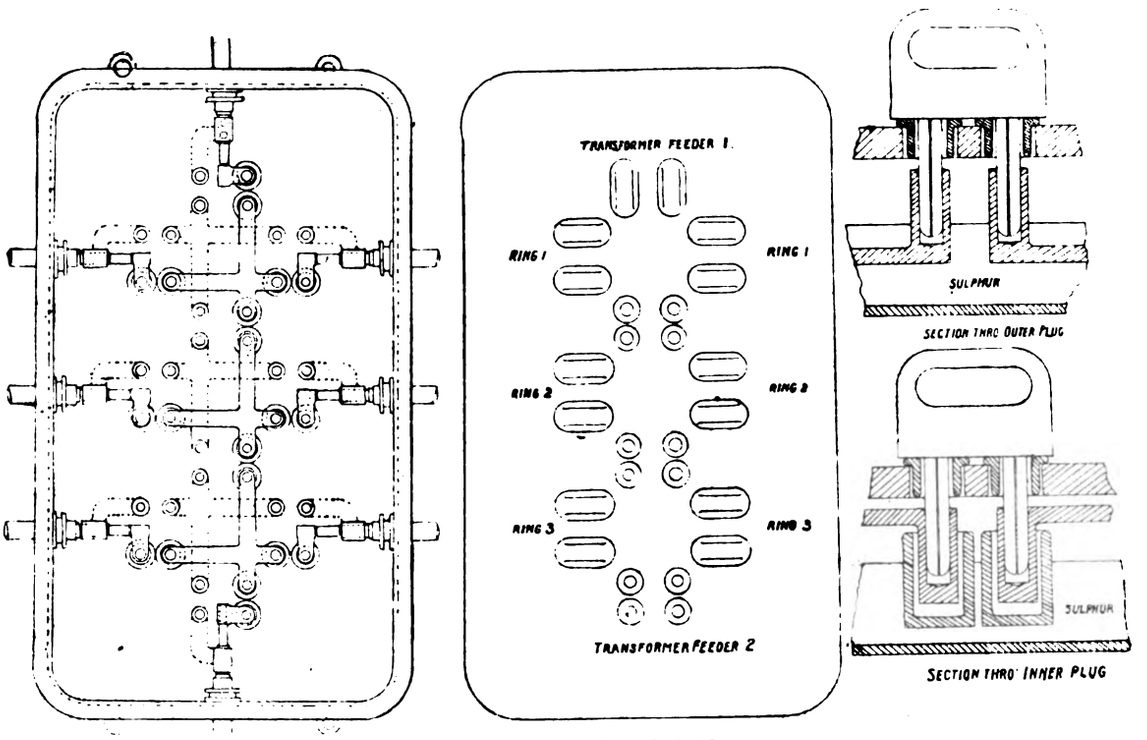

FIG. 8.—H.T. Circuit Board, South Shields.

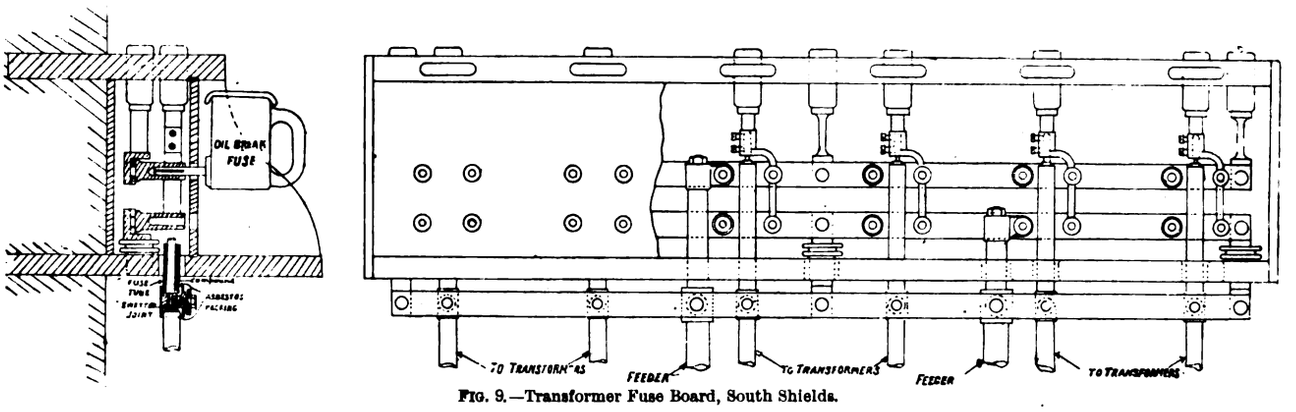

FIG. 9.—Transformer Fuse Board, South Shields.

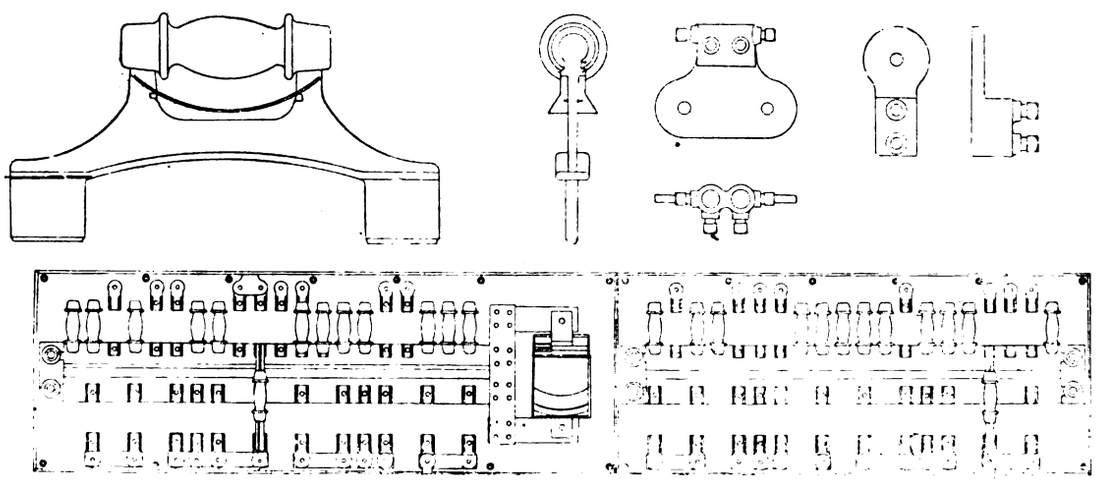

FIG. 10.—Sub-Station Switchboard, South Shields.

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the weep holes, into the channel, and thus to the drain. The roof is composed of concrete and iron girders. It is convenient that the roof should be arched, so that any condensation which occurs when the sub-station is put to work at first will run down the walls, and not drop on to the transformers. These sub-stations will be ventilated with fans, the air being driven out from a convenient place in the sub-station near the roof, and drawn down through the cavity and out of the weep holes. Thus excellent circulation will be obtained. An earth-plate of copper, sunk well below the floor into the clay, and a copper tape, 1in. by ¼in., is fastened across this plate, being soldered and riveted to it. The two ends of this copper tape are brought into the inside of the sub-station, one end to each wall. Another tape is fastened to the wall of the sub-station, running completely round it at a convenient height, and to this are fastened both the ends of the tape which are attached to the earth-plate. On to this tape running round the sub-station is connected all apparatus which it is desired to earth. It will thus be seen that there are two earth connections to every piece of apparatus. It need hardly be pointed out the extreme advisability of having an excellent earth connection. In order to keep the earth-plate wet in some places a ¾ gas-pipe is laid over it, holes being made in the pipe where it crosses the plate, and the ends of the pipe being brought up through the floor of the sub-station, so that water can be poured down this pipe so as to keep the earth-plate wet. On the wall at the further end from the entrance is fixed the circuit board (Fig. 8). There is provision for three cables coming in and passing through, if necessary. At the top and bottom of this circuit board are the connections leading to the transformer board. The transformer board (Fig. 9) deals with six transformers. The transformer boards have a top and a bottom 'bus bar, and all the transformers can be fed off either bar, or some can be fed off one bar and the rest off the other. The transformers feed on their low-tension side the low-tension board (Fig. 10), which is in two halves, positive and negative; there are on the bottom the connections for the transformers, and on the top connections for 10 circuits. Connection is made from the transformer connections on to the 'bus bar by means of fuse plugs; the same applies from the 'bus bar to the circuits. Each of the connections is in duplicate, and each of the plugs is in duplicate, so if it were found that a fuse was heating abnormally, another fuse could be prepared and put in alongside with the fuse that was heating, and this latter fuse could be withdrawn without in any way interrupting the supply of current. An ammeter is provided to read up to 300 amperes on the right hand of the 'bus bar of the positive board; on the left hand there is a connecting link between the top and bottom of the 'bus bar, and in a normal state no current passes through the ammeter. Special long plugs are provided, so that any circuit or transformer can be bridged across, thus enabling the current from any transformer or circuit to be passed through the ammeter and measured by disconnecting the link on the left-hand side, which connects the upper and bottom 'bus bars. This is shown in Fig. 10. It is intended eventually to connect each of these sub-stations by telephone to the generating station, and also to have pressure wires carried to the station. A lamp is connected between the 'bus bar and earth. Thus on entering the sub-station it is at once seen whether there is any earth on the network; if that is so, it is very easy to discover on which circuit the earth is, and means are immediately taken to localise and correct the same. The most convenient lid for the sub-station is found to be one made by Waller and Co., Stroud; this being a watertight lid, and not too heavy to lift. A wrought-iron safety grating is provided in every case, so that the men can work in the sub-station without anyone having to be on the top. The floor of the sub-stations is covered with gratings made of teak similar to those on board ships. These gratings are fastened together with wood pegs, and thus form a considerable insulation to a man in the event of his getting a shock. It is convenient to carry the low-tension cables from the transformers across the floor, and these can easily be taken under the gratings between the cross battens. It may be mentioned that no man has received a high-tension shock of any kind since the works were started.

Street-Lighting.—The streets are lighted by arc lamps and incandescent lamps. There are 84 arcs; of these, six are alternating, the others are rectified 12-ampere lamps. These lamps are of the Brockie-Pell make, and have proved thoroughly satisfactory. Some of them are double-carbon lamps, and some single-carbon lamps. The light is steady, and gives every satisfaction. There are four 16-c.p. lamps, two on each side of the arc lamp columns. At 11.30 p.m. the arc lamps are turned off and the incandescent lamps turned on. The incandescent lamps are turned off at each lamp-post by the police, and in the event of an arc lamp going out the policeman on the beat turns on the incandescent lamps, and the arc lamp is attended to next day. By this means complaints are prevented, because as long as the police can turn on the incandescent lamps they don't send startling reports to the station with regard to the arc lamps, in the event of one happening to be out; this, however, is of rare occurrence, as the rectified lamps burn exceedingly well. The alternating arc lamps take 22 amperes, and with this amount of current give about as much light as the rectified lamps taking 12 amperes. The alternating arc lamps are run in parallel, and are turned on at each lamp-post, an economy coil and choking coil being provided for each lamp. The other streets are lighted with incandescent lamps, it having been decided that every street where low-tension mains are laid are to be lighted with electric light. The price charged for incandescent lighting is: two 16-c.p. lamps, 1s. per week; two 25-c.p. lamps, 1s. 6d. per week; two 32-c.p. lamps, 2s. per week. The fittings used are those made by the Reason Manufacturing Company, a sample of which is shown. The newer form of this fitting seems to be considerably better than the old shape of shade, because by this means two lamps are visible to a person walking along the street, whereas only one was visible before. Of course lighting, as is well known, is very much a matter of opinion and that which one man considers good, another man not unfrequently thinks the reverse, so that no absolute rule can be laid down for lighting. The turning on and off of the lamps costs a considerable amount, as a man cannot turn on separately more than 80 lamps, even if they lie close together.

(To be continued.)

SOME NOTES ON THE INFLUENCE OF THE SUB-STATION EQUIPMENT AND TRANSMISSION LINE ON THE COST OF ELECTRICITY SUPPLY.*

BY ANDREW STEWART, ASSOCIATE.

In the natural process of evolution through which all things are passing, changes, often of the most radical nature, take place in a comparatively short space of time, so rapidly, indeed, that it is only by a survey of all that has occurred over three or four years that the importance of all these changes is fully realised. One of the most striking changes has been the growth of electricity supply. Not so very long ago the narrow limits of a small town practically defined the area over which electricity supply was deemed advisable or economical. To-day such limitations no longer hold good, and a whole county is deemed none too small for the operation of one supply authority. With the extension of the area of supply have come new problems of a different nature to those already solved. Direct current is still the proper thing to distribute to consumers, but transmission over long distances postulates high pressures, and high pressures mean alternate currents—generally two or three phase. The transformation of high-pressure alternate currents to low-pressure direct current involves apparatus of a nature not yet well defined. Opinions seem to differ as to whether rotatory converters, synchronous or asynchronous motor-generators should be used. Sometimes the former is used, to the entire exclusion of the two latter; in other cases, one or other of the two last-named types is employed; while in some instances the two latter are employed together, generally asynchronous for the smaller and synchronous for the larger machines. The transmission and transformation of electrical energy under the conditions existing on a distribution system of the nature already defined is accompanied by losses, and involves annual charges for interest and depreciation which will bear investigation, producing, it is hoped, results of considerable value. What, however, is still more important by inducing others to discuss the subject, the diversity of opinion existing will assume concrete shape, and a more definite idea of the various considerations, both financial and engineering, will be the result.

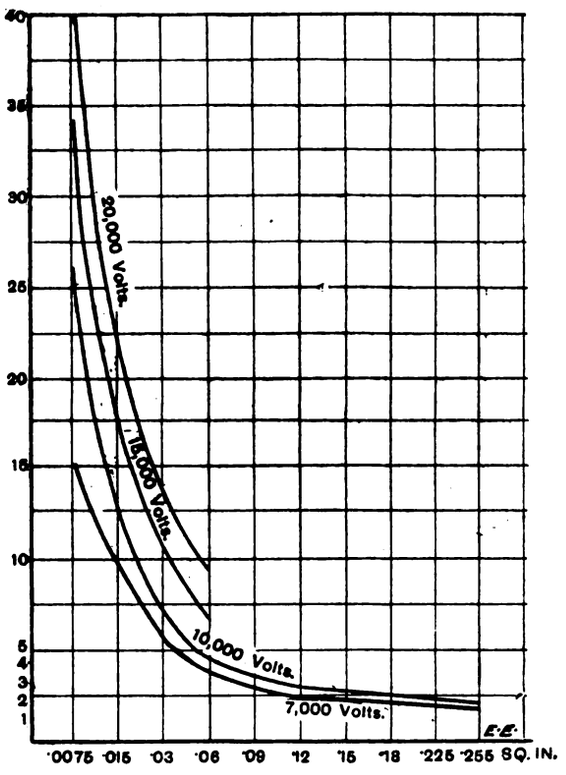

FIG. 1.

Starting with the transmission line, thanks, perhaps, to an autocratic Board of Trade, if any diversity of opinion does exist it finds little chance of expression. The manner in which the mains are laid being specified, a limit is placed on the amount of energy which may be transmitted by one cable, and overhead wires are, practically speaking, out of the question for the same reason. Within these limits one may exercise his ingenuity in bringing the cost of laying mains on the prescribed scale to an irreducible minimum, but beyond that the Board of Trade draw the line. There are, however, some features in relation to the cables, the cost of copper, insulation, and the material

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, Jan. 27.

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necessary to preserve the integrity of the latter, or give it mechanical protection, which demands attention. These are, of course, points which principally concern the cable manufacturer, but are, nevertheless, of great importance to the electrical engineer, who has to consider the question from its dividend-earning aspect. Fig. 1 gives some curves plotted from the cost of high-tension paper-insulated lead-covered and armoured cables, showing the relative cost of copper and insulation at various E.M.F.'s. (The abscissæ represent the size of the cable, and the ordinates a value obtained by dividing the cost of insulation by the value of the copper in the cable.) The most remarkable feature is the very great cost of insulation at high voltages. With small cables, the cost of insulation becomes a serious matter: its cost, in fact, varies in proportion to the E.M.F., suggesting at once the proposition that if the copper varies inversely as the square of the E.M.F., while the insulation varies more or less in direct proportion to the E.M.F., there must be a point where copper will cost so very little and insulation so much that it will pay to work with a lower E.M.F. This point will depend upon the relative price of copper and insulation.

Fig. 2 shows the approximate weight of copper to transmit 1,000 kw. 10 miles with 10 per cent. loss at full load at E.M.F.'s of 7,000, 10,000, 15,000, and 20,000 volts between the three-phase lines, at power factors varying from unity to ·5. It should be noted in passing that the curves are plotted for the same percentage loss in watts, and

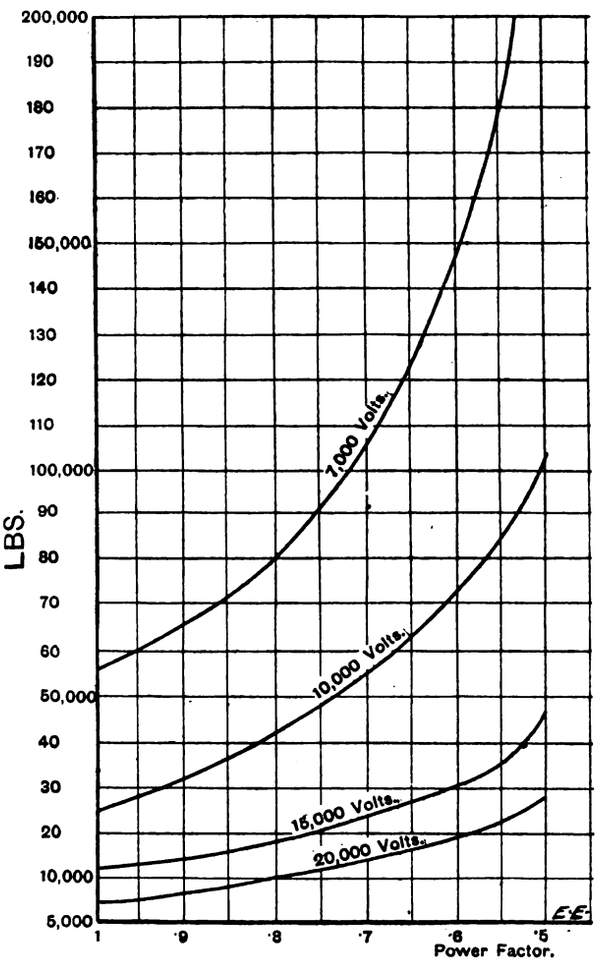

Fig. 2.

not for the same percentage drop in volts; were the latter taken instead of the former, the curves would be much flatter at low power factors. The influence of a high power factor on the cost of copper is too obvious to require any comment. I have taken 90 per cent. as the efficiency of transmission at full load, chiefly because opinions differ as to whether or not a fairly high efficiency of transmission should be taken. It is, as is well known, a commercial question depending upon how many hours per day the maximum load will last.

Fig. 3 shows the cost of copper, insulation, and total cost of three-core cable to transmit 1,000 kw. at 7, 10, 15, and 20 thousand volts over a distance of 10 miles with 10 per cent. loss in watts at full load. The large cost of insulation on such a line is very apparent, as also is the fact that the economic voltage is a definite one in this particular case. Beyond 15,000 volts, the line becomes more costly, and this is also the case at less than 15,000 volts; a line for a power factor of ·9 shows the same configuration. The section at the lower power factor is worked out for the same percentage loss in watts; the cable is, therefore, larger and more costly. The power factor indicated is what may be expected if large induction motors are employed. The value 9 will only be obtained, however, if the wave-form of motor and generator are alike, and this has been assumed throughout. If they are not alike, then one need not expect a power factor of ·9, but much less. These observations also apply to synchronous apparatus. No amount of juggling with the exciting current of a synchronous motor will make the power factor unity if the wave-forms are dissimilar. Carried much further, these curves assume a U shape; on one side copper predominates, on the other insulation.

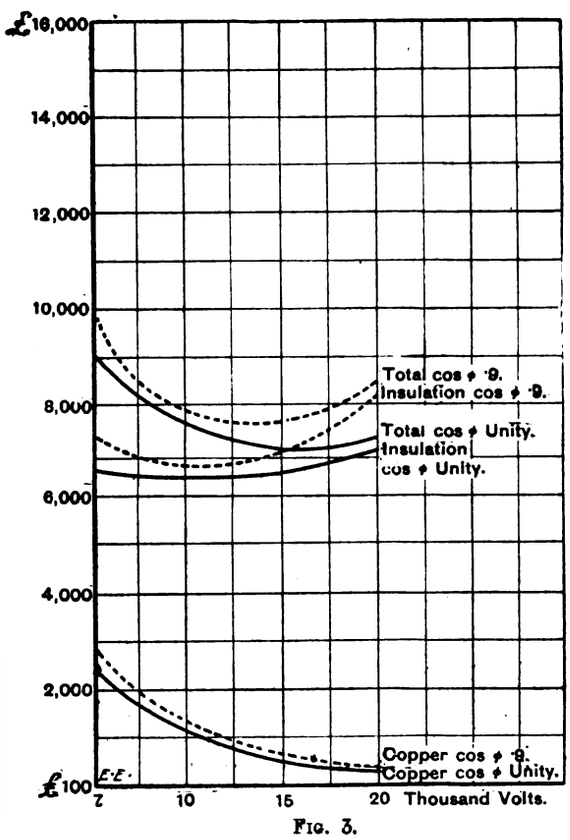

Fig. 3.

Taking two cables of approximately half the section and plotting copper and insulation as before, it will be seen (Fig. 4) that pretty much the same contour is obtained, but the influence of the pre-

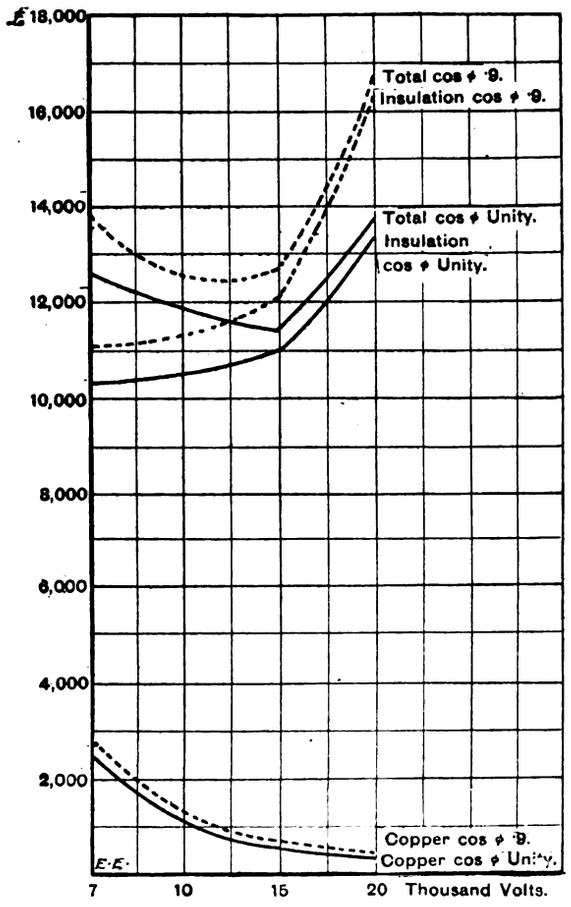

Fig. 4.

dominant factor—viz., insulation—is still more marked, and the engineer who declines to rely on one cable must pay a heavy price in insulation for his additional safety. Of course, in most cases with a fairly long line, it will be better to run a cable from the nearest sub-

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station if there are others in the vicinity, as, for instance, with two sub-stations, A and B. From the generating station to A, and also to B, with a cable linking up A and B, either sub-station may be fed direct from the generating station, or A may be fed *via* B, or B *via* A. Nevertheless, were a sub-station located 10 miles distant, and no other in proximity to it, it is to be doubted if any engineer would rely on a single three-core cable, no matter how carefully laid.

The important point which is brought out prominently by these curves is that while the cost of copper varies inversely as the square of the E.M.F., the insulation follows a law quite the reverse, though perhaps not so definite; also that with underground cables and the cheapest of all known reliable insulators one cannot take full advantage of extra high pressures, and on a large system the money sunk in insulation may reach a formidable figure. It is also apparent from Fig. 4 that 7,000, 10,000, and 15,000 volts are all more economical than 20,000 volts, which goes to prove that under existing regulations long-distance power distribution will develop along lines entirely different from American or even Continental practice. From these curves we may conclude at once that there is a definite voltage at which, with any given set of circumstances, maximum economy is secured, and that voltage will depend upon the size of the cable, it being obvious that if the power to be transmitted reaches several thousand kilowatts, so that cable of comparatively large section has to be employed, a higher voltage becomes commercially possible, because, as is seen from Fig. 1, with large sections insulation costs are not abnormal in their relation to the cost of copper. It may be pointed out in passing that the prices which the writer has been able to obtain do not always agree, especially with cables of large section; in some cases the insulation costs more than is shown in the diagram. The difference is not, however, very great, and in the cables of smaller sections there is a remarkable agreement between British and Continental prices, so that such conclusions as may be drawn are applicable over a fairly wide range.

The Sub-Station.

The sub-station equipment has been so fully discussed by several members of this Institution that I will not take up your time with any lengthy observations upon it. Nevertheless, one or two engineering points will be raised in order that their influence upon any conclusions at which we may arrive shall not escape observation. The simplest sub-station is undoubtedly one equipped with asynchronous motors driving one or more direct-current dynamos. The station plant and switch gear are about as simple as one could wish. The pressure on the direct-current side is entirely independent of the alternate-current side and capable of considerable variation, hence a mixed lighting, power, and traction load can be easily served. The asynchronous motor possesses most of the characteristics of a shunt-wound direct-current motor, hence is unlikely to disturb anything else on the system, nor have sudden overloads, such as shorts, any disorganising effect upon several induction motors in parallel. Such machines may be built to take the line pressure on the stator, consequently saving the cost of and losses in step-down transformers. Variations in the line voltage does not influence it, except to limit its overload capacity, while no direct-current excitation is required. On the other hand, it has a power factor less than unity, which involves either additional capital outlay in copper or increased line loss, while its power factor drops with overloads, hence limits its overload capacity when most wanted by lowering the impressed E.M.F. Sub-stations so equipped are economical in point of attendance, no synchronising being necessary—indeed, they may be started with the ease of a shunt-wound direct-current motor, either by an auto-transformer or a resistance in the rotor, the latter by preference. Their ability to carry an overload, provided the impressed E.M.F. is maintained, is limited almost entirely by the capacity of the direct-current generator which they drive.

The next type of sub-station equipment is the synchronous motor-generator, which possesses most of the advantages which have already been cited as pertaining to an equipment whose direct-current side is independent of the alternate current. It has one feature possessed also by the rotatory converter, that its power factor is adjustable over a fairly wide range, hence may be maintained at or near unity, or may be employed by reason of its condenser properties to cover the sins of some neighbouring induction apparatus, and is in some cases employed in conjunction with induction motors for this purpose. It has considerable overload capacity, but this is, of course, to some extent determined by the rating of the machine. If seriously overloaded it will pull up, but, unlike an induction motor, will not generally recover when the overload has passed off. It is influenced by the cyclic irregularity of the power-house engines, direct-current excitation is a necessity, and must be synchronised before paralleling, which postulates a more skilful type of attendant. It is as liable to hunt as is the rotatory converter, but it seems that the tendency of either type to do so has been exaggerated: certainly so far as I have been able to ascertain, it seems that, provided the cyclic irregularity of the power-house engines is kept within certain limits, other causes, such as shorts, etc., do not seriously influence its stability.

The rotatory converter is perhaps the most popular means of converting alternate to direct current; its outstanding advantage—viz., low first cost and high efficiency—has won for it a place which otherwise it might not have occupied. As an engineer must, if he is to justify his existence, do things for less money than anyone else, he generally finds that he must modify, as far as possible, the undesirable features of the cheaper apparatus, and use it. It is not altogether remarkable, considering their characteristics, that converters have not found much favour in this country; they are sensitive to fluctuations of the line E.M.F., and as the direct-current pressure bears a definite ratio to the impressed volts on the alternate-current side, any variation on the latter side will be reproduced on the direct-current side. Moreover, systems where the ratio $\frac{\text{mean load}}{\text{maximum load}}$ is low need not, in order to ensure a maximum economy, have so much feeder copper as one with a higher ratio, hence the rapid drop in line volts due to a sudden overload would become apparent on consumers' lamps. Another disadvantage is that, should several well-loaded rotatory converters be in parallel, and one become suddenly overloaded it would tend to cause hunting all round, as a condition of unstable equilibrium is set up. Of course a liberally rated machine, fitted with damping coils, would modify these disadvantages considerably, but liberal rating means more capital, and, as will be shown presently, capital really has more influence on the cost of electricity supply than anything else. Nevertheless, rotatory converters are in practice more reliable than is generally supposed. Some time ago the writer carried out numerous experiments with a converter feeding lamps, and it was only under the most adverse conditions, sudden and heavy overloads, that the objectionable characteristics of the machine became apparent. On a large tramway system with which the writer is acquainted, the converters are run in parallel on loads of the most trying nature, yet their performance is all that can be desired.

Coming to the resultant costs per unit delivered, we must, in order to institute a comparison, have some definite figures. That these figures must be hypothetical is obvious; indeed, not until someone designs, say, six power schemes equipped with six different systems of transmission and conversion, will any definite data be forthcoming. We can, however, by assuming certain conditions, arrive at conclusions which may serve as a guide in determining the merits of one or other method of transmission or conversion. The generating station is assumed to cost £25 per kilowatt installed. I may point out *en passant* that the above figure is merely as a basis. Some large stations have been built and equipped for this sum, but as what a station is estimated to cost, what it really has cost, and what it is likely to cost before it is ultimately finished, are all points over which much might be said, the figure is quoted with all due reserve. Assuming that 20 per cent. of the plant is spare, the cost per kilowatt available for supply purposes will be £31·2, while a diversity factor of 1·5 has been taken, making the cost per kilowatt maximum demand = £20·8.

(To be continued.)

FORTHCOMING EVENTS.

Friday, Jan. 31.

Royal Institution.—At 9 p.m., Prof. A. Crum Brown on "The Ions of Electrolysis."

Electro-Harmonic Society.—Smoking concert at St. James's Hall Restaurant.

Institution of Mechanical Engineers.—At 8 p.m., further discussion on "Workshop Methods," by Mr. H. F. L. Orcutt.

Saturday, Feb. 1.

Institution of Electrical Engineers.—At 2.30 p.m., students' visit to the Willesden station of the Metropolitan Electric Supply Company.

Monday, Feb. 3.

Society of Arts.—At 8 p.m., Dr. Samuel Rideal on "The Purification and Sterilisation of Water" (Lecture IV.).

Tuesday, Feb. 4.

Royal Institution.—At 3 p.m., Dr. Allan MacFayden on "The Cell: Its Means of Offence and Defence" (Lecture IV.).

Thursday, Feb. 6.

Society of Arts (Indian Section).—At 4.30 p.m. Paper: "The Coal Resources of India," by Prof. Wyndham R. Dunstan.

Rontgen Society.—At 8.30 p.m., ordinary meeting. Paper: "A System of Radiography," by Mr. E. W. H. Shenton.

Friday, Feb. 7.

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. Paper: "The Electric Passenger Elevator," by Mr. W. J. Cooper.

North-East Coast Institution of Engineers.—Special meeting at Newcastle. Mr. D. B. Morison will read a "Report on Memorandum submitted to the First Lord of the Admiralty on the 16th day of July, 1901, with reference to the present unsatisfactory condition of the Engineer Branch of H.M. Navy."

Saturday, Feb. 8.

Institution of Electrical Engineers (Students' Section).—At 11 a.m., and 3 p.m., Visit to the Shepherd's Bush Generating Station of the Central London Railway.

Manchester Association of Engineers.—Ordinary meeting. Paper: "Applications of Portable Machine Tools," by Mr. J. A. Rawcliffe.

VERTICAL BOILERS.

Messrs. Cochran and Co., Limited, Annan, Scotland, have recently issued from their new works a catalogue descriptive of their patent vertical multitubular boilers. Special advantages are claimed for these boilers on the score of economy in fuel in fuel consumption, due to careful design and the perfect combustion obtained. Under proper conditions, it is stated that the boilers will evaporate 10lb. of water per pound of good coal consumed. It is further pointed out that the boilers are especially adapted for awkward and cramped positions. Full particulars relating to the dimensions, weight, fuel consumption, and evaporative capacity, etc., of each boiler are given, the boilers listed ranging in output from 10 i.h.p. to 180 i.h.p.

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TO CORRESPONDENTS.

All Rights Reserved. *Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE LONDON TRAMWAYS.

On Tuesday last a further expenditure of some six hundred and forty-four thousand pounds was authorised by the London County Council for the electrification of a number of tramways on the south side of the Thames. The equivalent length of a single track in these lines now to be converted is nineteen and a quarter miles. The position of these lines is given elsewhere in this issue, as is also the report of the Finance Committee on the financial outlook of the tramway undertakings of the Council. It must be remembered that for the sum mentioned not only are the lines to be completely relaid, but also large generating works and new rolling-stock have to be provided. Thus the London County Council have to face the serious question that the conversion and reconstruction will practically reduce their present tramway assets to much less than old iron value. The same question has had to be faced by many other towns in the United Kingdom who have bought out tramway companies, and then had to condemn practically the whole of the material they have purchased. In practically all these cases, however, and in those others in which companies have carried out the work of conversion, the capital cost of the same has been considerably less, because the overhead system of carrying the tramway conductors has been employed. These conversions from horse traction to electric have afforded reliable data as to the influence which the change of system in London will have on the earning capacity of the lines, and also on the profit available for paying the extra capital charges incurred. In the case of the London tramways, where the conduit system is to be used, the cost of conversion is naturally abnormally high. We also regret to find from the report of the Finance Committee of the London County Council that all the preliminary estimates on which so many promises have been made by the chairman of the Tramways Committee are quite unreliable. For instance, we are calmly told that the preliminary forecast of the cost of conversion of a mile of single track of fifteen thousand pounds was based on the assumption of only two and a half cars being required for that length. As the estimate included not only the provision of the cars, but also the necessary plant and buildings to generate the energy for driving the same, it will be seen that this assumption has two effects on the capital outlay. For instance, on the lines now to be converted eight cars per mile of single track are required. It will be seen, therefore, that after allowing for spare cars, the estimate for the generating plant may well have been too low by 150 per cent. It cannot be conceived that the advisers of the London County Council were unaware of the actual number of cars required on the system they were reporting on, and we can see no excuse for the great discrepancy now disclosed between original estimates and actual figures. Thus the work now authorised for nineteen and a quarter miles of single track works out at between thirty-two and thirty-three thousand pounds per mile. We would, however, deprecate this way of considering the cost of equipping electrical tramways, as it leaves out the essential fact that the cost is to a large extent proportional to the density of the traffic. It would be much more to the point if the Highway Committee would divide up their items into three heads—*i.e.*, permanent-way equipment, rolling-stock, and generating works. Without this division it is quite impossible to make any useful criticism on the present authorised outlay. We turn to the question of the Finance Committee's report as to the working of the system after conversion, and find that their assumptions are reasonable. Thus, it is assumed that with the capacity of each car increased by 50 per cent., the

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receipts per car mile will rise from 10·68d. up to one shilling. This increase has been more than realised in other places. The assumed reduction of working expenses to sixpence per car mile is also quite within the range of modern practice. The result will be an increased profit of over seventy-eight thousand pounds per annum, while the increased capital charges on the present authorised expenditure will be forty thousand pounds per annum at first, with a decrease as the debt is paid off. The committee, however, also estimate that the number of car miles run per annum will increase from four million seven hundred thousand, the present value, by one million car miles. This would give an additional profit of twenty-five thousand pounds. On these figures, therefore, the expenditure was authorised on Tuesday last, and we trust that we shall not again have to call attention to discrepancies between estimated cost and actual expenditure in this matter. The opposition on the Council suggested that the matter should be delayed until the first lines now under conversion are completed. This course we are glad to see was not adopted, as the old cry of wait until experiments have been made is fatal to progress. In fact, we see no reason why even larger sections of the London County Council lines should not have been converted for electric traction at an early date. Only one point remains for comment. These electric tramways are urgently needed for the suburban passenger traffic of London. They are at present the cheapest and most convenient means of dealing with this traffic. They have, however, their inconveniences, especially in narrow streets, and these inconveniences may call for expensive remedies in the near future. We would, therefore, echo the views of the chairman of the Finance Committee of the Council, that the debt now being incurred should be paid off in a shorter period than twenty-five years if possible. We think that the London County Council would be well advised not to return surplus profits to local authorities, but to use them for reducing the debt for these tramways. This course would leave them free to adopt bold expedients in the future in dealing with the serious problem of our London communications.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

APPRENTICESHIP.

SIR,—I have a son apprenticed to a small motor-manufacturing company in the Eastern Counties. He has served half of his time (18 months) to winding and wiring, with a little knowledge of turning and fitting. He has had a public school education. What position would he be able to take at the expiration of his time, and what knowledge is essential to his becoming an *electrical engineer*, and perhaps, at a future date, a *M.I.E.E.*? You would do me a great favour if you could reply in next week's issue of the *Electrical Engineer* "Answers to Correspondence."—Yours, etc., W. J. F.

[The answer to the above queries cannot but be indefinite. The position which the young man is qualified to take at the expiration of his apprenticeship is wholly dependent on his acquired knowledge at that date, and on his mechanical skill. To that end, study of the theoretical side of electrical engineering is equally essential with a good practical training. Also, besides a general knowledge of the theory and practice, a special knowledge in one branch of the subject is a good thing. Thus, the young man who can so design small motors and organise shops for their production as to produce a better article at a cheaper rate than any of the competing manufacturers, will not be long in qualifying for a M.I.E.E. This will illustrate our meaning as to specialisation, and also, perhaps, the converse fact, that the mere passing through an apprenticeship does not necessarily qualify a youth for a remunerative post.—ED. *E. E.*]

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

451. Given a lead-covered, armoured concentric cable, say, 1,000 yards long, having a fault between outer and lead covering. By means of the loop test the fault is located within a length of, say, 10 yards. How can the exact position of the fault be found with a minimum of interruption to the supply?—J. D.

452. Given a cable such as the above, but with a fault between inner and outer conductors, such fault having a high resistance as compared to that of the conductor itself. How could the fault be located?—J. D.

ANSWERS.

Question No. 445.—The diagram (Fig. 1) shows the present connections of electrical bells in a mine. All the three wires are bare. The two wires B and C are suspended on porcelain insulators, but the return wire, A, is allowed earth connection. By bringing the two wires

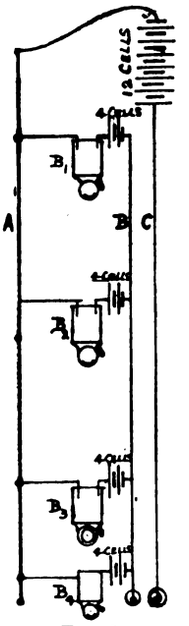

FIG. 1.

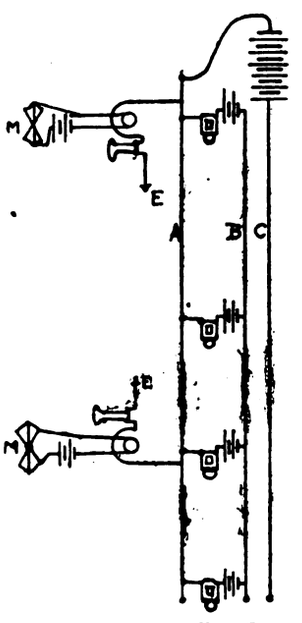

FIG. 2.

B and C together at any point, all the bells ring. The bells are about 500 yards apart. It is now intended to add telephone connection between B_1 and B_3. Would it do to insulate the wire A and to connect the telephones as in Fig. 2?

Best Answer to No. 445 (*awarded* 10*s.*).—The question does not say what sort of telephones are to be used, but we will suppose them to be ordinary wall telephones, with their own bells and cells in circuit, which in my opinion would be the easiest to fix. We will suppose A were line wire for the telephones. To make A line wire we would have to wire the bells on metallic circuit, thus allowing them no earth connection, for it would not answer for the telephones to have A to earth, as the return wire for the telephones is already earthed. The telephones would now work all right until the bells were put into circuit, when it would ring both telephones and bells, putting former in

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series, as in Fig. 1. The current would then flow as follows when the bells were ringing: down C on to B, through bell No. 4, up A and through telephone No. 2, where it would go to earth and into telephone No. 1, and

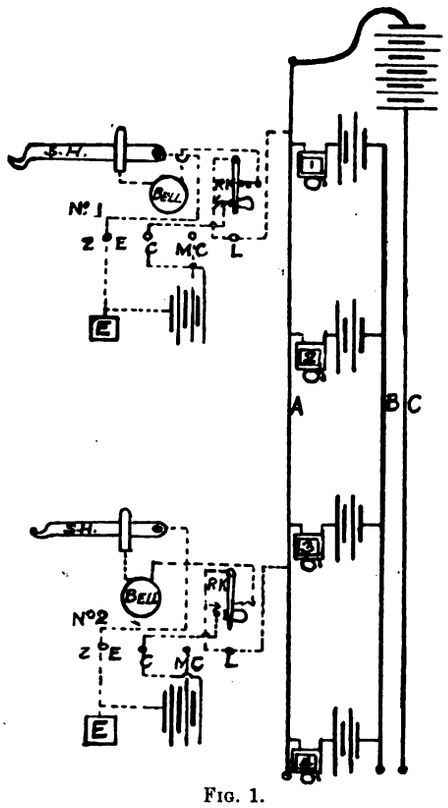


FIG. 1.

from here back to bell battery, so it would not answer to wire the telephones as in Fig. 1.

The best way to connect the telephones would be to make C the line wire for the telephones, putting bells on

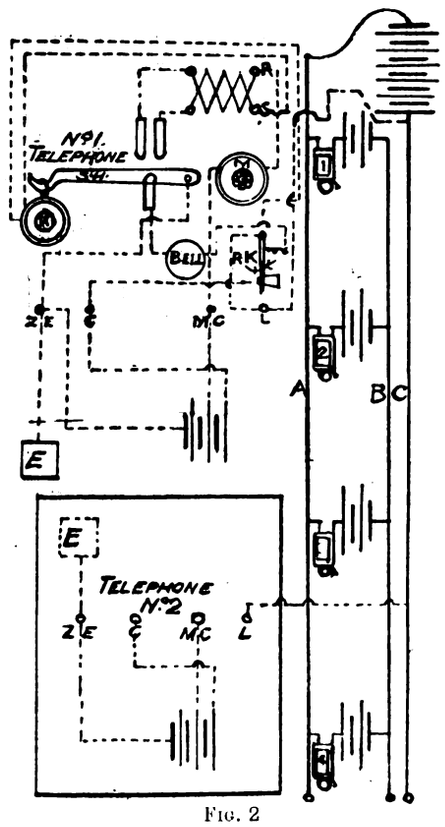
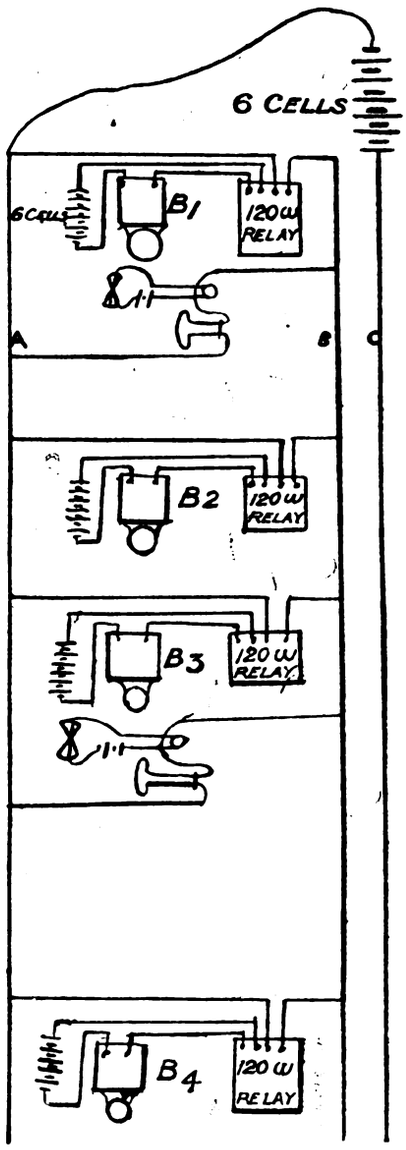


FIG. 2

metallic circuit and bring the telephone return to earth. Now the bells could be put into circuit without their return flowing through and ringing the telephones. Care must be taken that all the three wires, A, B, and C, are free from earth, because if either of them got to earth, great trouble would be caused to the telephones, and if A and C got earthed together it would make complete circuit and run the cells down. It is very seldom that an insulated cable is put down in a mine, as there is generally water dripping, thus rotting the insulation, etc. I would advise to run A also with bare wire on porcelain insulators, and to wire the telephones according to Fig. 2.—J. P. S.

Answer to No. 445 (*awarded* 5*s.*).—You must certainly insulate your return wire if you wish to use it for telephone line with earth as return. You will notice your line would be short-circuited to earth. The accompanying sketch will enable you to use line B already insulated and pick up the existing return. I take it from sketch you



don't wish to ring specially from 'phone to 'phone, but to speak after contact has been made with C and B, and if you do, tap line C on to the ringing key of 'phone and arrange a call ring. Reduce your cells on C to six Leclanché No. 2, and join up four relays wound to 120 ohms resistance, and fix six Leclanché No. 2 on local; then tap your telephones on line B, taking care (if they are the pattern will bell in circuit) to disconnect the bell, which is of much lower resistance than the relays, and would rob them of the current. You will have no difficulty in regulating the relays, and when the 'phones are in use, the relays will still work without any apparent loss; also the speech will be good. I know a circuit joined up like line B, with eight stations, seven miles in length, and conversation can be carried on whilst the end stations signal to each other with 10 Leclanché No. 2, the line wire being 100lb. copper.—F. B.

Answer to No. 445 (*awarded* 5*s.*).—The diagram (Fig. 2) which accompanies the question is quite in order, providing the wire A is insulated, and would work fairly satisfactory.

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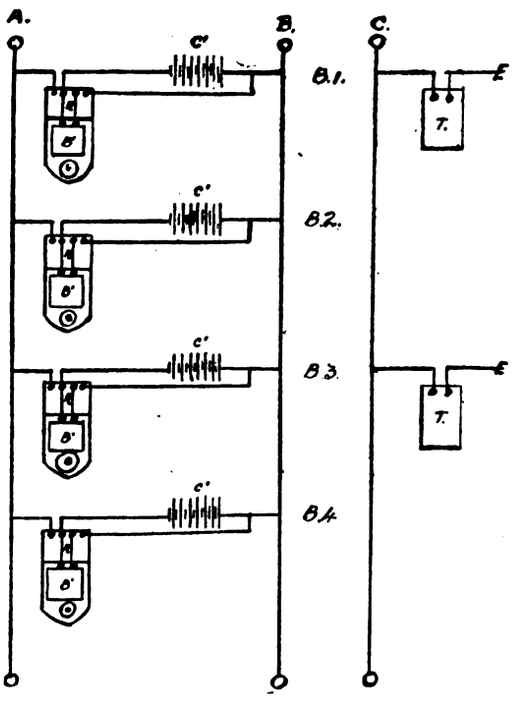
When I say fairly, I should not care to say perfectly, as there would be a large area of wire which would have to be perfectly insulated from earth. In fact, all the wires in the installation would have to be free from earth, as if any leakage should develop, the talking would not be so satisfactory, and part of the current which would flow from one instrument to the other would find its way to earth through the leakage. The same thing applies even now to the bell circuit, as if any earth leakage should develop on either the wires B or C, the batteries would be leaking to earth—*i.e.*, either the local batteries or the ringing battery—and it will be beneficial to the whole circuit to insulate wire A. This must be insulated the whole length, as the only wires having earth connection would be the return wires of the telephones. The ringing, I presume, has been done by ringing the number which was required, either B_1, B_2, B_3, or B_4, so that if such was the case you will notice further on that this will require some alteration. It would be advisable when ordering the instruments to have them fitted with receiver, microphone, induction coil, ringing key, and automatic switch hook, also the termiuals for connecting a bell to if necessary; but for the present the bell-connections would not be required, and the ringing would be done as before, by connecting at any point B and C. In



order to communicate from B_1 to B_3, B_1 would give four rings, and then wait for B_3 giving a reply ring—*i.e.*, one single ring. Then the two persons would take off their receivers and commence talking, and when finished hang up the receivers; also if B_3 wanted B_1, B_3 would ring two rings, and then B_1 would give a reply ring and have their conversation, hanging up their receivers when finished as before. When three or four different points are connected by bells or telephones, and when the intercommunication system is too expensive, a system of call ringing has to be adopted—viz.: B_1 answers to two rings, B_2 answers to three rings, B_3 answers to four rings, B_4 answers to five rings, and one ring is the reply ring for all the four points.

There is another method which may be tried, and which would, I think, give better results, but mines are very difficult places to wire for any electrical work, and it makes it more so in this case, when no sizes of wires and no bell resistances are given. Referring to my diagram, you will notice that I am still using the three bare conductors, A, B, and C, and the only extras that would be required for efficient working would be four relays; T is the telephones; E is the earth-wires to water-pipe or earth-plate; R the relays; B' the bells; C' the battery. In adopting this system it is not necessary to insulate wire A, but it would be wise to do so in any case if convenient, and the ringing now would be done by connecting at any point A and B wires, thus leaving wire C entirely for the telephone circuit, so that it could be used at any future time for more instruments. The number of call rings in the former instance would apply to this also, and the same class of instruments would be required.

By adopting this system, the talking would be very satisfactory and free from leakage. The connections to the relay and bell are plainly shown in the diagram, also the battery connections, which consist of seven cells at each point, dividing equally the 12 cells which are now used for ringing, thus giving each point three more cells. The telephones would be connected to wire C; one wire from each instrument and the other terminal or return would be connected to earth, or, if no earth was at hand, to the wire A, which you say has earth connection already; but it would be wise to insulate wire A from earth and connect to a water-pipe or earth-plate.—T. W., HARROGATE.

Answer to No. 445 (*awarded* 5*s.*).—If the wire A (diagram 2) be insulated from earth, then a pair of telephones may be connected as in diagram 2 and communication established, but this arrangement is open to several objections. "E. J. F." does not state whether bells B_1 and B_3 are to be used for calls. Presumably each telephone will contain a call bell. In that case it would be advisable to use magneto call bells, otherwise main bell battery and telephone call batteries must be arranged so that they are not opposed. If not so arranged, and bells B_1, B_2, B_3, and B_4 are switched on, and also telephone bells are used at same time, the E.M.F. due to main battery will interfere with E.M.F. of telephone batteries, and therefore with telephone bells. Also, if telephones are in use at same time as bells B_1, B_2, B_3, and B_4, the intermittent current along A, due to bells B_1, B_2, B_3, and B_4, will interfere with speaking current of telephone. This may be somewhat overcome by using coils in telephones with high secondary resistance. Again, in a mine, all wires and apparatus are usually damp, so that it is very difficult to keep batteries thoroughly insulated from earth. If insulation of main battery (12 cells) is not good, there will be a leak along wire A, through telephone bells, and so to earth. This current will probably not be sufficient to ring telephone bells (if for continuous current), but may seriously interfere with speaking circuit, as then the leak current will flow through telephone receivers to earth. This current may strengthen or weaken receiver magnets. If the magnets are only very slightly affected, this may not give trouble so long as the current is steady, but if bells B_1, B_2, B_3, and B_4 are switched on, the "leak" current through receivers will assume a wave form (due to the varying pressure between B_1 and B_3 along A), thus causing the receivers to click at each stroke of the bells. If these faults develop, the only remedy is to use an insulated return for the telephones, but obviously it would be much better to use this insulated wire as line and earth for return, and so not have any metallic connection between the bell and telephone circuits.—H. J. G.

Question No. 446.—Are there any reasons, and what are they, why japanned iron clips should not be used for lead-covered wires?

Best Answer to No. 446 (*awarded* 10*s.*).—Japanned iron clips are much used, as they are cheap, keep their shape well, and are easily fixed in position. Where the lead-covered cables are in a fairly dry place there is no practical objection to be raised against their employment. Of course, if the cables are in a damp situation the iron will deteriorate owing to electrolytic action, the iron becoming corroded and in time so wasted away as to be useless. With regard to the time iron clips will last, a great deal depends on the quality of the japanning. To ensure the clips having a thorough coating, they should be bent, holes punched, etc., before being japanned. There is one objection to their use (perhaps we should call it misuse), and that is that, being so much harder than lead, a careless wireman by hammering or otherwise forcing the clips into place may cause serious injury to the lead covering in so doing. To meet some of these objections, iron clips are sometimes fitted with a saddle-piece of leather or other insulating material. In damp situations, particularly where not easily accessible, it is better to have the clips galvanised or tinned, and the best practice is to use lead clips.—M. M.

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Answer to No. 446 (*awarded* 5*s.*).—There are no practical reasons for not using these clips for lead-covered wires, providing the attachment is done with proper care and, preferably, with a packing of vulcanised fibre sheet between. The danger of this method of installing wires lies in using clips with sharp edges, which tend to cut the lead covering should there be any movement of the wires. This might happen through domestic duties, or be due to expansion and contraction induced by external heating or internal $C^2 R$ effects. Should the querist, however, have in his mind corrosion, this would be most unlikely without the above-mentioned fibre bushing and impossible where it is used.—B. C. H. J.

LONDON COUNTY COUNCIL TRAMWAYS.

On Tuesday night the London County Council voted a sum of £644,350 in connection with the reconstruction for electrical traction of further portions of their tramways on the south side of the Thames. The total length of the lines, for the cost of the reconstruction of which this provision is made, is equal to 19¼ miles of single track, and they are laid between (*a*) Kennington-road, at its junction with Westminster Bridge-road, and St. George's-circus; (*b*) the Elephant and Castle, *viâ* New and Old Kent roads, and New Cross-gate; (*c*) the Elephant and Castle and St. George's Church, Borough, and thence to the junction of New and Old Kent roads; (*d*) the Elephant and Castle; *viâ* Walworth-road and Camberwell-road, and New Cross-gate; (*e*) Camberwell Green and the terminus near Vauxhall Bridge; and (*f*) Kennington Park-road and Brixton-road. The actual cost of reconstructing these tramways for electrical traction is estimated at £576,350, while the balance of the capital vote, £68,000, will be applied to new buildings and bridge construction required by the scheme. The report of the Finance Committee on these estimates followed that of the Highways Committee, both of which were adopted by the Council. In their report the Finance Committee have dealt with the matter in a most thorough and businesslike manner, and the information which it contains is of such importance that we have no hesitation in reproducing it in full. The report reads as follows:

It devolves upon us under the standing orders, in submitting the estimates, amounting together to £644,350, of the cost of the reconstruction of a further portion of the Council's southern tramways for electrical traction, to report upon the financial bearings of the proposal. From the report of the Highways Committee, it will be seen that the proposed works consist of the laying of about 19¼ miles of single track, with the necessary cars and car-sheds and feeder mains, also the machinery, etc., which is required for these lines, and which will be placed in the large generating station at Greenwich.

It is proposed to spread the repayment of the amount (£68,000) required for new buildings and bridge construction over the full period of not exceeding 60 years, while the cost (£576,350) of lines, machinery, generating plant, rolling-stock, equipment, and alterations to existing buildings will be spread over 25 years.

In considering these estimates, we desired to compare them with the preliminary forecast of £15,000 a mile of single track, which, we believe, the Council has generally understood to be the approximate cost of converting the existing tramways in London for electrical traction. It appears that this figure includes provision for cars and the necessary power to work them at the rate of only 2½ cars for each mile of single track, whereas most, if not all, of the tramways in London are at present equipped with a much larger number of cars. Taking, however, the allowance adopted for the forecast, we are informed that the cost per mile of single track of the lines now under consideration works out at about £18,000. The cost of the Tooting lines, on the same basis and according to the tenders which have been accepted for most of the works, is £17,670 per mile. The excess of these estimates over the £15,000 is explained by the Highways Committee as follows: that the estimate of £15,000 (which was put forward only as an approximate forecast in the report obtained from Dr. Kennedy in 1899) applied to the whole of the existing tramways in London; that it was not limited to underground conduit as the only system to be adopted; and that while Dr. Kennedy had anticipated that some portion of the lines, especially the first or experimental lines, would cost more than £15,000 a mile, he expected that other portions might be constructed at a lower cost. The estimates for the 19¼ miles of lines now under construction have been prepared on the basis of the tenders received (not merely the lowest, nor the accepted tenders, but the tenders generally) for the Tooting lines; this appears to us to be a safe basis to proceed upon, and we think it not unreasonable to expect that the work will be carried out at a cost within the estimates.

As already stated, the allowance of 2½ cars per mile is insufficient. We are informed that at the present time the number of horse cars on the Council's southern system is about eight per mile, and the Highways Committee expect that a larger number will be required for electrical traction, notwithstanding the increased accommodation which each car will provide. The estimates now under consideration contain provision for 10 cars per mile and the corresponding power to work them.

We understand, however, that the estimates include provision for more generating plant and car-sheds than will be required for the working of the 19¼ miles of line now in question, but, on the other hand, they include nothing in respect of the proposed generating station buildings at Greenwich, which will be the subject of a separate vote. The Highways Committee inform us that on the basis of these estimates the cost of this section works out to between £32,000 and £33,000 per mile of single track fully equipped.

Although the increase in the number of cars will doubtless be accompanied by better returns, it adds largely to the capital commitments of the Council. The cost of conversion of the southern system (about 47 miles of single line) being now estimated at approximately £1,500,000, it is obvious that the conversion of all the existing 200 miles of London tramways, as they come into the possession of the Council, will cost considerably more than the sum of £3,000,000 (calculated as 200 miles of single line at £15,000 a mile), which was inserted as the parliamentary estimate in the London County Tramways (Electrical Power) Act, 1900, even though so large a number of cars per mile may not be required elsewhere as on the Council's southern system. In addition to this heavy outlay during the next few years on the conversion of existing lines, the new lines for which power has been obtained or is being sought are estimated to cost about £1,365,000, exclusive of the proportion of the estimated cost of street widenings to be charged to the tramways account, amounting to about £241,000.

As to the financial results that may be expected to follow the conversion of the 19¼ miles now under consideration, we submit the following figures. The car mileage on these lines at the present time is over 4,700,000 miles per annum. During the year 1900-1 the average receipts for the southern system amounted 10·68d. per car mile, and the average expenses were 9·23d., leaving a profit on working of 1·45d. per car mile. The year, however, was one in which expenses were abnormally heavy, and it would perhaps be fairer to take the figure of 2d. a mile as representing the profit on working under more normal conditions. Out of this 2d., interest and sinking fund charges on the existing debt, amounting to a little over 1d. a mile, have to be paid

When the lines are converted to electrical traction the carrying capacity of each car will be increased by about 50 per cent., and, having regard to the popularity of electrical tramways and to the fact that the existing horse cars are frequently crowded, it is expected by the Highways Committee that the receipts per mile will average at least 1s. The committee also estimate that the working expenses will not exceed 6d. per mile, including the whole cost of the provision of power—*i.e.*, not only the cost of maintaining and working the generating plant, but also the charge for interest on and repayment of capital outlay on the generating station, mains, etc., required for the supply of power. We understand that this estimate includes provision for a renewals reserve fund, and we are strongly of opinion that a sufficient reserve fund should be provided. The estimates of receipts and working expenses are, we understand, fully supported by the experience of other undertakings.

We therefore assume that the Council will earn a profit on electrical working of 6d. per mile run instead of 2d. per mile on horse traction, or an increase of profit of about 4d. per mile for the 4,700,000 miles per annum at present run, or £78,333 a year. But in addition to this the Highways Committee anticipate that, owing to the increased speed at which the cars will travel and to the popularity of the system, the traffic will increase, and they consider it quite safe to estimate for an increased car mileage of 1,000,000 per annum. This estimate also is supported by the experience of other similar undertakings. On this extra mileage there would be an additional profit (at 6d. per mile) of £25,000, making a total estimated increase in the profit on working of, say, £103,000. Out of this will have to be paid interest and sinking fund charges on the cost of conversion, which, excluding items relating to the supply of power (covered by the 6d. a mile estimate for working expenses), amounts to £573,500. Interest on this sum at 3½ per cent. would be £18,640, and the annual charge for repayment (£68,000 in 59 years and the balance in 25 years) would be £21,373, making together £40,013, which, however, would decrease as the debt is paid off. Thus it is evident that the result of conversion should be advantageous financially.

It must be remembered, however, that there must be an interval during reconstruction when the traffic will be interfered with and the receipts will consequently suffer, and, further, that the capital outlay on reconstruction will be for the time unremunerative. Every endeavour should be made to shorten this interval as much as possible; but, in any case, the amount of the temporary loss will soon be recouped out of the large additional profits which will arise as soon as the electrical lines are working.

There is one other point to which reference may be made—viz., that the tramways debt, which on March 31 last amounted to £854,733 for the southern system, will, after the reconstruction of the lines, include a large part of the debt now existing in respect of the purchase of the tramways. The roadwork of the existing horse tramways will be entirely replaced by new lines, and the cars will be practically worthless. There will be a small receipt from the sale of old materials, and the horses will be sold, and may possibly realise the sum at which they stand in the balance-sheet of the undertaking. These receipts will be treated as on capital account and applied in reduction of tramways debt, reducing the annual charge for interest and sinking fund and increasing the amount of net profits. For a limited time, however, the tramways debt will exceed the constructional value.

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Having regard to this fact and to the possibilities of further improvements in the methods of electrical working and other developments of the locomotion question in London, we feel that the term of 25 years determined on for this expenditure is a liberal one, and that it would be to the ultimate advantage of the tramways undertaking if the debt could be paid off more rapidly.

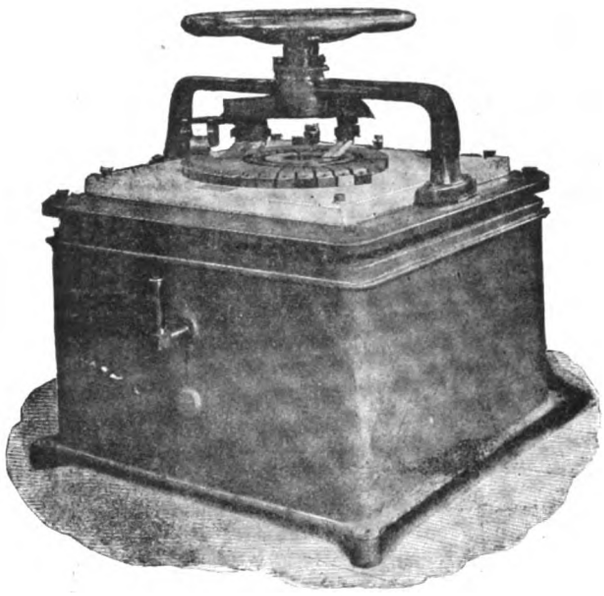
While feeling no doubt as to the expediency, from a financial point of view, of converting the lines for electrical traction, we are impressed with the magnitude of the expenditure involved and the necessity for caution as regards these large proposals for conversion and extensions of the tramways system.

In the discussion which took place on this report, Mr. Allen Baker said he believed there would be a larger profit than 6d. per mile, which, when the 200 miles of line were completed, would give a total profit of £630,000 a year. If his anticipation of a profit of 1s. 3d. a mile were realised, they would get an annual profit of £1,000,000. If the Council extended their lines in the same way as had been done in Philadelphia, for instance, the profit would amount to £4,000,000 a year. The report was then agreed to.

TRADE NOTICES AND NOVELTIES.

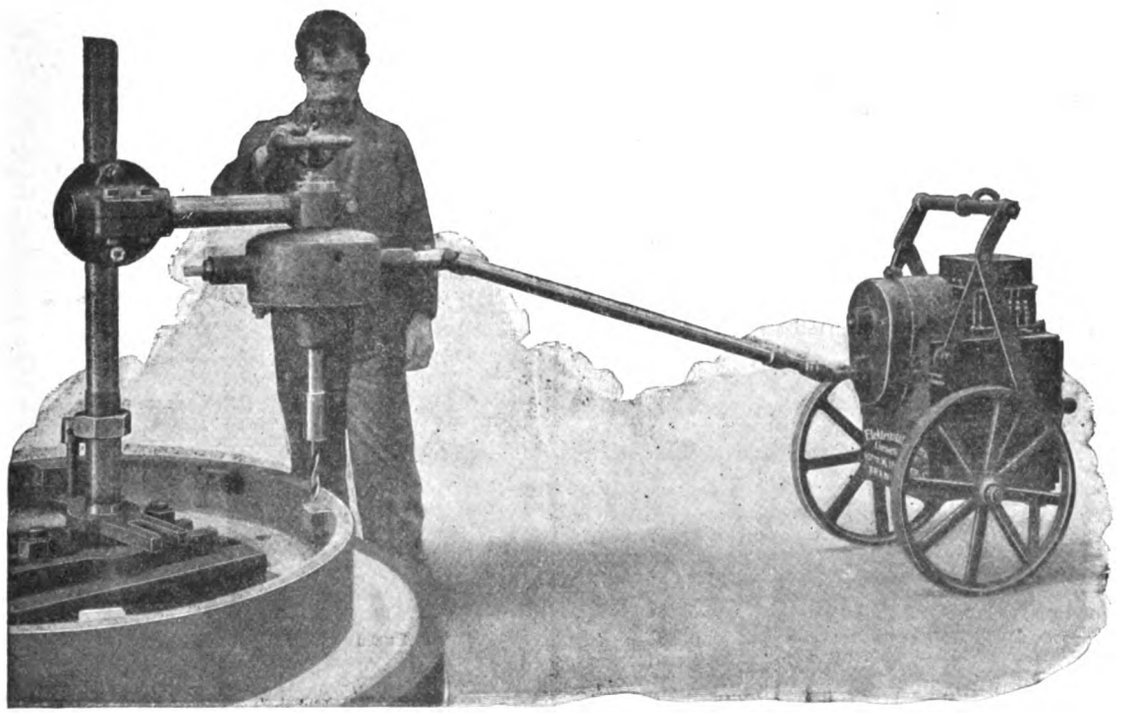
Lahmeyer Specialities.

From the Lahmeyer Electrical Company, Limited, 109-111, New Oxford-street, London, W.C., we received recently an illustrated description of their works at Frankfort-on-the-Maine, together with a collection of price-lists serving to show the range covered by the manufactures of this great establishment. The description for the most part consists of a splendid series of interior views of the different shops comprising the works. Much may be learned from these views as to the equipments of the shops, while plans serve to show their arrangement in relation to each other. In fact, a good idea of the extent of the factory and the variety of the work turned out may be obtained without perusing the preliminary description, which latter, however, greatly adds to the value of the production. Roughly speaking, complete electric generating and motor plants of every description may be said to constitute the range of work undertaken by the company, while they have more particularly specialised the construction of large slow-speed generators and motors for continuous and alternate current working. It is quite beyond the scope of this notice to describe the works or their organisation, so for the present, at any rate, we must refer the reader to the source of information in question for further details. That the works are among the very best of their kind to be found anywhere, in point of equipment and organisation, is a matter of common knowledge in the electrical world, which fact makes the information thus placed at our disposal in so convenient a form doubly appreciable. Coming now to the collection of price-lists previously referred to, we find therein described continuous-current dynamos, alternators, balancers, boosters, controllers motors, regulators, resistances, switchboards, and transformers, etc., of the company's standard types. Illustrations of the different types of machines are given; also full particulars relating to the machines of the several classes and types, such details of the construction as the purchaser may require to know being included. In each of the classes a wide range of outputs is covered. Continuous-current and three-phase generators and motors are shown coupled in different manners to suit various conditions. So far as design is concerned perhaps the continuous-current flywheel dynamos constitute the most notable departure from the practice hitherto in vogue over here. The first of the accompanying illustrations is an example of the company's box type of starting resistances, with carbon and roller contacts, for motors up to 500 volts. As a rule, these resistances are enclosed in oil containers. Modified forms to suit different conditions of working are listed for motors ranging in capacity from 2 h.p. to 210 h.p. We



Box Type of Starting Resistance for Motors.

notice, also, combined starting and regulating resistances of similar form, and a further novelty in the shape of a liquid starting resistance of peculiar design. The second of the illustrations herewith shows the application of an electrically-driven portable drill. Two forms of this drill are made—one with motor and drill separate, coupled by means of flexible shaft or telescopic spindle with two universal joints, and the other with motor and drill combined for drilling vertically, the drill being driven by means of belting. In the illustration the drill is shown connected to the motor by means of a telescopic spindle. The motor, completely enclosed by means of a cast-iron case, is fixed on a trolley, to which is also fixed the starter, cable drum, with six yards of flexible cable, plug switch, D.P. fuse, and the necessary gearing for driving the connecting spindle. By means of a lever and clutch coupling the gearing can be changed whilst the motor is running from a ratio of 1 : 4 to 1 : 8. When the lever is in the middle position the spindle is disconnected; on turning to the right or left the spindle revolves slowly or quickly, as the case may be. While we have by no means exhausted the contents of the lists before us, the space at our disposal prevents a fuller review at present by reason of its being limited.



Electrically-Driven Portable Drill.

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PHYSICAL SOCIETY.

At the ordinary meeting of this society held on Jan. 24, Prof. S. P. Thompson, president, in the chair, a paper on **"The Factors of Heat"** was read by **Mr. James Swinburne.** In all branches of physics, except heat, energy is divided into pairs of factors. Heat is generally thought of as a sort of indivisible energy and is not split into factors, but is treated as a whole, so that we have conductivity for heat, capacity for heat, specific heat, etc. Capacity for heat and specific heat are also taken when they include external work, at constant pressure, for instance; so that the capacity is reckoned as capacity for energy, which is only partly in the body or substance. So little is heat realised as energy that it has its own unit, so that equations involving other forms of energy with it need to be complicated with a coefficient. Temperature might be a factor of heat; but there is no corresponding quantity factor. There is no unit of temperature; it is measured in degrees which have no proper connection with anything. Temperature is sometimes treated as a tension factor with heat as the quantity factor, as when heat is said to run down temperature. Heat is thus regarded as its own quantity factor. Entropy is sometimes incorrectly used as the quantity factor corresponding to temperature. Entropy is at present indispensable as a function involving information as to whether heat has been, or might have been, converted into work. The author discusses "chy" as a possible factor for use with absolute temperature where "chy" is a quantity factor such that when multiplied by the temperature at which it is added or withdrawn gives the energy added or withdrawn. In the θ, χ system capacity, specific capacity, and conductivity vary inversely as the temperature. These factors are not analogous with the factors of other forms of energy, and are not convenient. The energy of heat is therefore split into τ π, where τ is proportional to the square root of the temperature, and is called by the author "tasis." The other factor, π, is called posot. In any gas, tasis is proportional to the effective velocity and posot to the momentum. Tasis and posot are analogous to the tension and quantity factors already in successful use, and indispensable to the treatment of other forms of energy. Conductivity of posot follows Ohm's law, and the capacity of a body for posot is constant.

Prof. Everett said the author of the paper had made a bold attempt to put the theory of heat on a better foundation. One objection to his proposals was that the two new variables, tasis and posot, were not independent, at all events in dealing with a perfect gas. The energy of the gas being $\frac{1}{2} m r^2$, tasis was represented by r and posot by $m r$. There was thus only one independent variable (for m was a constant mass), and arbitrary variations in the condition of the gas could not be represented. Another objection was the dubious nature of posot. Posot was described as momentum; but the total momentum of the gas was zero, its centre of gravity being at rest. Momentum as a determining element in physical phenomena was always a vector, and yet posot was a scalar. It was not even the mass multiplied by the arithmetical average of velocity, for r was not the average of velocities, but the velocity of mean square. The claimed simplification of the law of conduction rested on the erroneous assumption that the conductivity of a metal was inversely as its absolute temperature. He thought the proposed changes involved loss of simplicity without compensating advantage, and had been suggested by an undue desire to imitate electrical methods in the treatment of heat.

The Secretary read a letter from **Prof. G. H. Bryan**, in which he said that the author's system was very difficult to understand from his paper, but when reduced to its simplest terms it appeared to possess great disadvantages in comparison with the conventional method of thermodynamics. Mr. Swinburne's proposal to put $d V = T d \chi$, where χ is what he calls "chy," had the disadvantage that $d \chi$ was not a perfect differential, and the value of χ for any body depended not only on its actual state, but also on its past history. The same thing occurred when tasis and posot were used, as $d \pi$ was not a perfect differential, and the two quantities seemed more inconvenient than "chy." The paper overlooked points of vital importance, and contained a great deal of irrelevant matter about standpipes and reservoirs. It would be interesting to know whether the heat element, $d Q$ (not the total variation of energy, $d \pi$, used in the paper in defining tasis and posot), could be put into the form $q^1 d p$, where q^1 is of the dimensions of velocity, and $d p$ of the dimensions of momentum.

Dr. Donnan said that Mr. Swinburne's objections to entropy as a factor of heat energy seemed, at any rate, as far as reversible operations were concerned, to be based either on a misconception, or on some novel conception of the real significance of such factors. All that was really known was that the "actions" of the external world on a given system could be expressed in reversible thermodynamics, by differential terms of the form $i d m$, where i and m were parameters of the system. In general, the separate terms were not perfect differentials, and the futility of an attempt to give a false reality to what were merely mathematical functions suitable under certain conditions had been pointed out by Planck. The suggestion to replace temperature by its square root so as to bring heat energy into line with electrical and kinetic energy had already been made by Mash. In dealing with irreversible actions the author claimed that the phenomena of heat conduction could be represented as a flux of posot along a down gradient of tasis, according to the same law as a flux of quantity of electricity along a down gradient of potential. He pointed out that it was not necessary to abandon entropy to achieve this result, as Wiedeburg had shown that by making some very simple and plausible assumptions it was possible to bring entropy into line with other quantity factors, so that the entropy of a heat isolated system remained constant, and the flow of heat could be represented as an entropy flux obeying a law analogous to that of Ohm.

Mr. Macfarlane Gray said that he had found the paper difficult to understand. Such expressions as "but the gas has increased its entropy by H/θ collected in the gas and caught there," "the gas loses entropy," "a flow of entropy," were strange to him, his idea being that there is no entropy in any substance or in nature, neither is it a property or a quality of any body, but only length upon a diagrammatical representation of the related heat states of a body of unit mass according to a systematised mental conception. He thought temperature and entropy were sufficient for this purpose, and he could see no advantage in the factors proposed. From certain statements in the paper, he had concluded that "chy" was the specific heat of the working substance, but there were other statements inconsistent with this conclusion. He had, with what he had taken tasis to be, constructed a diagram to ascertain how the system proposed differed from the θ, ϕ method. Starting with tasis proportional to the square root of the temperature, he had not enquired what posot might be, because with heat energy and one ordinate fixed the other would declare itself. On this new diagram a graph is not a series of state points, and a cycle performed thermodynamically is not a closed curve. In the vapour field the adiabatics are sloped curves, and the dryness fraction is measured in the same way as on the old diagram. In the gas field he had set out problems similar to the illustrations in the paper, and found that the features were the same, so that he thought he had operated with the same "posot," although undisclosed.

Mr. Swinburne, in reply to Prof. Everett, said that τ and π were only proportional when the capacity was constant. The factors proposed were not only analogous to those used in electricity, but also to those used in other branches of physics. Prof. Bryan had discussed what ought to come in a subsequent paper, and evidently thought the subject should be commenced by dealing with generalised co-ordinates, whereas he (the author) had started simply, and on that account had used standpipes and perfect gases as illustrations. He remarked that although some members had found the paper difficult to follow, others had complained that it was too simple.

Mr. Eustace Large then exhibited some twinned crystals of selenite, and the society adjourned until Feb. 14.

NEW COMPANIES REGISTERED.

Manufacture General D'Enseignes, Limited.—Capital, £4,000. Objects: to acquire the business now carried on by Jaquet et Cie. at 8, Rue du Quatre Septembre, and at 27, Faubourg Poissoniere, as the Brilliant Sign Company, Limited, and to carry on in Great Britain, France, Belgium, or elsewhere the business of manufacturers and engravers of letters in metal, wood, glass, in particular the signs and letters known as "Brilliant" signs; also as mechanical engineers, electrical engineers, producers and suppliers of electricity for the purposes of light, heat, or power, etc.

London Express Motor Service, Limited.—Capital, £20,000. Objects: to carry on the business of an omnibus company in all its branches (primarily between Putney and Piccadilly), with either steam, electric, petrol, or other power, etc.

T. Emlyn Jones, Limited.—Capital, £15,000. Objects: to acquire the business of T. E. Jones, Glebe-street, Penarth, and to carry on the business of general and furnishing ironmongers, as plumbers, gasfitters, bellhangers, electricians, electrical engineers, etc.

MacLeish, Morrison, and Co., Limited.— Capital, £15,000 Objects: to acquire the business of a sanitary, hydraulic, electric, and heating engineer, etc., carried on by James MacLeish at Mill-street, Perth.

Leicester Tramways Company, Limited.—This company was originally constituted by special Act of Parliament, dated Aug. 2, 1877, with a capital of £50,000, and is now registered as a limited company, with a capital of £100,000, in £10 shares, all taken up and fully paid.

Long-acre Motorcar Company, Limited.—Capital, £10,000. Objects: to carry on business as manufacturers of and dealers in motors of every description, cycles, omnibuses, tramcars, wagons, ships, whether propelled by electricity, steam, gas, oil, or other mechanical power, etc.

APPOINTMENTS VACANT.

Mains Superintendent, Harrogate Corporation, £150 per annum, Feb. 4. Full particulars in our advertisement columns.

Draughtsman, Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board, Feb. 11. Full particulars in our advertisement columns.

Principal Traffic Clerk, Manchester Corporation Tramways Department, £150 per annum, Feb. 8. Full particulars in our advertisement columns.

District Foreman for mains department, St. Pancras Borough Council, 50s. per week. Full details in our advertisement columns.

Engineer to represent manufacturing electrical firm for sale of meters. Full particulars in our advertisement columns.

Assistant Draughtsman for main switchwork, Manchester district. Full particulars in our advertisement columns.

Draughtsman accustomed to large switchboard work. Ful particulars in our advertisement columns.

General Traffic Manager, Wolverhampton Corporation Tram ways. £250 per annum, Feb. 15.

Assistant Electrical Engineer, Stalybridge, Hyde, Duckinfield, and Mossley Tramways and Electricity Board, Feb. 11. Full particulars in our advertisement columns.

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LEGAL INTELLIGENCE.

BRIGHT'S LIGHT AND POWER COMPANY.

Before Mr. Justice Swinfen-Eady, in the Chancery Division of the High Court, on Friday, Mr. H. T. Eve, K.C., applied in the case of Bright's Trustee *v.* Vidal, to restrain the defendant from dealing with certain shares in Bright's Electric Lighting and Power Company. At the conclusion of a lengthy discussion the learned Judge decided that the defendant, Vidal, must be restrained, not only from dealing with the shares, but from voting upon them until the action was tried, and he made an order accordingly in terms of the notice of motion.

The affairs of this company also came before Mr. Justice Byrne, in the Chancery Division on Saturday, in the matter of Bright's Light and Power Company *v.* Moreno. It was a motion for the appointment of a provisional liquidator and also to restrain the defendant from dealing with the books of the company, and for an order that he might be directed to give them up. After hearing counsel on both sides, his Lordship appointed the official receiver forthwith as provisional liquidator, limiting his power to taking possession of the books and assets of the company.

COLLISIONS ON THE WEST LONDON TRAMWAYS.

Claims for Damages.

In the King's Bench Division on Friday, Mr Justice Bruce and a common jury heard an action brought by Mrs. Esther Menlemin against the London United Tramways Company to recover damages for personal injuries sustained through the alleged negligence of the defendants' servants.

The plaintiff's case was that on June 8 last she was driving in an Irish car along the High-road, Chiswick, when the carriage came into collision with one of the defendant company's electric cars, which was being taken into the depôt. As a result the plaintiff was thrown out on to the road and received a severe shock to her system and injuries to her shoulder. The plaintiff alleged that the defendants' servants were guilty of negligence in turning the car into the depôt without seeing that the road was clear. The defendant company, on the other hand, contended that the accident was due to the negligence of the plaintiff's husband, who took no notice of the signal given by the pointsman.

In the result the jury returned a verdict for the plaintiff, assessing the damages at £200, and judgment was entered accordingly, with costs.

Mr. Justice Darling and a common jury disposed of a similar action against the same company on Monday. In this case the plaintiff was Mr. A. R. Bulley, a builder and contractor of Fulham, and he sued the London United Tramways Company to recover damages for personal injuries on the ground that the collision, which occurred on the evening of April 25 last, was due to the negligence of their servants. The accident occurred in High-road, Gunnersbury. The plaintiff stated in his evidence that he pulled out on to the tramlines for the purpose of passing some vehicles which were immediately in front. He saw an electric car coming toward him, and he waved his whip indicating to the driver of the car that he should reduce speed. The driver, however, neglected to do this, with the result that the car caught the trap and dragged it for several yards, when a second car, coming from Hammersmith, dashed into the trap and smashed it. Plaintiff and his friend were thrown into the road, and the plaintiff received a severe shaking and an injury to his knee which prevented him from attending to his business for some time. Plaintiff said that if the driver of the car had put on his brake the accident would have been avoided. Defendants denied negligence, and contended that the accident was attributable to the plaintiff endeavouring to dash between the car and certain vehicles. They further said that the driver put on the brake, but found it impossible to stop the car in time to avoid an accident.

Eventually the jury found a verdict for the plaintiff for £100 damages.

Judgment was entered accordingly, with costs.

ELECTRIC LIGHT IN A WESTMINSTER HOTEL.

Mr. Justice Kekewich, in the Chancery Division of the High Court on Friday, heard the case of Husey *v.* the London Electric Supply Company. It was a motion by the plaintiff, the receiver in possession of St. Ermin's Hotel, Westminster, for an injunction to restrain the defendants from taking any proceedings by cutting off or discontinuing the supply of electric current from their mains to the hotel, to recover the amount due to them in respect of electric current supplied to the hotel prior to Jan. 17 last. The plaintiff's case was that under the Electric Lighting Acts he was entitled to be supplied with electricity, and that the defendants could not decline to supply him because a previous occupier had not paid his bill. The defendants contended that the plaintiff had not brought himself within the conditions of the provisional order of 1889 to entitle him to a supply of electric energy, and he had not given the usual notice requiring it.

Mr. Warrington, K.C., and Mr. Mitchell argued the case for the plaintiff, and Mr. P. Ogden Lawrence and Mr. Cartmell were counsel for the defendants.

Mr. Justice Kekewich, in the course of his judgment, held that the defendants had taken a wrong view of the case. The plaintiff was clearly in the hotel as occupier, and was entitled under the provisional order to have a supply. The plaintiff must serve proper notice for a supply, and enter into a contract for that purpose. Until that was done, the supply of electricity must be continued. Order accordingly.

EDMUND'S METHOD OF BONDING RAILS.

The case of Glover and Co. *v.* the American Steel and Wire Company came before Mr. Justice Farwell in the Chancery Division on Tuesday, on the motion of the plaintiffs for an injunction to restrain the defendants from infringing Edmund's patent, No. 3,119 of 1893, for improvements in the formation of solid ends in connection with flexible or compound electrical connectors. Mr. T. Terrell, K.C., Mr. C. F. Jenkins, K.C., and Mr. Frost were counsel for the plaintiffs, and Mr. Fletcher Moulton, K.C., and Mr. A. J. Walter appeared for the defendant company.

From **Mr. Terrell's** opening statement it appeared that the patent in question had reference to the manufacture of bonds for rails for electrical tramways and railways. Edmund's idea was to make the connection just as if the many wires and the solid ends were one piece of the same metal, either by putting them into a mould or by making them one by a heat process. His invention, said counsel, had been adopted throughout the electrical world for the purpose of bonding rails together. It had become a very important invention and a very successful invention. The defendants, it was alleged, had started making a solid end, and had taken out a patent for it, they contending that there was no subject matter in the plaintiffs' patent. The defendants had brought an action complaining of infringement of their patent for making the solid end in a particular way, but had since written to the plaintiffs a letter, stating that they had discontinued the action because there was no proof that the plaintiffs had infringed the particular method adopted by the defendants.

Mr. James Swinburne, Mr. Philip Dawson, and **Mr. Beaumont**, electrical experts, gave evidence in support of the plaintiffs' case.

Sir Frederick Bramwell, called for the defendants, said the only process he found described in Edmund's specification was to take a group of metallic wires, put the ends of those wires into a mould, and pouring metal into that mould to fill it and embrace the wires. So far as that was a process of binding two metals together it was not new at the date of the specification. As regarded the specification itself, there was nothing limiting the scope or kind of the metal composing the wires or fixing the ends. "Burning on" in the sense used in this specification was commonly known in connection with metals of all sorts at the date of the specification. In his opinion the defendants did not use the process claimed by the plaintiffs.

Cross-examined by Mr. Terrell, the witness admitted that before the date of the plaintiffs' specification he never knew of a rail bond made with a flexible part of two ends to it, which ends were fastened on to the flexible part without the introduction of any other metal. He conceded that a conductor of this kind possessed advantages over a soldered conductor.

Mr. Walter, for the defendants, contended that the plaintiffs' patent was bad, on the grounds that it claimed an old material, an old process, and an old method.

Mr. Justice Farwell, in giving judgment, said he thought the construction of the specification was plain. He agreed that it was a patent for a process, and that where the patentee alluded in the specification to metals, he alluded to all metals. His lordship held, however, that the claim was for an old process, as it had always been applied to substances in the way hitherto applied. He could see no sort of invention at all in it. What the defendants did was to "weld," and reading the plaintiffs' specification by the light of scientific knowledge at the time, he thought the intention was not to include welding, because it was not known at the time that copper could be welded to copper. The action, therefore, failed, and the application for an injunction would be dismissed, with costs.

ELECTRICAL WORK.

In the Westminster County Court on Tuesday, his Honour Judge Woodfall had before him the case of Nightingale and French *v.* Evelyn, in which the plaintiffs, a firm of electrical engineers, of Wimbledon, sued the defendant, a lady residing at Lyric-chambers, 27, Shaftesbury-avenue, to enforce payment of a debt of £17. 6s. 6d. in respect of electrical work carried out to her instructions.

His Honour said the defendant had not chosen to appear, and in her absence he should make an order for payment of the amount due, with costs, or, in default, committal to Holloway for seven days.

ALLEGED DAMAGE TO ELECTRICAL FITTINGS.

In the Westminster County Court on Monday, his Honour Judge Woodfall and a jury tried the case of Birt *v.* Allen, in which the plaintiff, a dealer in electrical fittings and appliances, sued the defendant to recover damages for injury done to a quantity of brass and bronze fittings alleged to have been caused by the defective condition of the drainage on the defendant's adjoining property.

The defence was that the defendant, as freeholder of the premises, was not personally liable, as he had never undertaken to do the repairs for his tenants.

The jury found that the defendant was liable in respect of the leakage from his tenant's water-pipe, and gave judgment for the plaintiff for £15, with costs on the higher scale.

ELECTRICAL ENGINEER'S CLAIM.

In the Westminster County Court on Tuesday, his Honour Judge Woodfall had before him the case of Bayley *v.* Cattle by way of an application for a new trial. The plaintiff was Mr. Arthur Bayley, an electrical engineer, carrying on business at 27, Artillery-row, Westminster, and he sued the defendant to recover payment of an account of £7. 10s. in respect of electrical work and fittings carried out to his instructions, and obtained judgment against him on Jan. 15 on the ground that the debt in question had been assigned to him by

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his father in respect of wages due to him. The case was reported in our issue of the 17th inst.

The **Defendant** now applied for a new trial on the ground that the plaintiff was not entitled to recover the amount, inasmuch as he had since been applied to for payment by the plaintiff's father, to whom the order for the work was given.

His Honour thought that in view of the fact that the plaintiff's father was claiming against the defendant for payment of the account for which the plaintiff had obtained judgment, there ought to be a new trial, and when that trial took place it could be decided once and for all whether the plaintiff or his father was entitled to the money.

LIGHT RAILWAYS SYNDICATE.

In the Winding-up Court, before Mr. Justice Wright, the petition of L. D. Nicholl, a creditor, for the winding up of this company was allowed to stand over for a month by consent, it being stated that the company were endeavouring to sell a light railway order, and when they had done that they would be in a position to pay all the creditors.

COMPANIES' MEETINGS AND REPORTS.

CITY AND SOUTH LONDON RAILWAY.

Mr. C. G. Mott presided at the ordinary general meeting of this Company on Tuesday at the offices, Finsbury pavement, E.C. The directors' report, together with the statement of accounts, appeared in last week's issue.

The **Chairman,** in the course of his remarks, said they had again to congratulate themselves on having carried a large number of passengers in perfect safety. Some alarm in reference to electric railways had been caused by the unfortunate fire which occurred recently in the terminal station of the Liverpool Overhead Electric Railway, and questions were raised in the newspapers as to the safety of the underground electric railways. The history of this line showed how unfounded any such fears were. During the 11 or 12 years that this undertaking had been opened they had carried nearly 100 million of people without seriously injuring one of them. The mode by which the Liverpool company's trains were worked differed considerably from what had been in use on this railway. In the case of the Liverpool line the motors were placed under the train itself, part at one end and part at the other end, both being under the control of the driver at the front of the train. The result was that anything which went wrong at the rear was unknown at once to the driver, and that fact primarily accounted for the Liverpool accident. In the case of this Company both motors were placed, not under the carriages, but on a separate isolated engine, and were both under the full control of the engine-driver, who, if anything went wrong would know of it in a moment, and could act accordingly. The only thing which a line like theirs was liable to was what were called short-circuits, but the only effect of that would be the stoppage of the train. On their line they had such an experience two or three weeks ago, but no one was hurt, or could be in such circumstances. The Board were quite satisfied that there was no risk of injury to any passengers on the railway, but in view of the public alarm which had been excited they had thought it better to take steps to increase the security already existing. With that object additional appliances were being provided which would, in the case of a short-circuit, reduce the time of any stoppage, and enable the driver to at once communicate with the stations behind and in front of the train. Arrangements were also being made whereby the electric light could be at once switched on from an independent source, and as there was a good wooden footpath from end to end of their tunnels, passengers would, in the event of a temporary stoppage of the train through a short-circuit, be enabled to walk out in a well-lighted tunnel to the nearest station. It was impossible, so far as the directors could see, for any serious accident to ever occur on the railway. He then proceeded to deal with the accounts in detail, and mentioned that in the half-year they had carried 7,008,842 passengers, against 5,018,842 in the corresponding period of the previous year. Part of this increase was due to the opening of the Islington extension, but there was a steady growth in the traffic independently of that. In order to deal with the growing traffic at the London Bridge Station, arrangements had been made with the City and Brixton Company to abandon the larger portion of their railway, and construct the section to Lambeth. By this means a station could be built at London Bridge on the portion of the old line at present disused, thereby giving an alternative route to the City and Monument. By means of this arrangement the Company would get what it wanted without any practical charge falling on it at all. As to the Islington and Euston extension, the Company had agreed to work it, but the terms were not yet settled. He concluded by moving the adoption of the report and accounts.

The motion having been seconded and adopted, a special meeting was held, at which the agreement with the City and Brixton Company received the approval of the shareholders.

EASTERN TELEGRAPH.

The half-yearly meeting of the shareholders in this Company was held at Winchester House on Wednesday, Sir John Wolfe Barry in the chair.

The **Chairman** moved the adoption of the report, a summary of which appeared in our last issue. He remarked that they were comparing the present half-year's revenue with a period which produced the largest traffic receipts since the inception of the Company. In the corresponding period of last year their receipts from the traffic with South Africa and China were abnormally large, owing to the military occupation of the Transvaal and the Orange River Colonies and the military operations of the European Powers in China. He hoped that a tariff of 2s. 6d. between Europe and India would be introduced within the next few weeks. Dealing with the question of wireless telegraphy, he said they did not fear any competition from this source but, on the other hand, he thought that it might be in special places an adjunct or handmaid to submarine cables. The essential conditions of an efficient telegraph system were speed of transmission, avoidance of error, secrecy and trustworthiness under all circumstances of climate, locality, and natural electrical conditions. He went on to show that in all these conditions wireless telegraphy was at present hopelessly behind telegraphy by cables. This Company had a station of their own where they were making enquiries with a view of thoroughly studying the possibility and economy of erecting a wireless telegraphic adjunct to their system for about 100 miles, because in this particular situation there were disadvantages in the use of a cable. Prof. Oliver Lodge and Sir William Preece completely bore out the conclusions to which they had arrived. They pointed out that wireless telegraphy, as now understood, laboured under inherent and inseparable disadvantages compared with cable transmission, which must, whatever improvements may be made in years to come, prevent it from being anything more than an inferior mode of transmission, even over comparatively short distances. Dr. Oliver Lodge summed up the situation as follows: "Wireless or open methods cannot compete in point of secrecy and certainty with closed or cable methods, and could only compete with them in point of speed and accuracy by aid of great improvements and new inventions involving little less than discoveries." Sir William Preece doubted the possibility of sending more than two or three paying words per minute across the Atlantic even if the system could be made to work, of which at present no evidence had been produced. He also pointed out the extreme difficulty of any system of tuning between the transmitting and receiving instruments, so as to avoid, at any rate, some portion of the risk of the messages being tapped. He then formally put the motion for the adoption of the report.

Sir James Denison-Pender seconded, and the motion was carried unanimously.

The proceedings then terminated with a vote of thanks to the chairman.

TYPEWRITING TELEGRAPH CORPORATION.

The adjourned ordinary general meeting of this Company was held at Winchester House, E.C., on the 23rd inst., for the purpose of taking a poll on the proposed adoption of the report of the committee of shareholders read at the adjourned general meeting held on the 9th inst., and published in this journal.

Sir James Fergusson (chairman) presided, and reminded them that the meeting was adjourned for the purpose of ascertaining the opinion of the shareholders on the report of the committee by proxy. The proxies returned were largely in favour of the committee. The Board had just conferred with the members of the committee present as to the most convenient course to be pursued in the interests of the Company, as the directors were desirous of giving effect to the vote of the shareholders with as little trouble as possible, and it was their unanimous opinion that the best way of giving that effect would be, seeing that there were at present five directors, while the articles provided for seven, to elect two members of the committee to the Board, so that the management of the Company might be continuous.

Mr. Arthur J. Parker (chairman of the committee) said he was satisfied that if they were to carry the matter in a hostile manner, and if the Board stuck to the articles, which would delay all business for a month, it would be to the disadvantage of the Company. Therefore, on behalf of the committee, he desired to state that the present arrangement met entirely with their approval.

Mr. Arthur J. Parker and Mr. G. H. Chantry were then re-elected members of the Board, and the **Chairman** announced the resignation of himself, Mr. C. E. Spagnoletti, Mr. H. Knatchbull-Hugessen, and Colonel Seddon as directors of the Corporation.

Dr. Ledlie moved a vote of thanks to Sir James Fergusson for the courtesy with which he had met the committee, and the motion was duly seconded, and carried unanimously.

DUBLIN UNITED TRAMWAYS.

The report of the directors of this Company for the half-year ended Dec. 31 last states that the directors have declared a dividend for the half-year at the rate of 6 per cent. per annum on the preference shares and at the rate of 6 per cent. per annum on the ordinary shares. These dividends will absorb £34,949, leaving a balance of £4,668 to be carried forward, after writing off £1,000 from preliminary expenses. In addition to a full half-year's interest on the debentures, a further £1,891 has been charged against the revenue for the half-year, providing for all the interest under this head to Dec. 31, 1901. A sum of £1,475 in excess of the full half-year's "wayleaves," payable to the local authorities, has been similarly charged so as to clear them up to the last gale days. The rates and taxes charged against the last half-year's revenue are £2,028 in excess of the corresponding period in 1900, and are fully charged up to Dec. 31, 1901. A policy has been effected with the English and Scottish Law Life Insurance Company to insure the payment to the Company at the end of 38 years of the discount on the "B" debenture issue, and the premium for the half-year has been charged against revenue. The directors have always considered that no charge should be made against revenue in respect of the large amount of obsolete property, such as cars, horses, etc., which were necessarily sold at a loss in connection with the conversion of the tramway system from horse to electric traction. This principle has been acted on in all similar undertakings of which the directors have any knowledge, but deferring to

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the views of the auditors, £8,049, part of the difference between the sum at which the horses stood in the books of the old company and what they realised when sold, was charged against revenue and reserve, and the balance—namely, £7,076—was placed to a special suspense account with a view of writing it off out of revenue in future half years. The directors have now the authority of the auditors for saying that, in the event of the shareholders approving of this item of suspense being charged to capital account, the same as the losses incurred on all other items, involved in the conversion of the tramway system, the auditors will offer no objection.

METROPOLITAN RAILWAY.

The report of the directors of this Company for the half-year ended Dec. 31 last states that the net revenue account, after providing for the interest upon the debenture stocks and other fixed charges, shows a balance of £160,436, which will suffice for the dividends upon the preference and guaranteed stocks, and leave a sum of £83,734 available for dividend upon the ordinary stock. The directors accordingly recommend a dividend upon the ordinary stock for the past half-year at the rate of £2. 5s. per cent. per annum, and to carry forward the balance of £19,251 to the next half-year's accounts. On the subject of electric traction the directors state that immediately after the decision of the Board of Trade in favour of the continuous-current system they "communicated with the Board of the District Company, and arrangements are now in progress for settling the details of the installation, so that the railways of the two companies may be equipped for the traffic to be worked upon the continuous-current system. With the view to the work being completed at the earliest possible date, your directors issued a complete specification and form of tender for a power station on land belonging to the Company at Neasden, and they are pleased to report that several tenders on very favourable terms have been received. They are advised by your electrical engineer that these tenders will enable the Company to erect the station and generate the current required for working your railway at a very low rate. The tenders have been very carefully considered and reported upon, and your directors have decided to place contracts for the necessary works with one or more of the firms who have tendered. The power station is to be completed within 18 months, and the equipment of the railway and the provision of new rolling-stock will proceed simultaneously with its erection. The station will be laid out so as to be capable of extension in order to provide in the future for generating the current required for working your lines north of Baker-street." After referring to the Bills which the Company are promoting in the present session of Parliament the report proceeds: "The directors have appointed Mr. A. C. Ellis, who has had a large railway experience and is thoroughly conversant with the Company's affairs, to be the general manager. The Board deeply regret that the continued unsatisfactory state of Mr. Bell's health has obliged him to resign the chairmanship. Mr. Bell's long and faithful services to the Company extending over a period of 30 years, call, in the opinion of the directors, for some recognition, and a resolution will be submitted providing for a superannuation allowance to him upon terms which they consider are just and equitable. As soon as Mr. Bell's services as a director can be conveniently dispensed with he will vacate his seat at the Board, but the benefit of his advice and assistance will always be at the disposal of the Company. The revision of the directors' remuneration and the changes in the managerial staff consequent upon Mr. Bell's retirement will enable the proposed allowance to be provided without any additional charge upon the Company. The Board have unanimously elected Mr. J. J. Mellor, J.P., D.L., as chairman and Mr. Francis Pavy, J.P., as deputy chairman. The proprietors will remember that Mr. Yerkes and an American syndicate which has obtained control of the District Railway made an offer some months ago to take over and work your railway on wholly inadequate terms. The offer, though based on a so-called guarantee, was without any tangible security for its performance, as your auditors, Messrs. Waterhouse and Fowler (of the firm of Price, Waterhouse, and Co.), pointed out at the time; and the directors, with the proprietors' approval, declined to accept it. Moreover, its acceptance would have deprived them of all the advantages which will accrue from the growing development of the resources arising out of the suburban extensions. An attempt is now being made, in a circular just issued (in which the proprietors are asked for their proxies), to revive this proposal. The Board think it right to warn the proprietors against sending their proxies in support of this agitation, as the only effect would be to render impossible a fusion of interests with the District Company beneficial to the Metropolitan Company, and to help a foreign speculation, and aid, at the Company's expense, the District Company and certain 'tube' railways not yet constructed. The directors recommend that the dividends be payable on Feb. 8 prox."

GREAT NORTHERN AND CITY RAILWAY.

The directors' report for the half-year ended 31st ult. states that with the exception of part of the station tunnels and one or two short lengths, the tunnels between Drayton-park and Finsbury-pavement are driven to their full extent. At Drayton-park the up and down line tunnels have been driven northwards 54 and 139 lineal yards respectively. At Essex-road Station the connecting passages from the shafts are nearly completed, and about 800 yards of tiling have been done. At Old-street the up-line station tunnel has been driven to its full extent, and the down-line station tunnel for a distance of 123 lineal yards. At the Finsbury-pavement terminus the up-line station tunnel has been driven to its full extent, and the down-line station tunnel for a distance of 135 lineal yards. A contract for the electrical plant and equipment has been entered into with the British Thomson-Houston Company, Limited, and the generating station is in course of construction on land abutting on the Regent's Canal. Generally, the progress made during the six months is satisfactory. The Bill which the Company is introducing into Parliament to extend the time for completion of the line, for further capital powers, and for an extension of the line to Lothbury, will be explained at the general meeting to be held after the general meeting on Feb. 4.

CENTRAL LONDON RAILWAY.

The directors in their report for the half-year ended Dec. 31, 1901, state that the amount expended on capital account during the half-year has been £146,724. The receipts from all sources on revenue account have amounted to £168,359 and the working expenses to £90,544 (being 53·78 per cent. of the receipts), leaving a balance of £77,814. The number of passengers carried since the opening of the railway is as follows: Five months ended Dec. 31, 1900, 14,916,922; half-year ended June 30, 1901, 20,385,739; and half-year ended 31st ult., 20,802,650, a total of 56,105,311. The traffic continues to progress steadily and satisfactorily. During the last half-year the average number carried per month was 3,467,108, as compared with 2,983,384 per month for the five months ended December, 1900. After providing for interest on debenture stock, the net revenue account shows a balance of £82,774, including £18,432 brought forward (£9,900 of which was a reserve for dividend on the deferred ordinary stock, which is payable yearly). The directors propose a dividend on the undivided ordinary stock at the rate of 4 per cent. per annum for the half-year; a dividend on the preferred ordinary stock at the rate of 4 per cent.; a dividend on the deferred ordinary stock at the rate of 4 per cent. for the whole year; to transfer £10,000 to a reserve fund, leaving £5,874 to be carried forward. The No. 2 Bill, promoted in the last session of Parliament, providing for the acquisition of land to enable the Company to construct additional lifts at Shepherd's Bush Station, and to authorise the raising of £150,000 share capital with £50,000 borrowing powers, received the Royal assent on Aug. 5 last. The proprietors will be asked at a special meeting, to be held at the conclusion of the ordinary meeting, to pass a resolution authorising the directors to create and issue the share capital and to exercise the borrowing powers authorised by that Act. The Bill No. 1, providing for the construction of loop lines at Shepherd's Bush and at the City, by way of Liverpool-street, was suspended in common with other Electric Railway Bills. After careful consideration of the whole position, the directors have decided to abandon the suspended Bill, and to promote in lieu thereof a Bill to construct a new line from Hammersmith to the City. The line as submitted to Parliament will be a continuation of the present Central London Railway, with which it will be connected at its eastern end by a curve serving Liverpool-street and at the western end by a curve from Hammersmith to Shepherd's Bush. This proposal is in harmony with the views expressed on this subject by the Joint Committee on London Underground Railways in their recent report. The convenience which such a railway will afford to the enormous traffic passing along the busy and important thoroughfares of Fleet-street, the Strand, Piccadilly, etc., will be very great, and a remunerative return for the outlay will no doubt be secured. As the whole line will be worked as a circle delays attending shunting operations at the termini, as at present, will be avoided. The provision of a more rapid service, together with a large number of trains, will become practicable, thus giving ample accommodation for the growing traffic along the route above indicated, and affording much-needed relief in the crowded streets. This Bill will be submitted to the proprietors at the Wharncliffe meeting, to be held after the ordinary meeting on the 5th prox.

WATERLOO AND CITY RAILWAY.

The directors in their report for the half-year ended Dec. 31 last state that the capital account shows a total outlay of £599,201 on Dec. 31 last. The gross receipts of the line, less Government duty, amounted to £16,678, and the working expenses to £7,589, being at the rate of 45·50 per cent. The balance is sufficient, after providing for interest on the debenture stock, to pay a dividend at the rate of 3 per cent. per annum on the ordinary stock. The number of passengers carried during the past six months, exclusive of season-ticket holders, was 2,190,532, showing an increase of 152,132 over the number carried in the corresponding period of 1900. The season-ticket holders on Dec. 31 last numbered 1,030, as against 883 at the end of December, 1900. Several underground railway schemes, some of which may affect this railway, will be considered by Parliament in the present year, and these will be carefully watched in the interests of the Company.

SUSSMANN ELECTRIC MINERS' LAMP.

The directors' report to be submitted at the meeting on the 11th prox. states that the accounts cover the period from the reconstruction in August, 1900, to Dec. 31 last, and show that 20,677 shares were applied for and allotted credited with 17s. 6d. per share paid up, and that the cash actually received amounted to £2,584. Out of this sum £1,254 was of necessity paid away to satisfy the liabilities of the old company and the liquidation expenses. During the above-named period every effort has been made to effect sales of the lamps, both by personal visits to collieries, interviews with colliery owners, and by means of correspondence and circulars, but the directors regret to say with only very indifferent success. Several important collieries have had sample installations of the lamps, and in each case with favourable results, but the owners do not seem disposed to lay aside the oil lamps in large quantities in favour of the Sussmann. In the present condition of the colliery world it seems a fixed resolve not to embark in the outlay of any additional capital. The directors, in common with all the shareholders, feel the keenest

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regret that an invention so eminently useful and practical as the Sussmann electric miners' lamp has not been appreciated at its true worth by colliery owners, especially so as it has received the most complete approval wherever it has been used, and it has also been very favourably reported on by the leading miners' experts of the day. The endless delays affecting negotiations for the sale of some of the foreign patents forbid the directors from holding out any hope of success on this point. The only alternative to liquidation is for the shareholders to take up the whole of the unpaid capital of 9,323 shares credited with 17s. 6d. paid, which would give the Company a further working capital of £1,165. Alternately, under all the circumstances, the directors have come to the conclusion that the shareholders should not be asked to embark any further capital in the business, but submit to them the desirability of a final liquidation of the Company and the sale of all the patents for the best price that can be obtained.

DIRECT UNITED STATES CABLE.

The general meeting of this Company was held at Winchester House on Tuesday, when the directors' report, given in our last issue, was submitted for approval.

Sir James Pender presided, and, in putting the motion to the meeting, referred to the Marconi system of telegraphy. The general consensus of expert opinion was against the Marconi system having any effect commercially in short or long distance cables. Mr. Marconi had not yet attempted to bring his system out on a working basis, and until he showed them something which would work successfully over long distances, and carry a great amount of traffic, they need not worry about the value of their cable shares. As a matter of fact, their reserve fund was worth £7. 10s. a share, apart from any goodwill they had got.

The motion, being duly seconded, was carried.

ANGLO-AMERICAN TELEGRAPH.

The directors, after placing the sum of £12,000 to the credit of the renewal fund for the half-year, recommend the declaration of the following dividends: a balance dividend of 16s. per cent. upon the ordinary consolidated stock for 1901, a balance dividend of £1. 10s. per cent. upon the preferred stock for the year, and a first and final dividend of 2s. per cent. upon the deferred stock for the year. After paying the foregoing dividends there will be a balance of about £1,265 to be carried forward. The above dividends, together with those already paid, will amount to £3. 1s. per cent. on the ordinary consolidated stock, £6 per cent. on the preferred stock, and 2s. per cent. on the deferred stock for the year.

NEWCASTLE ELECTRIC SUPPLY.

An extraordinary meeting of the shareholders in this Company was held in Newcastle on the 23rd inst., when the following resolution was adopted: "That the Bill proposed to be promoted by the Company in Parliament in the ensuing session, and entitled 'A Bill to confer further powers upon the Newcastle-upon-Tyne Electric Supply Company, Limited, for the construction of works and the supply of electrical energy, and for other purposes,' be hereby approved, subject to such additions, alterations, and variations as Parliament may think fit to make therein." The resolution will be submitted for confirmation as a special resolution at a second extraordinary general meeting to be convened.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Tulcea (Roumania).—The Municipality invite tenders for lighting the town. Tenders by Feb. 25.

Bacau (Roumania).—The Mayor invites tenders for electric lighting of the town by March 15. The estimate is £5,646.

Ghent.—The Municipality require tenders for the electric lighting of the town. Tenders must be posted before March 1, 1902.

Cuellar (Spain).—The Municipality require tenders for an electric lighting installation and working of the same for 20 years, by Feb. 27.

Madrid.—The Municipality invite tenders for the supply of material, maintenance, etc., of the electric lighting of the corn market. Tenders by 12 noon on Feb. 4.

Irun (Spain).—The Municipality require tenders for the installation of private and public electric lighting. The former is estimated at about £6,000. Tenders by Feb. 6.

Engoibar.—The Municipality invite tenders for a public electric lighting installation. Tenders will be received by the same until Feb. 2. Address as above, Province of Guipuzcoa, Spain.

Aberdeen.—The Tramways Committee invite tenders for the supply of steel tramway poles, bases, and trimmings for the same. Tenders by Feb. 12. Details in our advertisement columns.

Bournemouth.—The Town Council invite tenders for the following: steel poles, overhead line, section boxes, arc lamps, arc lamp-poles, carriers, etc. Tenders by Feb. 12. Details in our advertisement columns.

Madrid.—The Post and Telegraph Department invite tenders for supply of 3,000 telegraph poles of horse-chestnut wood. The estimate is 7 and 8 pesetas per pole of 7m. and 8m. length respectively. Tenders by Feb. 22.

Hammersmith.—The Council invite tenders for the supply of electrical stores and best Welsh smokeless steam coal for 12 months ending March 31, 1903. Tenders by Feb 12. Details in our advertisement columns.

Middleton (Lancs.).—The Corporation invite tenders for the electric wiring and fitting of their free library, Long-street, and technical school, Suffield-street. Specification, etc., may be obtained from Mr. Entwistle, town clerk, Middleton. Tenders by Feb. 1.

Glasgow.—The Corporation invite tenders for the supply, delivery, and erection complete of materials for switchboard extensions. Tenders by Feb. 21. Details in our advertisement columns.

Rochdale.—The Corporation invite tenders for the supply, delivery, and erection of all the additional panels, instruments, and switchgear, and connections for the extensions to the lighting switchboard. Tenders by Feb. 2. Details in our advertisement columns.

Shipley.—The Urban District Council invite tenders for the supply, delivery, and erection, at their electricity works, of traction switchboard, boosters and balancers, and alterations to existing switchboard. Tenders by Feb. 10. Details in our advertisement columns.

Redruth.—The Urban District Council invite tenders for lighting the town of Redruth, in accordance with specifications and conditions which can be seen at the office of Mr. Henry Paige, clerk, or at the office of the Surveyor, Station-hill, Redruth. Tenders by noon on Feb. 10.

West Ham.—The Council invite tenders for the supply of engine-room stores, cable, boxes, jointing materials, etc., recording watt-meters, double-pole house cut-out boxes, transformers, and incandescent lamps. Tenders by Feb. 11. Details in our advertisement columns.

Fulham.—The Guardians invite tenders for the supply, delivery, and erection on their premises of two 50-kw. steam dynamos and boosters, four dry-back marine boilers, storage battery, and wiring for about 2,000 lights. Tenders by Feb. 25. Details in our advertisement columns.

Huddersfield.—The Corporation invite tenders for the construction of new tramways and the reconstruction of existing tramways. Specifications, etc., may be obtained on application at the offices of Mr. K. F. Campbell, M.I.C.E., borough engineer and surveyor, 1, Peel-street. Tenders by Feb. 3.

Madrid.—The Department of Agriculture invite tenders for the construction of an electric tramway from Linares to the mines of San Roque and Torilla, in the Province of Jaen. Tenders by Feb. 24. This is the extension of the tender advertised for Nov. 17, but the conditions have been modified.

Croydon.—The Town Council invite tenders for the supply of 10 double-deck double-truck cars, equipped complete with motors, etc., for overhead trolley system. Specifications, etc., can be obtained on application to Mr. E. Mawdesley, town clerk, Town Hall, Croydon. Tenders by Feb. 17.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Stuart-street generating station and sub-stations of surface condensers, oil separators, and hot-well, cooling towers, and feed-water heaters. Tenders by Feb. 13. Details in our advertisement columns.

Aberdeen.—The Tramway Committee invite tenders for the electrical equipment of three of their horse-car routes, comprising overhead equipment and bonding (poles and bonds supplied by Corporation), and supply and laying of cables. Tenders by Feb. 15. Details in our advertisement columns.

General Post Office.—Tenders are invited for the purchase of about 25 tons of guttapercha, 60 tons of copper, 50 tons of lead, a quantity of other metals (brass, zinc, and iron), indiarubber-covered wire, limed hide pieces, electric glow lamp tops, tarpaulin, felt, jute serving, cabinet work, etc. Tenders by Feb. 12.

Newcastle-on-Tyne.—The Corporation invite tenders for the laying down of about 1½ miles of single-line tramway and passing places, the rails, fastenings, points and crossings being supplied by the Corporation. Specifications, etc., can be obtained from the City Engineer, Town Hall, Newcastle. Tenders by Feb. 12.

London, S.W.—The London County Council invite tenders for two lots of 50 double-decked double-bogie electric tramcars, equipped with a plough for working on a conduit system, and to be capable of seating about 68 persons. Specification and other particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by March 4.

Sunderland.—The Corporation invite tenders for the supply of 10 double and 4 single deck car bodies and trucks, equipped with all electrical fittings for overhead trolley system, gauge 4ft. 8½in. Specification, etc., can be obtained on application to the borough electrical engineer, Mr. John F. C. Snell, A.M.I.C.E., Town Hall, Sunderland. Tenders by Feb. 6.

Wolverhampton.—The Tramways Committee invite tenders for the supply of the necessary materials and labour for the construction of tramway track and contingent works in the Dudley-road, from Snow-hill to the borough boundry. The length of the route is about 1½ mile, consisting of partly double and partly single track. Specifications, etc., can be obtained from the Borough Engineer's Office, Town Hall, Wolverhampton. Tenders by Feb. 4.

Walsall.—The Corporation invite tenders for the following works in connection with the construction of the permanent way and overhead equipment of about six miles of single track and 1½ miles of double track of tramways on the overhead trolley wire system. Specification, etc., may be obtained from the office of Mr. Richard Henry Middleton, borough surveyor, Walsall, and of Mr. Alexander Wyllie, borough electrical engineer, Electricity Works, Wolverhampton-street, Walsall. Tenders by Feb. 21.

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RESULTS OF TENDERS.

Buxton.—The Urban District Council have accepted a contract for cables from the Callender Cable, etc., Company.

Walsall.—The Town Council have accepted the tender of T. Parker and Co., at £1,236, for armatures, etc.

Hull.—The Electric Lighting Committee have accepted the tender of Mr. Greenwood for the erection of the new power station, at £8,184.

Stepney.—The Borough Council have accepted the tender of the New Century Arc Light Company, Limited, for supplying and erecting 20 arc lamps and columns, at £525.

Southend.—The Town Council have accepted the tender of H. Warner to provide and fix telephonic communication between the existing fever hospital and the small-pox hospital (now in course of erection) for £13. 5s., including all labour and materials, and the supplying and fixing two poles and insulators.

Woolwich.—The Borough Council have received the following tenders for the supply of electrical instruments in the electricity department, Plumstead: Siemens Bros. and Co., Limited, 12, Queen Anne's-gate, Westminster, S.W., £731. 10s.; Elliott Bros., Century Works, Lewisham, £620. 5s.; Kelvin and James White, Limited, 66, Victoria-street, S.W., and Cambridge-street, Glasgow, £612. 16s.; Everett, Edgecumbe, and Co., Limited, Charterhouse-square, E.C., £526. 12s. 6d. (accepted); International Electric Company, Limited, Limited, 55, Red Cross-street, Barbican, E.C., £138. 7s. (offer incomplete); Gambrell Bros., 17, Giltspur-street, E.C., £86. 1s. (offer incomplete).

Willesden.—The Guardians have received the following tenders for the electric light and power installation at the new infirmary, Acton-lane, to the specification of Mr. Morgan Williams, M.I.C.E.:

Section A.—Boiler-house plant.

Tinkers, Limited	£4,822	0	0
Danks and Co.	4,088	10	0
Lowcock and Co.*	292	0	0
Davey, Paxman, and Co.	3,873	10	0
Crompton and Co. (accepted)	3,571	0	0
Johnson and Phillips	3,795	0	0
Alley and Maclellan	5,106	0	0

Section B.—Engine and battery room plant.

Davey, Paxman, and Co.	2,815	10	0
Ditto	3,025	5	0
Ditto	3,135	10	0
Holmes and Co.	3,073	0	0
Ditto	3,293	0	0
Ditto	3,048	0	0
Ditto	3,118	0	0
Electrical Construction Company	3,097	0	0
Brush Electrical Company	2,852	0	0
Siemens Bros.	2,800	0	0
Ditto	2,640	0	0
Ditto	2,630	0	0
Mather and Platt	2,946	0	0
Ditto	2,926	0	0
Ditto	3,016	0	0
Geipel and Lange	2,816	14	0
Ditto	2,866	14	0
Crompton and Co. (accepted)	2,882	0	0
Johnson and Phillips	2,780	0	0
Alley and Maclellan	3,015	0	0
Bruce Peebles and Co	2,981	0	0
Ditto	2,899	0	0
Newton Electrical Works, Limited	2,675	0	0
Mavor and Coulson	2,864	17	0
Ditto	2,953	7	0
Ditto	2,981	17	0
Ditto	3,031	1	0

Section C.—Wiring and mains.

Belshaw and Co.	2,143	6	8
Troy and Co	2,861	0	0
Geipel and Lange*	1,802	0	0
National Electric Wiring Company	2,258	10	0
Crompton and Co. (accepted)	1,612	0	0
Johnson and Phillips	1,559	16	8
Spagnoletti and Co	1,988	14	0
Alley and Maclellan	2,115	0	0
H. M. Leaf	2,114	16	8
Strode and Co.	2,675	16	0

Section D.—Crane, motors, fans.

Carrick and Ritchie*	86	0	0
J. Carrick and Sons	738	0	0
Ditto	630	0	0
Holmes and Co.	597	0	0
Electrical Construction Company	701	0	0
Brush Electrical Company	532	0	0
Siemens Bros.	633	0	0
Mather and Platt	651	0	0
Ditto	544	0	0
Geipel and Lange*	391	10	0
Crompton and Co. (accepted)	642	0	0
Johnson and Phillips	590	0	0
Ditto	540	0	0
Alley and Maclellan	1,540	0	0
Ditto	1,215	0	0
Spencer and Co.*	110	0	0
Bruce Peebles and Co	778	0	0
Newton Electrical Works*	275	0	0
Mavor and Coulson	565	10	0

* Tender for portion of a section only.

London County Council.—The tenders of the National Electric Wiring Company, Limited, to execute the wiring and to supply the fittings for electric light installations at the Perry Vale fire station and the Homerton sub-station for £129. 6s. and £95. 15s. respectively, have been accepted.

London County Council.—The following tenders have been received for wiring, etc., of the reformatory at Farnfield for female inebriates:

Anti-Vibrator, Limited (accepted)	£450	0	0
A. H. Marshall and Co.	516	0	0
Buchanan and Curwen	562	10	4
J. G. Statter and Co.	575	0	0
Jackson Bros.	679	16	8
G. T. Newling	725	0	0
W. Simmons	751	0	0
G. Weston and Co.	795	0	0
J. Barker and Co., Limited	825	0	0
T. H. Duncan	831	12	0
T. S. Marriage and Co.	866	10	6
Tamplin and Makovski, Limited	880	0	0
Barlow Bros. and Co.	890	0	0
C. Peacock and Co.	965	0	0
C. W. Grifkins and Co.	1,174	0	0
T. H. J. Dennis and Sons	1,217	0	0
Simmonds Bros., Limited	1.384	0	0

BUSINESS NOTES.

TRACTION.

Norwich.—The Town Council have approved the tramway by-laws for confirmation by the Board of Trade.

Ealing.—The Town Council have decided to dissent from the terms of the Middlesex County Council Tramways Bill.

Rotherham.—A Corporation deputation visited Hull on Saturday for the purpose of inspecting the tramway system.

Darlington.—The tramways have been formally taken over by the Corporation from the Imperial Tramways Company.

Horndean Light Railway.—A start has been made in the laying of the new light railway from Cosham to Horndean.

Wigan.—The electrical engineer has been authorised to obtain tenders for four tons of trolley wire and one mile of ·2 cables.

Notts.—The County Council have appointed a committee with powers to deal with the various light railway orders affecting the county.

Bath.—The promoters of the proposed electric tramways have obtained the consent of the Town Council to certain variations in the routes to be followed.

Sydenham.—It is reported that a single-rail electric railway is to be constructed in the grounds of the Crystal Palace, something after the principle of the monorail.

Salford.—A special meeting of the Town Council has approved the promotion of a Bill in Parliament for various purposes relating to tramways and other matters.

Bingley.—Consideration by the District Council of the scheme for a line of tramways from Shipley to Keighley passing through this place has been postponed for a time.

Cardiff.—The Tramways Committee of the Corporation are still considering the question of the provision of workmen's cars when the new electrical system is inaugurated.

Appointment.—Mr. H. Howard, of Leicester, has been appointed chief assistant distributing engineer to the Manchester Corporation electric lighting and tramways department.

Holborn.—At their last fortnightly meeting the Borough Council refused their consent to the London County Council's proposal for an electric tramway along Tottenham Court road.

Hull.—It has been referred to the Tramways Sub-Committee to enquire into the memorial of the Savile-street tradesmen, who object to the proposed tramway in that thoroughfare.

British Electric Traction Co.—The directors of this Company have decided to pay the dividend on £1,000,000 6 per cent. cumulative preference shares for the half-year to 15th prox.

Aberdeen.—It was agreed at a meeting of the Tramways Committee on Tuesday to equip the Rosemount section of the tramways for electric traction. The cost of the conversion will be over £12,000.

Manchester Tube Scheme Abandoned.—The examiners of Standing Orders in the House of Commons have been informed that the Manchester City Circle Railway Bill will not be proceeded with this session.

Loughborough.—It is proposed to transfer the electrical powers of the Corporation to the Loughborough and District Light Railway Syndicate, and to this end a small committee has been appointed to arrange terms.

Keighley.—Mr. R. C. Quin has recommended the Corporation to apply, in conjunction with the other municipal authorities affected, for an order authorising the construction of a light railway between Shipley and Keighley.

Brighton.—Two more tram routes of the Corporation service have been opened this week. Another route yet remains to be opened. This last will run to the edge of the racecourse, and will thus make access to the breezy Downs quite easy.

Dunedin (New Zealand).—We learn that the Corporation are seriously considering the advisability of constructing the proposed

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electric tramways in the city themselves in preference to the work being undertaken by a company.

Lye.—The construction of the electric tramway at this place is being vigorously pushed on. The line should be completed in six months, and will cover a distance of two miles of the old coach road from Stourbridge to Birmingham.

Dundee.—Should matters have reached a sufficiently advanced stage in regard to the proposed tramway from Dundee to Broughty Ferry and Monifieth, the promoters intend to apply to Parliament for the necessary powers in the spring.

Levenshulme.—The negotiations between the Urban District Council and the Manchester Corporation with reference to electric tramways have so far progressed that it is proposed to apply at once for a loan of £8,000 on this account.

Walthamstow.—An enquiry was opened at this place yesterday into an application by the Metropolitan Tramways and Omnibus Company for an order authorising them to construct a line of electric tramways from the Green-lanes, Harringay.

Ripley.—In regard to the light railway schemes for the district, the Urban District Council have decided to support the Erewash Valley scheme and also approve the Mansfield scheme, subject to the promoters accepting the terms of the Council.

Peckham.—Official notice has been given of the withdrawal of the deposited Bill under which powers were sought to construct a "tube" railway nearly 10 miles in length from Peckham Rye Common to Gracechurch-street, and from thence to West Ham and Plaistow.

Paris Metropolitan Railway.—A fire occurred on the electric underground railway in Paris on the night of the 22nd inst. due to a short-circuit. The flames, however, were soon subdued, and the only damage done was the burning of part of the floor of one of the carriages.

Oldbury.—The District Council have passed a resolution consenting to the Birmingham and Midland Tramway Company's Bill for tramway extensions, except the line along Hales Owen-street, which will be opposed unless the tramway company agree to widen the street at their own expense.

Slough.—At a special meeting of the Urban District Council this week it was resolved to oppose the scheme of the Hounslow, Slough, and Datchet light railway so far as it applies to the area in their district, and that a public meeting of the ratepayers be called to endorse their action.

Maidenhead.—At a special meeting of the Town Council on Thursday week it was decided to apply for an order authorising the Council to construct a light railway in the borough. It was further agreed to oppose the scheme of the Metropolitan District Electric Traction Company as it affects this place.

East Ham.—Negotiations are proceeding between the Council and the West Ham Council as to whether the former shall take over and work the tramways proposed to be constructed by the West Ham Council from Green-street to Romford-road, and from Green-street along Barking-road to the Greengate Tavern.

Fulham.—The question of the introduction of electric tramways in the borough by the London County Council was the subject of an exciting discussion at the last meeting of the Council. Eventually an amendment to refer back the recommendation of the committee in favour of the scheme was rejected by 15 to 17.

Shoreham.—The Urban District Council have decided to support the scheme to run trams through the district conditional on the company complying with certain terms. It is understood that the company have agreed to the more vital of these terms, and it is believed that their assent to the whole will follow in due course.

Skene.—It is reported that a movement is on foot to form a company for making a light railway in this district, and it is believed that certain gentlemen are prepared to offer substantial support. The Great North of Scotland Railway Company some years ago got a provisional order to make such a railway, but the scheme fell through.

Blackpool-Garstang Light Railway.—We hear that the preliminaries in connection with this scheme are being pushed forward as rapidly as possible, and before long some definite announcement will be made as to the letting of the contracts and the commencement of the work. The rumour that the scheme has been abandoned is not correct.

Sunderland.—The Rural District Council have decided to oppose the application of the United Kingdom Tramway Syndicate for an extension of time in the commencement of the tramway to Houghton unless the syndicate agree to certain terms. The net profit from the Corporation tramways for the six months ending September last was over £8,000.

Gorton.—The District Council have received a communication from the Manchester Corporation Tramways Committee stating that the Corporation would be in a position to work the tram services within the Gorton district electrically by May 31 next, and asking that no effort be spared on the part of the Council to get the conversion completed as quickly as possible.

Christchurch (New Zealand).—The Christchurch City Council are considering how they may utilise the heat of the new city dust destructor for generating steam power to supply the city with light and power, and a special committee has been instructed to enquire into the cost of a 1,000-h.p. electrical power plant for traction and lighting in connection with the central yard.

Liverpool Overhead Railway Co.—Out of an available balance of £12,192 for the past half-year, the directors have resolved, after setting aside £3,000 to meet contingencies in connection with the accident at Dingle Station, to recommend payment of a dividend at the rate of 5 per cent. per annum on the preference shares and 1 per cent. per annum on the ordinary shares—balance carried forward £3,692.

Bute.—The Buteshire County Council have formally approved the action of the Bute District Committee in opposing the new provisional order for the extension of the electric tramway system from Port-Bannatyne to Ettrick Bay. It was stated, however, that they had drawn up a draft agreement and submitted it to the company, and if the latter agreed to the conditions therein the opposition would be withdrawn.

Isle of Man.—It is reported that Mr. Shenk, the chairman of the Crystal Palace Company, has bought the electric sections of the Isle of Man Tramways and Electric Power Company's lines. The company has been in liquidation, and by the present sale and a previous sale of the lines within the borough of Douglas to the Corporation, the liquidator has obtained £73,500 more than was first offered at public auction for the assets of the company.

Kirkcaldy.—The tramway scheme is being very energetically carried forward. Arrangements are now being made for a start to the laying of the rails in Links-street, and the hope is entertained that the cars will be running between Linktown and Gallatown by the end of the present year. The generating station is to be pushed forward with all possible speed. The station will be sufficiently large for the extension of the scheme to Dysart.

Newcastle.—The total mileage run by the electric cars last week was 23,553, and the total receipts £1,398, with an average of 14·25d. per car mile, being the highest amount since the opening of the electric tram system in the city. It is expected that Colonel Von Donop will visit the town on the 4th prox. and inspect the new lines in Westgate-road, Elswick-road, Shieldfield district, as far as the Red Barns, and Westmorland-road, as far as it is completed.

Rochford.—With reference to the Southend-to-Colchester light railway scheme, the Rural District Council suggest that if the proposed railway be proceeded with, the roads over which it passed should be made at least 40ft. wide, that the rails be laid on one side of the road, and that the electric current be carried underground and not by overhead wires. The Council have agreed to enter formal opposition to the scheme in order to put forward their views.

Abandoned "Tubes."—It has been officially notified that the promoters do not intend to proceed further with the Brompton and Piccadilly-circus Railway Bill, and the Central London Railway (No. 1) Bill, two of the measures which were suspended from the session of 1901. The latter proposed the construction of a loop at the City end, and may be regarded as superseded by the very much larger proposal the company now has before Parliament.

Liverpool.—As the result of the working of the electric tramways and the electric lighting undertaking of the Corporation, it has been found that for the year 1901 there are net profits amounting in the case of the tramway system to £52,000, and in that of the lighting system to £24,000. The respective committees have decided to devote £25,000 to the relief of local rates, the result of which will be a reduction in the rating of the city of 2½d. in the pound.

Private Bills.—Among the Bills which have been reported for first reading in the House of Commons are the Great Northern and Strand Railway Bill and the London County Council Subways and Tramways Bill. In the case of the City, Wandsworth, and Wimbledon Electric Railway Bill and the Victoria, Kennington, and Greenwich Railway Bill the parties have made no appearance, and it is presumed that the measures are not to be further proceeded with this session.

Wolverhampton.—It is nearly a fortnight since Colonel Yorke, on behalf of the Board of Trade, made an inspection of the completed section of the new Corporation tramline in Cleveland and Bilston roads, on which the Lorain system of traction is to be tested, and considerable surprise is being shown in the borough owing to the certificate to allow the cars to run not having been received. When the certificate reaches Wolverhampton, the system will undergo a 30 days' test.

Alfreton.—The promoters of the Mansfield extension scheme of light railways, who are proposing to run a line through Alfreton and district, have made an important concession to the Alfreton Urban District Council. They have now definitely agreed not only to extend their line from Alfreton to Pye Bridge, but also to run a branch from Swanwick to Somercotes, through Leabrooks. Upon this understanding the Urban District Council will continue to support the Mansfield extension scheme.

Naples.—A few days ago the new electric tram service commenced from the centre of Naples (Piazza Spirito-Santo) to the Capo di Posilipo. The last tramcar drawn by horses was going up the hill at Posilipo when, says the *Daily News* correspondent, half-way between Mergellina and Capo di Posilipo, an electric tram, which was descending, on turning a corner came into collision with it, there being only one line, except at certain points. The three horses were killed, but except for a few bruises the passengers escaped uninjured.

Vienna.—Horse cars have made their final disappearance from the streets of Vienna in favour of electric traction. According to a Vienna correspondent the event was observed with much pomp and ceremony. It was, in fact, very like a funeral procession. The last horse-drawn car paraded the streets of the city on Tuesday night, driven by the oldest driver in the company's service, and accompanied by a band of music. In the words of the correspondent, "the horses bore wreaths of flowers, and crowds of people cheered the last of a dying race."

Portsmouth.—We learn that Mr. E. Rotter, A.M.I.C.E., has resigned his appointment as general manager of the Portsmouth Corporation tramways, resuming his former position as engineer, in order that he may engage in private practice. Mr. Rotter has been retained by the Provincial Tramways Company as consulting electrical engineer for the Portsdown and Horndean light railways, and will, we understand, be appointed consulting engineer to the Portsmouth Corporation tramways on the completion of their conversion to electric traction.

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Steyning West.—The Council had brought before them at their last meeting the schemes of the Brighton, Worthing, and District Tramways Company to promote a tramway between Brighton and Worthing. The company asked the Council to give their permission for the trams to run through Kingston-by-Sea, but, after a lengthy consideration of the matter, it was decided that it should be deferred for a year, the Council having reason to believe that Hove would initiate a scheme to run trams between Hove and Shoreham in the meantime.

Barnet Light Railway.—The Earl of Jersey and Colonel G. F. O. Boughey, sitting as Light Railway Commissioners, have held a public enquiry as to the expediency of granting the Hertford County Council an order for the construction of what is described as the County of Hertford (Barnet) No. 2 Light Railway. At the conclusion of the enquiry the chairman intimated that they would recommend the order being granted subject to the alteration suggested respecting the minimum fare so as to cover the distance from the station to Barnet Church.

Bournemouth.—The work of erecting the electrical generating station in Southcote-road, in connection with the proposed electric tramways through the borough, is going on vigorously, and the buildings are now ground high. This week several gangs of workmen in the employ of Messrs. White and Co., of London, the contractors for the construction of the permanent way, have been digging trial holes in the roads through which the tramways are to pass with a view of locating the gas, water, and electric light mains. The laying of the permanent way will shortly be taken in hand.

Bushey.—A week or two ago the Rural Parish Council agreed to support the scheme of the Watford and District Light Railway Company in preference to that of the Middlesex County Council. They have now adopted this resolution: "That this Council, having heard the assurance of Mr. Longmore that the County Council will make a light railway through Bushey, and considering the fact that they undertake to widen the roads and alter the gradient of Clay-hill as required by the Parish Council, heartily approves of the County Council scheme, and is opposed to that of the company."

Enfield.—A public enquiry was held here on Wednesday by the Earl of Jersey and Colonel Boughey, C.S.I., into the application by the Middlesex County Council for an order sanctioning the construction of an extension of the tramway service into Enfield Town. The scheme was supported by the Enfield, Edmonton, and Southgate District Councils, being in effect a continuation of the electric trams already sanctioned between Wood Green and Winchmore Hill. After hearing evidence, the Commissioners intimated that they would recommend the Board of Trade to grant the order. They would, however, restrict the taking of property to widen roads to 50ft.

Shipley.—The transfer of the lease of the Shipley tramways, now held by the Bradford Tramways and Omnibus Company, to the Bradford Corporation for the unexpired term was agreed to at the last meeting of the Town Council, and the deed of assignment sealed. It was explained that the Council were pushing forward with the preparations for the adaptation of the lines to electric haulage. An assurance had been desired from the Corporation that as soon as the lines on the Shipley section were ready they would be worked through to Saltaire by electricity, and rental be paid as fixed by the new lease. On this understanding the Council had granted the assignment.

Lancaster.—At Wednesday's meeting of the Town Council it was reported that as much speed as possible was being applied to the preparation of the tramways. Further tenders for platelaying were passed, and it was decided to purchase cars in addition to those already ordered, so as to have a more constant service. In reference to the proposed purchase of the undertaking of the Lancaster and District Tramway Company, whose line runs between Lancaster and Morecambe, it was reported that the negotiations were still in the hands of the special committed. The surveyor and tramways engineer were instructed to report as to the advisability of making a bridge over the Lune for the purpose of the tramway.

Bradford.—The East Ward Liberal Club has passed a resolution declaring that no scheme of tramway extension would meet the needs of the inhabitants of the East Ward and of portions of North and South Wards which did not provide for a broad and direct approach from the centre of the city, and that such could only be made by the Church Bank route. On Saturday next electric cars will be run for the first time on the Sunbridge-road and Manchester-road sections of the city tramways, and on that day also the running powers of the two tramway companies in the city will terminate, and all the tramlines will pass into the hands of the Corporation. On those lines not yet equipped for electric traction steam cars will be continued, but no time will be lost in making the conversion throughout the city complete.

Burnley.—The Parliamentary Sub-Committee of the Corporation at their last meeting received representatives of the promoters of the Rossendale Valley Tramways Bill and the Accrington and Burnley light railways order. After a lengthy interview, the deputations were informed that the sub-committee favourably regarded both projects, but they preferred that the Burnley Corporation should construct the necessary length of line in each case, within the Burnley borough boundaries, rather than have the roads taken up by the companies promoting the two projects. Major Druitt, of the Board of Trade, has inspected those portions of the Corporation electric tramways from Cheapside to Padiham and from Burnley to the tram depôt in Colne-road. Immediately after the inspection the cars were allowed to run for the convenience of the public, the first ones leaving for Padiham and Burnley-lane.

Motorcar Legislation.—A deputation from the County Councils' Association was appointed to wait upon Mr. Walter Long at the Local Government Board yesterday with reference to a resolution on light locomotives, unanimously adopted by their Executive Council. The resolution is as follows: "(1) That the general law of the land for all vehicles, as extended by the special regulations issued requiring the drivers of motorcars to stop on the request of any police constable or of any person having charge of a restive horse, if scrupulously observed and rigorously enforced, is at present sufficient to secure the public safety provided that each motorcar has affixed to it some number so as to afford an easy and complete means of identification; (2) that it is desirable that the statutory limit of speed be abolished; and (3) that the present penalty clauses of the Highways Act are insufficient as applied to motorcars."

The London-to-Brighton Electric.—Lord Cottesloe, presiding over the meeting of the London, Brighton, and South-Coast Railway Company on Wednesday, referred to the scheme for an electric railway from London to Brighton. He characterised the proposal as of an extraordinary nature, and he could hardly suppose that it could receive parliamentary sanction. The total length of tunnels would be between 19 and 20 miles, and in the parliamentary estimate the promoters put the cost of the line at £7,300,000, but he thought it would cost £10,000,000. He could assure shareholders that every step would be taken to protect their interests. Replying to criticisms, he said the Board had given an earnest that they were seriously considering the electric railway project by the fact that they proposed to add to the Board Major Cardew. The question would continue to have the serious attention of the directors.

Paris.—The Paris correspondent of the *Financial Times* sends further information of the strong desire existing amongst a number of French financiers interested in electric traction to bring about a gigantic combine of all the public traction companies in Paris. The basis of the scheme would be a working arrangement between the Thomson-Houston Electric Company, the Paris Metropolitan, and the Paris General Omnibus Company, and the chief object would be to so arrange matters as to prevent undue competition between the various lines. So far, however, the scheme has made very little progress owing to the numerous difficulties in the way, not the least of which is the strenuous opposition the Municipal Council is expected to offer to any combination partaking of the nature of a trust. The leading spirits of the Metropolitan and Thomson-Houston, however, appear quite content to bide their time, being perfectly convinced that a combination of the nature projected is inevitable within a very few years.

Spen Valley Light Railway.—This railway, the contract for the construction of which has has been let to Messrs. Dick, Kerr, and Co., is promoted by the British Electric Traction Company, and will run through the heavy woollen district. The line commences at Cleckheaton, and after passing over a small portion of the township of Gomersal, runs through Liversedge and Heckmondwike, where the ascent of Shaver-hill is made, till Staincliffe, an outlying part of Batley, is traversed, entry being made into Dewsbury at Batley Carr Top. Descending Halifax-road, the course runs into Dewbury Market-place (where three lines of rails are to be laid down), and then through Westtown to Ravensthorpe, the terminus. Under this scheme Thornhill Lees and Savile Town are served, and Dewsbury reached by Savile-road and Church-street. Dewsbury, it will be seen, is the centre of the system, and additional importance lies in the fact that the new line in Halifax-road foot will be close to that of the Dewsbury, Batley, and Birstall Tramway (at present worked by steam), that a tramway is being projected to run through Wakefield (from Castleford) and Ossett to Dewsbury Market-place.

Suburban Railway Traffic.—Lord Claud Hamilton, speaking at the general meeting of the Great Eastern Railway Company on Tuesday, said that with regard to the question of granting greater facilities for dealing with the suburban traffic of the line, he had mentioned to the shareholders that the Board inclined towards "tube" lines under the existing railway, but he expressed the hope at the last meeting that the Government would suspend the construction of tube lines for a certain period, and that course was adopted. During the period of suspension the Board had devoted their time to considering that very important question in all its branches, and in doing so they had not lost sight of the new conditions which had to be faced by all railway companies. They had to look the facts straight in the face, acknowledge that such conditions had come to stay, and act accordingly. In the first place, they had the increased obligations placed on them by the Board of Trade acting under parliamentary pressure, and then they had the shorter hours, higher wages, increased assessment, and higher rates. There had been attempts on the part of the London County Council and other elected bodies to force the railway to carry a certain class of passengers at unremunerative rates at inconvenient hours, and on the top of all that they had to face the construction of tramways and light railways out of the rates, which were run for the purpose of competing with the railways.

Middlesex Tramways.—Several letters were received from local authorities protesting against the action of the Middlesex County Council with reference to the London United Tramways Company at the last meeting of that body. A memorandum by the chairman of the Council (Mr. Littler, K.C.) was circulated, in which he traced the history of the tramway question in Middlesex from 1888, and sought to show that the Council's agreements with the tramway companies were a very good bargain for the ratepayers of Middlesex. He says the London United Company obtained parliamentary powers in 1889, which made their position in the county almost impregnable. The Council opposed various Bills promoted by the company, but they only obtained a limited *locus standi*, and the company had the support of the local authorities. It was only after great trouble that he was able to get the company to negotiate with the Council. The result of those negotiations was, he contended, favourable to the county. He also refers to the agreement with the Metropolitan Tramways and Omnibus Company to work the northern lines, observing that the arrangement made would give the Council a sum equal to several thousands a year without any outlay on their part. His conclusions are that the arrangement with the United Company was a statesman-

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like act of self-preservation, and that the arrangement whereby the Council has acquired control of the North Metropolitan Company in the county and is saved the raising of a large sum of money is equally prudent.

Birmingham.—The report of the Public Works Committee of the City Council contains a note upon the Birmingham and Midland Tramways Bill, under which it is proposed to authorise the construction of certain tramways in the parishes of Handsworth, Smethwick, Oldbury, and Rowley Regis. So far as the districts immediately adjoining the city are concerned, a line is proposed commencing at the terminus of the existing unused tramway in Heath-street, at the city boundary, and passing along Cranford-street and over the bridge at Soho Station. It then branches to the left along Rolfe-street, joining the existing Birmingham and Midland tramway near the Smethwick Town Hall, and to the right along Rabone-lane, joining the South Staffordshire tramway in Holyhead-road, a few yards beyond the terminus of the cable tramway at the New Inns. Another line is proposed, commencing opposite the King's Head Inn, in the Hagley-road, and passing along Bearwood-road to join the existing tramway opposite Victoria Park, Smethwick, with a branch along Waterloo-road, joining the existing tramway at Windmill-lane, Cape Hill. No new lines are proposed within the city, but the Bill contains powers to enable the company, with the consent of the local or road authority, to lay down double lines, etc., and to make, maintain, and alter such crossings, passing places, junctions, and other works on any of the existing tramways as they find necessary or convenient for the efficient working of any of the tramways. Also, with the consent of the local authority and of the owners or lessees of any other tramways, to form junctions between the proposed or existing tramways, etc. At present the Corporation are the promoters of the existing tramways within the city, and no alteration of or junction with such tramways can be effected without their consent, and their power to give or withhold such consent is absolnte. The committee are strongly of opinion that the existing rights of the Corporation over the tramways within the city should be maintained, and they therefore recommend that the Bill should again be referred to them, with power to take all such measures they may deem necessary or advisable for the protection of the Corporation.

LIGHTING AND GENERAL.

Macclesfield.—The Corporation have appointed a committee to formulate a scheme for electricity supply.

Coventry.—The Coventry City Council propose to oppose the Leicestershire and Warwickshire Electric Power Bill.

Bath.—The report of Mr. Manville upon the electric light works will probably be received at the next meeting of the Town Council.

Hull Telephones.—The Corporation will petition against and oppose the National Telephone Company's Bill in both Houses of Parliament.

Blackpool.—Colonel A. C. Smith has held an enquiry into the Town Council's application for sanction to borrow £1,655 for electric lighting purposes.

Driffield.—The National Telephone Company's system will be in working order in a few days. There are over 30 subscribers, including a number of guarantors.

Haslingden.—A letter from the Lancashire Electric Power Company relative to the supply of electricity in bulk, is before the Electricity Committee of the Town Council.

Westminster Electric Supply Co.—Subject to final audit, the directors recommend a dividend for the half-year ended Dec. 31 last at the rate of 11 per cent. per annum, less income tax.

Sale of Plant.—The Glasgow Corporation are prepared to receive offers for the purchase of 15 Willans engines, with dynamos, of various sizes. Full particulars appear in our advertisement columns.

Stroud. — The Urban District Council after discussing the Gloucestershire Electric Power Bill last week, put on record that they were not willing to reject the Bill, but only desired to obtain certain amendments.

Durham.—Applications have been made for power to break up roadways for the purpose of introducing the electric light at Blaydon, Leadgate, Stanley, and Tanfield, and in the Chester and Stockton rural districts.

Farnham.—The Urban District Council have asked Sir William Preece and Major Cardew to recommend other firms who would undertake the electric lighting scheme on terms similar to or better than those already suggested by them.

Sale of Order.—The Town Council of Hamilton invite offers from electric light and power companies or others to take a lease of and work the Hamilton electric lighting provisional order. Particulars appear in our advertisement columns.

Mickleham.—The Parish Council of Mickleham are in favour of the scheme of the Leatherhead and District Electricity Supply Company as applied to Mickleham, on the understanding that the lines are laid underground and throughout the parish.

Stock Exchange.—The Stock Exchange Committee have appointed Feb. 5 special settling day for Perth Electric Tramways, Limited (W.A.), £150,000 5 per cent. first mortgage debenture stock, and the said securities to be quoted in the official list.

West Bromwich.—Application is to be made for sanction to borrow £8,500 to carry out the sanctioned extensions at the electricity works which the tramway demand has necessitated. The tenders for this work will be placed before the Council at their next meeting.

Nuneaton.—The District Council have decided to apply for sanction to the borrowing of £5,000 for works in connection with the electric light undertaking, comprising a boiler and fittings, the extension of cables, street lighting, and the repayment of the amount overspent on the previous loans.

Ormskirk.—A deputation of the Urban District Council recently visited the Southport Corporation's electricity works and ascertained that the Corporation were prepared to supply electricity in bulk. The Council have now officially asked the Southport Corporation when and upon what terms they would be prepared to supply electricity to the town.

London Gazette.—A receiving order has been made in the estate of G. W. Clarke, Lyndhurst, Harold Wood, Essex, and 117, Queen Victoria-street, E.C., on creditors' petition. The first meeting in the estate of the above will take place on Feb. 3 at 12 noon at Bankruptcy-buildings, Carey-street, W.C., and the public examination on March 5 at 10.30 a.m. at the same place.

Wireless Telegraphy.—King Victor Emmanuel has conferred the Order of St. Maurice and St. Lazarus on Signor Marconi. Presiding over a meeting of the Eastern Telegraph Company, Sir J. Wolfe Barry told the shareholders that he had the authority of Prof. Oliver Lodge and Sir William Preece for assuring them that wireless messages as at present transmitted could not enter into serious competition with the submarine cables.

Wimbledon.—Mr. F. H. Tulloch has held an enquiry into the application of the Urban District Council for sanction to borrow £18,500 for purposes of electric lighting. This sum includes £14,500 already expended as excess over loans. The other £4,000 is required to meet present and future extensions, and includes mains and general stores, £2,850; meters, £300; wiring new buildings, £350; the remainder being for boiler foundations, platform, gangways, coal shoots, cables, office furniture, and contingencies.

Pumps.—Messrs. P. S. King and Son, Great Smith-street, Westminster, have just published a beautifully illustrated reprint of articles on "Pumps: Their Construction and Management," which have appeared in the *Engineering Times*, by Philip R. Björling, the author of "Pumps and Pump Motors." There are 91 illustrations in the work, which describes the various pumps ordinarily in use, and gives practical hints for their construction, giving those points which have to be attended to, and drawing attention to those which must be guarded against when designing pumps.

Catalogue.—Messrs. Ludw. Loewe and Co., Limited, 30-32 (opposite 109), Farringdon-road, London, E.C., have just published a beautifully executed catalogue illustrating and describing the machines made by the Bullard Manchine Tool Company, such as vertical mills, heavy turret machines, and special lathes, of which they are sole agents for Great Britain. We are informed that the firm will send readers copies of "A Treatise on Boring and Turning Mills," containing many illustrations, and describing different kinds of work most advantageously done on the vertical mill, in any number for firms' staffs and employés.

Halifax.—The council of the Halifax Chamber of Commerce are supporting the suggestions of the Edinburgh Chamber in reference to the laying of main-line telegraph wires underground, and express their willingness to join in the proposed deputation to the Postmaster-General on the subject. The United Committee of the Corporation, the Chamber of Commerce, and the Drapers' and Hosiers' Association having considered an offer from the National Telephone Company, do not recommend the Corporation to accept the terms offered by the company, but fully approve of the clause in the Corporation Bill, which is to confer powers to enable them to establish a municipal telephone.

Buxton.—The engineer (Mr. W. J. Leeming) in his last report states that since Dec. 2 240 8-c.p. lamps have been connected to the mains. The units sold in the quarter were 28,134, as compared with 20,773 in the corresponding quarter of 1900, which is an increase of 7,361. The cost of current for the last quarter was about 3·5d. per unit sold, exclusive of interest and sinking fund. The engineer suggests either a reduction of 10 per cent. for promptly-paid bills, or a general reduction of the price for the winter months in order to induce customers to use the current then, but this, he fears, would not give satisfaction to the large consumers, who use a quantity in summer and already get on to the lower rate in winter.

Liverpool's Progress.—The demand for lighting and power steadily increases annually at an almost uniform rate. The demand for lighting expressed as the equivalent in 16-c.p. lamps connected to the mains was on Jan. 1, 1901, 149,495 lamps, and on Jan. 1, 1902, 180,900 lamps. The demand for power expressed in horse-power of motors supplied was on Jan. 1, 1901, for 412 motors, 1,510 h.p., and on Jan. 1, 1902, for 587 motors, 2,083 h.p. The number of tramcars now in service was more than 380, as against 250 at the commencement of the year. The supply has grown from less than three million to over 20 million units during the past four years. The latest figures are—1901, lighting and power, 6,235,658 units; tramways, 13,782,508 units—total, 20,018,166 units.

Hammersmith.—Since the last Council meeting eight additional consumers have been connected, representing a maximum of 174 8-c.p. lamps; these added to the number previously reported, show a total of 1,049 consumers taking current from the mains. Extensions to Hythe-road *via* Brewster-gardens are to be made. The Council are supporting the Stepney Borough Council, who are in accord with the general principles of the London County Council (Electric Supply) Bill, but think that, if possible, a clause should be inserted therein enabling the highway authorities of the Metropolis to exercise a power of veto over the opening and reinstating of highways in connection with the laying of bulk supply mains and apparatus. It is suggested that the matter might be met by applying or incorporating the provisions of the Gasworks Clauses Act, 1847, with respect to breaking up streets for the purpose of laying pipes.

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Blackburn.—Another member of the staff at the Corporation electricity works (Mr. J. Bolton, switchboard attendant) has been selected by the Burnley Corporation to fill the position of shift engineer at their works at a salary of £120 per year.

Cable Rates to India.—It is announced that the cable rates to India are about to be reduced from 4s. to 2s. 6d. a word, with the prospect of a 2s. rate if the revenues justify expectation that a further reduction would not result in diminished receipts.

British Telegraphs in the Persian Gulf.—It is reported that Great Britain intends to obtain permission from the Porte to erect a telegraph line through Turkish territory from Koweyt to Fao in the Persian Gulf, where an English telegraph station already exists.

City of London.—We understand that the Court of Common Council propose to appeal against the judgment that the contract between the Corporation and the City of London Electric Lighting Company not affecting the central and western districts is valid.

Edinburgh.—The Secretary for Scotland has consented to the borrowing of a further sum of £90,000 for the execution of capital works under the Edinburgh Electric Lighting Order, 1901, raising the total sum authorised to be borrowed for such purpose to £790,000.

Falkirk.—Messrs. Burstall and Monkhouse have been engaged as consulting engineers for the Town Council's electric lighting scheme. The Electric Light Committee are taking steps to acquire as a site for electric light works about half an acre to the south-west of the burgh stables.

Tottenham.—At their last meeting the Tottenham Urban District Council, on a motion of Mr. Broadbank, decided to oppose the North Metropolitan Electrical Power Supply Bill for extending the limits of supply to Tottenham, Edmonton, Enfield, Wood Green, and Southgate.

Brierfield.—The Council have approved plans of the electric lighting scheme submitted by the surveyor, and will apply for sanction to borrow £10,110. The immediate expenditure will only be just under £3,000 (£2,942. 10s.), as it is intended to carry out the first section only at present.

Rochford.—The Guardians are dissatisfied with the price they are paying for gas—*i.e.*, 6s. 6d.—and have instructed the House Committee to take into consideration the question of having other means of lighting the house. It is thought that they will soon have power enough to work a dynamo.

Coal Mines.—The Hulton Colliery Company, near Westhoughton, are having electrical machinery put down in two new mines they are about to open near Atherton, Lancashire, and many leading firms in Lancashire propose, in addition to putting down electrical machinery in the pit brows, to introduce electrical coal-cutting machines.

Kent Electric Power Bill.—On Monday afternoon a meeting of representatives of many of the local governing authorities of Kent was held at the Westminster Palace Hotel, London, to consider the provisions of the above Bill. It was decided to oppose the Bill. A committee was appointed, and another meeting will be held on Feb. 3.

Liverpool.—The Liverpool Corporation Electric Power and Lighting Committee have decided that the price of electrical supply for lighting to any consumer in one establishment, after the end of the present quarter, be as follows: up to 3,000 units per quarter, 3½d.; beyond 3,000 units, 3d. per unit. The other prices charged for electrical energy will remain the same as now.

Antwerp.—The Antwerp Electricity Company have now installed three dynamos, two of 900 kw. and one of 400 kw. They are all connected with triple-expansion engines. Surface condensers are used. The Antwerp Ironworks have been secured as a customer, and the station has a guaranteed custom, enabling the company to work the plant constantly at its maximum capacity.

Kingston (Surrey).—Subject to the approval of the Council, the Lighting Committee have decided that two bracket incandescent electric lamps be affixed to each of the present arc lamp standards at an estimated cost of £200. The borough surveyor and borough electrical engineer have been instructed to prepare estimates and particulars for the provision of a new turbine and alternator and the extension of the engine-house.

Fulham.—The proposal to rescind a resolution by the late Vestry fixing the price of electric current purchased from the Council at 5d. per unit, and to adopt a report of the Establishment Committee recommending a graduated scale of charges for long-hour consumers, descending to 2d. per unit for all units consumed over and above an average of 24 units per 8-c.p. lamp per annum, failed to pass at the last meeting of the Council.

The February "Smart Set."—It is now, we believe, hardly a year that the *Smart Set* has made his regular appearance on this side of the water. Avoiding mud and blood, its contents are crisp, modern, and amusing. The February number is not behind in this way. Every line from cover to cover will be read with interest. The absence of the bugbear of many magazine readers, the "to be continued," is a most agreeable feature of this pleasant publication.

The Oxford.—Some novel and exceedingly fine electric light effects are produced at the Oxford during the production of the Japanese ballet and of Mr. Lawson's sketch of "Sherlock Holmes." The final tableau is astonishing work for a music hall. Crowded houses rule the day—a fact which is not at all surprising, seeing that an exceptionally good programme is staged, comprising two sketches, four elephants, and numerous singers and dancers.

Accident.—While Mr. Thomson, chief assistant electrical engineer, was inspecting some electric service boxes in a street at Swansea on Saturday night, to discover the reason of the presence of water in the main, a terrific explosion occurred, owing to an escape from a broken gas-main, the accumulation of which was ignited by the light carried by the engineer. Mr. Thomson and a foreman were badly burnt. It is said that the recent working of a steam-roller near the spot may have caused some damage to the gas-mains.

Llandudno.—The Council have adopted a resolution of the Electric Lighting Committee recommending that the sum of £300, surplus from last year's profits, after the allocation of £500 to the reduction of the rate, should be invested in Consols as a reserve fund. The charges for electricity will be reduced from 6d. to 5d. per unit where the current is supplied on the flat rate, and that where it is supplied on the maximum demand system the charge be 7d. per hour for the first hour as before, but that the rate afterwards be 2d. per hour instead of 3½d.

Abyssinian Telephones.—The Negus is now laying down telephone wires between his capital and different points of the Italian settlement of Erythea. Italy finds the wires and the Negus the posts. His Ethiopian Minister, to protect his new vehicle of communication against the superstitious hostility of different tribes, has promulgated an edict to warn them that the right hand of any person found guilty of cutting a wire will be chopped off, and his property seized to pay a fine and for the damage done. Addis Abeba and Harra are now in telephonic communication.

Copper Trust.—It is stated that the Amalgamated Copper Trust has completely lost the control of the markets, and that the Standard Oil Company lost heavily by first buying up independent copper at a high price and then selling it at the recent low level. The reports add that enormous quantities of copper were sold at the level of 5½d. per pound, and that the trust's product for months ahead is pledged at the same price. Copper prices rose between Jan. 23 and Jan. 29 from £48. 15s. to £51. 7s. 6d. per ton for cash, and from £49 to £51. 10s. for three months delivery in London and from 11 cents to 11⅞ cents per pound in America.

Stepney.—The Electric Lighting Committee in December last received from the New Century Arc Light Company, Limited (the contractors for arc lamps and columns to be erected in Mile End-road), a quotation for a cheaper and lighter form of arc lamp and column which they proposed to erect in Brick-lane, Osborn-street, Vallance-road, and New-road. The company offered to supply and erect complete 20 lamps for the sum of £493. 10s. Later on the company wrote that a clerical error had been made in their quotation, and their price for the work was £552. 14s. The difficulty has now been solved by the halving of the difference, and a contract has been accepted at £525.

Newark.—It appears that the Derby and Notts Electric Power Company (Chesterfield) are prepared to reopen negotiations for supplying the town with electricity, taking as a basis 4d. per unit as a maximum charge both for light and power. The company's last offer was 4½d. for light. With regard to the charge of 4d. for power, the company have promised that a considerable reduction upon this maximum price will be granted, but at the present moment, without having details of the amount of power required, they say it would be impossible for them to enter into a binding arrangement to supply at 1½d. per unit, which is the price offered by the Corporation. The Electric Lighting Committee regard 4d. per unit as an excessive sum to allow as a maximum for power, but they are not unanimous in the interpretation of the letter, and have now asked the company to state separately the terms they offer for light and also for power.

Devonport.—A local correspondent writes that there is an agitation among the armourers in Devonport Dockyard to improve their position. They allege that a new rating—that of electricians—has been established to do work which has been done most satisfactorily by chief armourers, and it is complained that the new rating will, to a great extent, take the place of armourers. Men with only two years' indentures, who would be refused for the armourers' crew, are joining as electricians. There never was a brighter prospect of their getting their petitions granted, because the Admiralty knew that there were not sufficient armourer ratings. According to a statement which has been made by Mr. C. Tiddy, armourers on board torpedo boats were not treated as are the electricians. The electricians are gentlemen in comparison. Armourers are called upon to do any dirty work, such as pumping and scrubbing, whereas electricians get treated, as all skilled men should be treated, as mechanics who know their work.

Stirling.—Mr. A. C. Hanson's last statement on the progress of the electric light undertaking for four weeks ending Dec. 28, 1901, gave the total units sold at 17,527. Applications had been received for 420 equivalent 8-c.p. lamps, making a total connected and applied for of 6,735 equivalent 8-c.p. lamps, as compared with 4,900 equivalent 8-c.p. lamps at the corresponding date in 1900. The report also stated with regard to plant extension that Messrs. Babcock and Willcox were connecting the feed-water heater, exhaust piping, and other connections. Messrs. Siemens Bros. and Allen and Sons had tested their machinery, and would deliver shortly. The first boiler had been tested at Messrs. Arnott's works, and was due by the New Year. The boiler foundations were ready to receive boilers, and the engine foundations were also practically ready. The following charges are to be made for power in place of the sliding scale fixed by the size of the motor: first 50 units per quarter, 4d. per unit; second 50 units per quarter, 3d.; all subsequent units, 1½d.

American Pacific Cable.—A Reuter's telegram states that the Committee on Commerce in the House of Representatives have decided in favour of the construction, operation, and maintenance by the Government of the Pacific cable, and ordered a favourable report to be made on the Bill for that purpose. The committee amended the Bill so as to provide that the cable shall be of American make if it can be supplied according to the highest standard, and at a cost not exceeding 10 per cent. above that of foreign manufacture. Arrangements for connections with Japan and China are authorised. As finally determined upon, the Bill provides for a Government cable between

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California, Hawaii, and the Philippines, *via* the Midway and Guam Islands, or whatever route the President may consider most practicable. The cost is not to exceed 10,000,000dol., and the work of construction will be entrusted to the army and navy departments. Provision is made for Government messages, and also for private messages, at a rate not exceeding 25 cents a word to Hawaii, and 50 cents to Manila.

Hull.—At the last meeting of Electric Lighting Committee it was stated that the mains to the several schools would be laid free of charge, and the supply would be at the same rate as that of ordinary customers, the cost of the mains being estimated at £4,000. The *Eastern Morning News* says it will be an item of satisfaction to Hull ratepayers to know that the Electric Lighting Committee, notwithstanding the extensions of buildings, plant, and machinery, will make no call on the rates during the present year. What is more encouraging is, that it is not likely to do so in future. The prospects point to an enhanced profit, which may be applied to the reduction of the rates or the lowering of the price of the light. Last year, when the prices charged were 5½d. and 5d. and 2½d. per unit, 1,500,000 units realised £26,562. 10s., whilst in the ensuing year the output is estimated at two million units. At the lower prices of 5d., 4½d., 2d., and 1d. this will bring in £32,083, an increase of £6,520. The total expenditure is estimated at £32,655, and it includes £7,650 interest on loans, as against £6,000 last year, and £5,875 payments to sinking fund, as against £4,330 last year.

London County Council.—At Tuesday's meeting of the Council it was agreed to lend the Hammersmith Borough Council £10,455 for electric light installation. The employment of a temporary inspector to supervise the electric light installations at the West Hampstead and East Greenwich fire stations was sanctioned. The following notices under Electric Lighting Acts and Orders were agreed to: from the County of London and Brush Provincial Electric Lighting Company, under the Southwark Order, 1892, of intention to lay low-tension mains along and across Bermondsey New-road; the Kensington and Knightsbridge Electric Lighting Company, under the company's order and the Kensington and Knightsbridge Electric Lighting Act, 1893, to lay mains along a portion of Pelham-street; the Metropolitan Electric Supply Company, under the Paddington Order, 1890, of intention to lay high-tension mains along portions of Carlton-terrace and Kensal-road. Notices, as follows, served under orders granted to local authorities, and under which the Council has no power of approval or disapproval of works, were also received: from the Battersea Borough Council, under the Battersea Order, 1896, of intention to lay mains along Park-road; and from the Islington Borough Council, under the Islington Order, 1893, to lay mains along Shepperton-road and Southgate-road.

Swansea.—The committee formed to institute a municipal telephone service, after considering Mr. Bennett's report on the establishment of the proposed new service, have decided to apply for a loan of £18,000 for the purpose. Mr. Bennett thought that a rate of £5 per annum would immensely increase the number of subscribers. He proposes to provide 1,500 lines, including 50 public telephones, but he would at first completely finish only one-half, say, 750 lines, including 25 public telephones; for the other half, ducts would be laid and provision made as regards space in switch-rooms, designs of switch-boards, spare room on poles, etc. The capital expenditure is estimated at £18,000, the estimated revenue from 725 subscribers and public telephones, etc., at £4,301, and the cost of working expenses and interest and sinking fund £3,566, leaving a net revenue of £735 per annum, to be added to which would be £150 a year now paid to the National Telephone Company. Local intercommunication could only be had with the consent of the National Company, unless they came, as in some other places, within the Telegraph Act, 1889. This might be effected whenever the Corporation exchange becomes the larger one. The sub-committee of the Swansea Electric Lighting Committee on Monday instructed their engineer, Mr. Prusmann, to obtain tenders for two more engines of a collective capacity of 1,500 h p., thus increasing the power of the station from 1,000 h.p. to 2,500 h.p.

Private Bills.—The Earl of Morley, chairman of committees of the House of Lords, and Mr. J. W. Lowther, chairman of Ways and Means, as representing the House of Commons, recently met to determine in which House each of the private Bills of the session should be first introduced. The measures that are to be brought in in the Commons include those of the London County Council in relation to electric supply, general powers, subways and tramways, tramways and improvements, etc. The officials of the Private Bill Office sat to receive any memorials that might be presented alleging non-compliance with the Standing Orders in respect of any of the remaining Bills on the general list of petitions, but at the expiration of the allotted time no deposit had been made. The measures that are unopposed at this stage include the Middlesex County Council Tramways. Mr. Jeune, one of the examiners of private Bills, having enquired into the case of the memorial lodged by Mr. A. P. Bagnold, secretary to the Fire Offices Committee, alleging breach of the rules by the promoters of the West Ham Corporation Bill, decided that the Standing Orders had not been complied with. The Bill will accordingly have to go before the Standing Orders Committee. At their last meeting the examiners recorded non-compliance with Standing Orders in the case of the Central Argentine and Rosario Railway Bill. The measure will accordingly have to go before the Standing Orders Committee. Proof of compliance with Standing Orders was given in the case of the City and Crystal Palace Railway Bill, the Brighton and Rottingdean Seashore Electric Tramroad Bill, the North Metropolitan Electric Power Supply Bill, the Medway and Thames Canal Bill, the London, Brighton, and South Coast Railway (Various Powers) Bill, the London, Tilbury, and Southend Railway (Various Powers) Bill, and the Whitechapel and Bow Railway Bill. In the case of the Manchester City Circle Railway Bill there was no appearance, and it is therefore understood that the Bill is abandoned. Several Bills were reported for first reading, including the Great Eastern Railway Bill, the Great Northern and Strand Railway Bill, the London County Council (General Powers) Bill, the London County Council (Subways and Tramways) Bill—the opposition to the stage in the last-named Bill being withdrawn. In the case of the City, Wandsworth, and Wimbledon Electric Railway Bill and the Victoria, Kennington, and Greenwich Railway Bill there was no appearance of the parties, so that it is presumed that the measures are not to be further proceeded with this session.

Uxbridge Electric Supply Co.—We understand that Mr. A. Randall Bell, chief engineer and business manager of the Company, is prepared to supply current in the district within a few weeks. The current will be distributed at a pressure of 3,000 volts alternating at a periodicity of 50 cycles per second, converted by means of transformers placed in a sub-station to a pressure of 200 volts. From this sub-station it will be taken along low-pressure feeders to points in various streets, and then allowed to enter the distributing cables, which are laid in wooden troughing filled in with Trinidad bitumen. This—the sub-station method—applies to the urban district only, not to the outlying district. Around Ickenham, Hillingdon, Hayes, Cowley, and Denham the house transformers will be employed fed direct from the high-pressure mains. The contract for laying all the cables and ducts in the various districts has been placed with Messrs. Callender, of London and Erith, and the work is being carried out under the supervision of Mr. E. L. Heelis, their engineer. The whole work is being carried out to plans and specifications prepared by Messrs. Kincaid, Waller, and Manville, of 29, Great George-street, Westminster, who are the consulting engineers to the Company. The Company will charge 7d. and 3d. per unit on the maximum demand system. The Company have undertaken a system of free wiring, for which they will charge 5½d. per lamp per quarter. The consumer will have the option of purchasing the installation within 18 months from the date of connection at the original cost to the Company plus 25 per cent., and at any time after that period at the original cost plus 20 per cent., less 1½ per cent. per annum off the original cost for depreciation. The generating station is situated in Waterloo-road, near the Grand Junction Canal. The engine-room is 44ft. by 27ft. in superficies, and contains three sets of engines by Messrs. Belliss and Morcom; these are of their standard high-speed self-lubricating type, running at about 500 revolutions per minute. Below is installed a surface condenser by Messrs. Mirlees, Watson, and Yaryan, of Clydebank. In the pump-room are two feed pumps installed, one driven by steam and one electrically, both built by Messrs. J. Weir, of Cathcart, Glasgow. The boiler-house contains two modern marine-type boilers, by Messrs. Davey-Paxman, of Colchester, capable of evaporating about 4,500lb. of water per hour. The alternators and exciters, which are direct driven, are by the General Electric Company, of Queen Victoria-street, London. The switchboard is of Messrs. Ferranti's high-pressure type, and was built at Hollinwood, Manchester. The frontage to the canal is being dockised in order to allow for the receiving of any heavy material or coal in the future. The contract for the steel steam-piping has been placed with Messrs. Spencer, Wednesbury, and the whole of the buildings are being erected by Messrs. Christie, of London.

Leith.—A new engine and a dynamo have been added to the electric lighting station, by which the power of the installation has been increased 50 per cent. The ceremony of starting the new machinery was performed by Mrs. Mackie, the wife of the provost, last Thursday. The *Scotsman* says: "Bailie Craig, in presenting to Mrs. Mackie a piece of silver plate, which had been subscribed by the members of the Council as a tangible proof of their regard and the honour she had done them in performing the service of starting the new engine and dynamo, explained that the new 500-h.p. engine and dynamo which had been inaugurated that day represented the latest addition to the plant of the station, and it presented special features of a novel character as compared with the original plant. The engine exceeded in size anything they had had before, and it was of the triple-expansion type—that was to say, the steam was used successively through three cylinders in place of the old method, where it was used through one cylinder and then dissipated in the open air. That was a great economy on the power of the engine, and by special by-passes the engine could be made to work at 25 per cent., an expedient which would be found of great value for coping with the heavy load which came on at certain hours in all stations. The installation of an engine of that size proved very clearly the rapid strides they had made since the inception of the undertaking by his friend Bailie Manclark. The street-lighting was first switched on on Dec. 23, 1898, and shortly afterwards the public supply was commenced. The original plant consisted of five small engines on the north side of the engine-room of altogether 700 h.p. It was soon found necessary to make additions to the plant, and a set of 300 h.p. was installed over a year ago, whilst the latest addition, inaugurated that day, had been installed to meet the further increasing demands for light and motive power, so that they had in their station now no less than 1,500 h.p. to generate their electricity. At the commencement of the station the consumers numbered about 80. To-day there were close upon 400. The number of public arc lamps originally was 74. The number to-day was 223. The units generated in the first year were under a quarter of a million. In the second year these increased to half a million, and during the year just ended the output had been three-quarters of a million units. The lamps connected at the outset numbered 15,000. In the second year these increased to 26,000, and at the present time they had connected a total of 35,117 lamps in 8 c.p. equivalent. The revenue in the first year amounted to £3,059, in the second year to £5,839, and in the year just ended to £9,000, while in order to popularise the use of electricity for all purposes the price, which at the outset was 6d. per unit for lighting and 3d. per unit for motive power, had been reduced to 5d. and 1½d., and at May 15 last these prices were still further reduced to 4d. and 1¼d.

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respectively, and it was to be hoped this endeavour on the part of the Council to increase the consumers would meet with success. The new engine and dynamo have been supplied by the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, Silvertown."

PROVISIONAL PATENTS, 1902.

JAN. 20.

1475. An improvement in feeder pillars for electric traction. Charles Beckingsale, 25, Clarence-square, Cheltenham.

1490. An electric mechanism for operating electric time circuits and the like. Harry Whidbourne, 1, St. Andrew's-place, Plymouth.

1496. Improvements in electric switches. Herbert Henry Berry, Philip Frederick William Simon, and Ernest Skinner, 128, Colmore-row, Birmingham. (Complete specification.)

1528. An improvement in the manufacture of incandescent electric lamps. Paul Scharf, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

1534. Improvements in electric light fittings. Gustave Markt, 173, Fleet-street, London.

1537. Improvements in and connected with insulators for closed conduits. William Griffiths and Benjamin Harry Bedell, 4, South-street, Finsbury, London.

1544. Improvements relating to electric ignition devices. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Fabrik Elektrischer Zünder Gesellschaft mit beschränkter Haftung, Germany.) (Complete specification.)

1546. Improvements in electric cars operated by the overhead conductor system. Hugh McGillivray, 18, Buckingham-street, Strand, London.

JAN. 21.

1565. An improvement in parallel-series switches for dimming electric lamps. Ernest Thomas Turner, 12, Tenant Co-operators, Hook-road, Epsom.

1575. Improvements in or relating to electric traction. Bahne Bonniksen, 18, Hertford-street, Coventry.

1654. Improvements in trolley pole connections and covers for tramcars and the like. James William Blakey and Ernest Deighton, 155, Ryan-street, Bradford.

1684. A method for producing electrodes for electric accumulators. Ernst Waldemar Jungner, 18, Buckingham-street, Strand, London. (Date applied for under Patents Act, 1901, Jan. 22, 1901, being date of application in Sweden.) (Complete specification.)

1688. Improvements in the electrolytic separation, deposit, and refining of zinc. Heinrich Paweck, 47, Lincoln's-inn-fields, London.

JAN. 22.

1734. Improvements in instruments having bifilar suspensions. Crompton and Co., Limited, and William Arthur Price, The Arc Works, Chelmsford.

1735. Improvements in electrical instruments. Crompton and Co., Limited, and William Arthur Price, The Arc Works, Chelmsford.

1745. Improvements relating to railway carriages or cars. Metropolitan District Electric Traction Company, Limited, 45, Southampton-buildings, Chancery-lane, London. (Charles Tyson Yerkes, United States.)

1765. An improved two-phase motor-starting switch. Alfred Soames and Walter Langdon-Davies, 101, Southwark-street, London.

1766. Improvements in arc lamps. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

1767. Improved devices for varying the speed of continuous-current electric motors. Arthur George Bloxam, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (The firm of Couffinhal et ses Fils, France.)

1768. An improvement in electric bell pushes. Charles Harley Burt, 321, High Holborn, London.

1772. Improvements relating to telephone systems. Edward Payson Baird, 45, Southampton-buildings, Chancery-lane, London.

1780. Improvements in transmitters (or receivers) for transmitting electrical waves through earth and water for steering torpedoes, signalling, and the like purposes. Carl Gustaf Georg Braunerhjelm, 322, High Holborn, London.

JAN. 23.

1803. A new appliance or device for facilitating changing the trolley pulleys of overhead electric tramcars from one cable to another. Joseph Boylan, 2, Market-street, Bradford.

1851. Improvements in the method of control of friction brakes, valves, and the like by electromagnets. Joseph Gershom Childs, 145, Farringdon-road, London.

1857. Improvements in prepayment electricity meters. Leslie Johnson and Robert Hornby, 4, South-street, Finsbury, London.

1874. Improvements in controllers for electric motors. Thomas Steel Perkins, Westinghouse-building, Norfolk-street, Strand, London.

JAN. 24.

1888. Improvements in systems of electrical distribution. Bertram Hopkinson, 26, Victoria-street, Westminster, London. (Complete specification.)

1894. Improvements in electric lighting arrangements for theatrical and similar scenic effects. William Justice Philipson, 3, St. Nicholas's-buildings, Newcastle-on-Tyne.

1910. Improvements in electricity meters. Knowles Anderson, 65, Albion-street, Leeds.

1925. A high-tension electric current commutator. Jack Arthur Cundy, 12, Great Tichfield-street, Oxford-street, London.

1961. Improved method of heating metals in electric baths. Joseph Girlot, 173, Fleet-street, London.

1967. Improvements in the manufacture of electric cables for telegraphic and telephonic purposes. Horace Walter Dover, 53, Chancery-lane, London.

1984. An improved electric transformer. William Thomas Stutchbury and Charles Gorik, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JAN. 25.

2018. Improvements in junction boxes for electric wiring. James Waldron and Ernest White, Prince's-chambers, Wolverhampton.

2019. An improved coupling socket for electric wiring. James Waldon and Ernest White, Prince's-chambers, Wolverhampton.

2024. Improvements in or appertaining to electrically-propelled tramcars and other vehicles. Aaron Hill, 22, Silverwell-lane, Bolton.

2034. Improvements in electric arc lamps. Henry Baggett, Norfolk House, Norfolk-street, Strand, London.

2035. Improvements in electric arc lamps. Henry Baggett, Norfolk House, Norfolk-street, Strand, London.

2058. Improvements in rail bonds or connecting strips for the rails of electric railways. George Barstow Blanchard, 45, Southampton-buildings, Chancery-lane, London.

2065. Improvements in or relating to driving gear for electrically-propelled vehicles. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Maschinenfabrik Oerlikon, Switzerland.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Feb. 13.

1900.

23462. Moulding machine for the manufacture of conduits for electric conductors. Wayss and Freytag.

1901.

1038. Paper for cleansing telephones. Henckel and Henckel.

3036. Trolley or like current collectors for electric traction. Upham.

4033. Controlling apparatus for electric lifts. Haddan. (Stigler.)

4050. Electrical switches. Perkins and Humphreys.

4776. Means for operating electric switches on sectional conductor electric railways. Barker. (Murphy Safety Third-Rail Electric Company.)

5062. Cord-controlled switches for electrical purposes. Thomson and Thomson-Davis Telephone System, Limited.

5088. Trolley head for electric tramcars. Russell.

5165. Switches for varying electrical resistance. Siemens Bros. and Co., Limited, and Hird.

5592. Method of manufacturing filaments for incandescing electric lamps. Voelker.

14897. Electric meters. Rieunier.

15508. Safety devices for overhead electric circuits. British Thomson-Houston Company, Limited. (Armstrong.)

17194. Electric arc light electrodes. British Thomson-Houston Company, Limited. (Read.)

18598. Alternating-current electric meters. British Thomson-Houston Company, Limited (Thomson.)

22279. Electric motor control systems. Armstrong. (Date applied for under International Convention, April 8, 1901.)

22540. Electric rheostats. British Thomson-Houston Company Limited. (Mackintosh.)

23378. Electric arc lamps. British Thomson-Houston Company, Limited. (Fleming.)

23381. End-play devices for rotary machines. British Thomson-Houston Company, Limited. (Geisenhoner.)

23722. Electric testing instruments. British Thomson-Houston Company, Limited. (Mullaney.)

24397. Multiplex telegraphy using undulatory or alternating currents. Thompson. (Soc. des Telégraphes Multiplex système E. Mercadier.)

24511. Electrodes for electric accumulators or batteries. Bainville.

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25182. Electric furnaces and production of chemicals in such furnaces. Brewer. (Taylor.)

25388. Electric fuses. British Thomson-Houston Company, Limited. (Geisenhoner.)

25810. Manufacture of incandescence bodies for electric glow lamps. Just.

26251. Means and appliance for starting electric lamps of the Nernst kind. Cervenka.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	—	—	—	—	—	—
Birmingham Tramways	—	—	—	—	—	—
Blackburn Corporation	Jan. 24	611	534	+ 77	2,186	1,905
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 25	161	141	+ 20	585	532
Bolton Corporation	—	—	—	—	—	—
Bradford Corporation	,, 26	1,038	759	+ 279	3,977	2,933
Bristol Tramways Company	,, 24	3,9'0	3,854	+ 106	—	—
Carlisle Tramways Company	,, 25	129	117	+ 12	475	424
Central London Railway	,, 25	6,615	5,961	+ 654	26,195	23,466
City and South London Railway	,, 26	2,909	1,975	+ 934	12,056	8,048
Cork E. T. and L. Company	,, 23	357	352	+ 5	1,254	1,186
Darwen Corporation	,, 24	204	154	+ 52	611	561
Dover Corporation	,, 25	170	169	+ 1	648	635
Dublin & Lucan Electric Railway	,, 26	82	62	+ 20	338	269
Dublin U. T., electric cars	,, 24	3,342	3,202	+ 140	—	—
Dublin S. District, Electric	,, 24	701	654	+ 47	—	—
Dundee Tramways Company	,, 22	642	441	+ 201	—	—
Glasgow Corporation	,, 25	10,639	8,460	+ 1,179	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 25	1,636	1,516	+ 120	—	—
Liverpool Corporation	,, 18	8,735	7,769	+ 966	27,280	23,860
Liverpool Overhead Railway	,, 26	1,343	1,457	− 114	5,595	5,994
Newcastle-on-Tyne Corporation	,, 25	1,398	—	—	—	—
Portsmouth Corporation	,, 25	892	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 26	3,646	—	—	—	—
Southampton Corporation	,, 23	730	643	+ 86	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £661 decrease.
Barcelona Eusanche y Gracia, £7 decrease. Barcelona, £279 increase.
Brisbane, £214 increase (month of Dec., £1,322 increase).
Buenos Ayres and Belgrano Electric, £125 decrease.
Calcutta, £20 decrease.
Cape Town (month of Dec.), receipts, £16,925; expenditure, £6,792.
La Capital Traction and Electric, Buenos Ayres (month of Nov.), £1,973 increase.
Mexico Electric (month of Dec.), receipts, £18,250; expenditure, £10,750.
Perth Electric, £245 increase.
Port Elizabeth (month of Dec.), receipts, £3,898; expenditure, £1,898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Tramways.—	£	£
Anglo-Argentine, 1-260,007	5 ..	4-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	123-126
Blackpool and Fleetwood Tramroad	10 ..	12½-13½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2⅞-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4⅛-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	102-104
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6⅞-7¼
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9-9¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	14-15
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12½-13
—— 5 per cent. Perpetual Debenture Stock	100 ..	126-129
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅞-2
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2-2¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	102-104
New General Traction, Ordinary	5 ..	2½-3¼
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10¾
—— 5 per cent. Cum. Pref.	10 ..	11½-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	10s. ..	¼
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	50 p.c..	50 p.c.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅝-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅛-¼
—— Ordinary, 1-125,000	1 ..	⅛-¼
British Insulated Wire, Ord., 1-70,000	5 ..	10-11
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¾-6¼ xd
—— 5 per cent. Mortgage Debentures	100 ..	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5¼-6
Brush Electrical Engineering, Ordinary	2 ..	1⅞-1⅞
—— Nos. 90,001-105,731	2 ..	1⅞-1⅞
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	97-100
Callender's Cable, Debentures	100 ..	110-114
—— Ordinary	5 ..	16½-17½
—— 5 per cent. Pref.	5 ..	5¼-6
Crompton and Co.	3 ..	3-3¼ xd
—— 5 per cent. Debentures	— ..	99-104 p.c.
Edison and Swan United, Ordinary	3 ..	⅛-¼
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	78-83
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	84-89
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9⅜-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	16½-17½
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	112-116
India Rubber, Gutta Percha, and Telegraph Works	10 ..	20-21
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15½-16½
Telegraph Construction and Maintenance	12 ..	35-38
—— 5 per cent. Bonds	100 ..	102-104
Telegraph Manufacturing, Ordinary	5 ..	10½-11½
—— 5 per cent. Cum. Pref.	5 ..	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	9¼-10¼
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6⅝
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	103-105
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅝-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	97-102
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9¼-10⅛
—— Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	9-9¼
—— 7 per cent. Preference	5 ..	8⅞-9¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7⅛-8¼
—— Nos. 20,001-30,000	5 ..	7-8
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10½ xd
Charing Cross and Strand	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5-5¼
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	103-105
Chelsea Electricity Supply	5 ..	5½-6
—— 40,501-50,936	5 ..	5¼-5⅜
—— 4½ per cent. Debentures	100 ..	108-111
City of London, Ordinary	10 ..	9-10
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	121-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	105-108
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5¼-6
—— 6 per cent. Cum. Pref.	5 ..	5½-6
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ltd., 6 p.c. Cm. Pf., 1-20,000	5 ..	4½-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5½-5⅝
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	103-106
Kensington and Knightsbridge and Notting Hill	100 ..	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅜-10¼
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	95-100
Metropolitan, Ordinary	10 ..	14½-15½
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7⅛-8
—— £4½ Shares, New	4½ ..	6⅞-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-2¼
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15½-16⅛
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	12-13
Electric Railways.—		
Central London, Ordinary	100 ..	105-108
—— 4 per cent. Pref.	100 ..	105-108
—— ,, ,, deferred	100 ..	106-109
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	114-117
City and South London, Consolidated Ordinary	100 ..	65-67
—— Ordinary	10 ..	6¼-6⅜
—— Nos. 60,001-70,000	10 ..	6¼-6⅜
—— 4 per cent. Debenture Stock	100 ..	112-116
—— 5 per cent. Pref. Stock '91	100 ..	129-134
—— ,, ,, ,, '96	100 ..	123-127
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Telephones.—		
National Telephone, Ordinary	5 ..	3⅜-3⅝
—— 6 per cent. Cum. First Pref.	10 ..	11-13
—— 6 per cent. Cum. Second Pref.	10 ..	11-13
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4⅜-5
—— 4 per cent. Deb. Stock, Red.	100 ..	94-97
—— 3½ per cent. Deb. Stock, Red.	100 ..	101-105
Oriental Telephone and Electric Company	1 ..	⅛-¼

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Supplement to "The Electrical Engineer,"

JANUARY 31, 1902.

BOILERS AND WATER SUPPLY.

BY F. G. ANSELL.

The Nature of Water

The chief property of water likely to give trouble in steam-boilers is its power of dissolving bodies with which it comes in contact. Some things it dissolves in large quantities, such as sugar or gum, but others it dissolves only sparingly, such as lime, and the nature of a sample of water depends upon what is dissolved in it. Lime and magnesia make water "hard," soda and potash make it "soft." As a general rule, hot water will dissolve more of any thing than cold, but there are some notable exceptions to this; for example, sulphate of lime, often called gypsum, is more soluble in water at 92deg. F. than at any other temperature, so that a sample of water saturated with sulphate of lime at 92deg. F. would begin to throw out a deposit very soon after the temperature left this figure in either direction. Another exception is common table salt, the solubility of which does not vary with the variation of temperature, and another exception is quicklime, which is far less soluble in hot than in cold water. Such things as soda, potash, lime, and magnesia are called bases, and tend to make water alkaline. Bases are the opposite of acids. An alkaline water will not dissolve iron, but an acid water will dissolve it, so that an alkaline water may be stored in an iron tank, but an acid water would immediately attack the iron, and, in fact, begin to dissolve it. Bases unite with acids to form bodies known in chemistry as salts, and whilst the different bases and the different acids have different properties, it is only natural that the various salts should also have different properties. Lime united with sulphuric acid, often called oil of vitriol, forms sulphate of lime. Lime with hydrochloric acid makes chloride of calcium, which is very soluble in water at all temperatures. Again, magnesia and sulphuric acid make sulphate of magnesia, while magnesia and hydrochloric acid unite to form chloride of magnesium. Magnesia alone is not soluble in water, but almost all salts of magnesia are very soluble. It will now be easily understood that rain-water in passing through the earth to get to the springs and wells has no difficulty in dissolving a considerable quantity of mineral matter, and so the comparatively soft rain-water becomes hard spring or well water. In fact, it would not be possible to find any natural supply of pure water, the solvent power of water being so great that even rain-water almost always contains two grains per gallon of mineral matter it has hastily collected from dust in the air, on the roofs, etc.

Sutton gives the usual proportion of mineral matter dissolved by waters as follows: 39 samples of rain-water gave an average of 2 grains per gallon; 195 samples of upland surface water, 6·7 grains; 198 samples of spring water, 19·7 grains; 157 samples of deep-well water, 30·6 grains; 23 samples of sea-water, 2,729 grains per gallon. The most usual constituents of the mineral matter of a boiler feed water may be taken as carbonate of lime, carbonate of magnesia, sulphate of lime, sulphate of magnesia, and chloride of sodium. Many other salts are also found, such as chloride of magnesium—a troublesome salt of which I must speak further on—carbonate of soda—a useful salt in many cases—and others of no great interest, such as chloride of potassium. Silica and iron are often found in small quantity, and occasionally phosphates. The organic matter in anything like a good water should be very small, and then it should not be a cause of trouble, but if, as sometimes happens, a boiler is fed from a dirty, stagnant pool, then trouble may follow owing to the vegetable juices, which are often acid, being dissolved by the water, and so acting upon the inside of the boiler and dissolving it away. Water from some metal mining districts is also troublesome from the amount of acid it contains. Very rarely a salt of some value is found in a water. The best example I can call to mind at the time of writing is chloride of lithium, found at a spring in Cornwall, and there is also the familiar Epsom salts—sulphate of magnesia. In addition to the above-mentioned bases, water also contains acids—*e.g.*, hydrochloric, nitric, nitrous, sulphuric, and carbonic in many cases and occasionally also sulphurous, phosphoric, and silicic—but these, when as usual combined with their bases, do not as a rule exert any bad influence upon the boiler except the chloride of magnesium, which is decomposed by heat. I should, however, mention that some of the water found in the neighbourhood of metalliferous mines is injurious to boilers, because it contains metallic salts in solution which are decomposed by contact with iron or steel. For instance, a water containing sulphate of copper in solution would dissolve a piece of iron, because the sulphuric acid would leave the copper to go to the iron, and metallic copper would be deposited, and the sulphate of iron thus formed would be dissolved in the water. The effect of any such water upon a boiler may easily be ascertained by merely plunging a clean knife blade into the suspected sample and leaving it there for a few hours. If the knife blade has been attacked in the least, the polished surface will easily show it, and that water should not be allowed to enter a steam-boiler until it has been properly treated to render it thoroughly alkaline. Such a water as this would easily pay for proper chemical treatment, the value of the copper obtained being considerable and the iron used to replace it cheap. Again, water containing sulphates in solution—*e.g.*, gypsum (sulphate of lime) or sulphate of magnesia—are apt to have these sulphates reduced by any decaying organic matter with which they may come in contact to sulphuretted hydrogen, which is capable of attacking iron rust. Sulphuretted hydrogen can always be recognised by its odour of rotten eggs. It is found in some natural springs—*e.g.*, at Harrogate and in volcanic regions—and it is a product of certain decaying vegetable matter containing sulphur in its composition, such as white of egg, albumen, etc., but for steam-raising purposes such water as this is rare, and belongs more properly to the class of mineral waters. Other gases dissolved in almost every water are oxygen, nitrogen, ammonia, and carbonic acid, all of which are derived from the atmosphere. Having carefully read the foregoing, some readers may perhaps enquire how they can form an opinion on the water supplied to their boilers. This question is best answered by a proper chemical analysis, and the information is well worth having, but I will endeavour to suggest a general way of forming a rough opinion. The first thing to do is to put a strip of litmus paper into the water and to leave it there for about an hour. If the litmus paper comes out blue the water is alkaline, if red, the water is acid. If the water will not change the colour of either blue or red litmus paper it is said to be neutral—*i.e.*, neither alkaline nor acid; but most water is slightly alkaline, if only from the amount of carbonate of lime it contains. A fresh sample should be put into a clean, clear, glass-stoppered bottle, the stopper placed in position, and the bottle being about half-full only, should be gently warmed, and then well shaken, and the stopper being removed the contents carefully smelt, when any odour should be noted. A good clean water will have no odour, but often any organic matter present will be recognisable, especially sewage. No odour, however, does not always mean no organic matter, therefore a small sample of the water, about 6oz., should be put into a clean white porcelain crucible and evaporated to dryness at a gentle heat, when the residue should be white, unless in the case of a chalybeate water, when it

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would be coloured brown by the iron. The crucib'e must now be heated gently and by increasing degrees, so that the residue can be carefully watched. If no organic matter is present the residue will not change colour, but if any is present the colour of the residue will become darker and darker as the organic matter chars until it has all disappeared, when the residue will be white unless iron is present. A chalybeate water would be known by its flat taste, somewhat like dilute ink, and a sulphurous water would be known by its odour of rotten eggs, so that no confusion is likely to arise in these simple tests. Of course, a water with much mineral matter will leave a considerable amount of residue, and, *vice versâ*, a water having little mineral matter in solution will leave little residue.

The next point to consider is the effect of heat on the water and on its mineral matter, some of which is affected and some not. Carbonates of lime and magnesia are thrown out of solution because the water loses carbonic acid and can no longer dissolve carbonates of lime or magnesia, and they being insoluble in either hot or cold water free from carbonic acid make the sediment, or scale, or "fur," or rock well known to all of us as occurring in boilers and tea kettles. If these carbonates are simply thrown out of solution by heat they have an awkward way of sticking very closely to the inside of the vessel, but if they are thrown out by chemical action, whether in hot or cold water, they fall to the bottom of the water as a loose powder and do not stick to the vessel. It is far better to render these salts insoluble outside the boiler, and only to allow the water to enter the boiler in such condition that boiling will not produce any further effect upon it than evaporating it; but unfortunately this state of perfection is very seldom attainable, because there are almost invariably other salts present in the water which cannot be got rid of by any practical means when cost has to be considered. The only means of getting a thoroughly satisfactory water for steam purposes is distillation, and this is too costly on land, but there are other methods which give very fair results, and are quite practical at a moderate cost, details of which are given later on.

Obviously, as heat evaporates the water, and the steam passes away through the engines, etc., the quantity of water in the boiler must get less, and more water must be forced in to replace that which has passed off as steam. However, no solid matter goes with the steam, and, therefore, since every gallon of the water pumped into the boiler takes in a small amount of solids, it necessarily follows that solids must accumulate in the boiler. As an illustration of the extent of this accumulation, suppose a water supplied to a boiler contains 20 grains of solids per gallon, and that the boiler evaporates 25 tons of water a day. Twenty-five tons of water would be 5,600 gallons, and as each gallon takes into the boiler 25 grains of solid mineral matter, it follows that about 20lb. of solid stuff is put into the boiler in a day, or more than half a ton a week. But some of this mineral matter is not greatly affected by the heat, and remains in solution—*e.g.*, chloride of sodium or potash, sulphate of soda or potash, chloride of calcium, and sulphate of magnesia, etc., so that the water inside the boiler would gradually become thicker and thicker, simply by reason of the non-volatile soluble salts it contains. In proportion to this, of course, the insoluble matter would also accumulate, some being deposited as powder and some adhering to the inside of the boiler as scale or rock. Hence the necessity for blowing some of the water out of the boiler at frequent intervals. If this operation were systematically neglected, the liquid contents of the boiler might set solid on cooling, although liquid before putting the fires out. There is much more danger of this with a water containing sulphate of soda than any other, and as many people use soda to prevent the scale adhering to the inside of the boiler, I feel justified in pointing out the necessity for care in this respect, because any water containing sulphates would produce sulphate of soda on being boiled with soda, whether the hydrate or the carbonate of soda were used. The gauge glasses will generally show when the water inside the boiler is becoming turbid, and also many boilers would "prime"—that is to say that the water would boil violently and throw up large quantities of liquid into the steam-pipes, owing to the water being too turbid to boil gently. "Priming" should always be avoided, because it is not good to have water in the steam-pipes, where it may be blown about by the steam and break the joints, and will generally, if not always, make a noise; but perhaps the worst happens when it gets into the cylinders of the steam-engines, where it may be the means of forcing the end off the cylinder, and the sediment is sure to be forced out through the stuffing box, and cut the pistons and valves and rods, etc. Where no priming occurs, the steam may generally be said to be free from insidious properties, unless the water contains chloride of magnesium, which is decomposed by the heat of the boiler into magnesia, which is deposited, and forms part of the "scale" or "rock," and hydrochloric acid, which escapes in the gaseous form in the steam unless the water also contains carbonate of soda or carbonate of lime, when the hydrochloric acid would unite with the soda to form chloride of sodium, or with the lime to form chloride of calcium, the carbonic acid gas being liberated in each case with the steam. Hydrochloric acid, being very corrosive, is an exceedingly bad thing to be in steam, as it will attack the brass of the valves and the iron of the pipes it gets in contact with, so that any water containing chloride of magnesium is best avoided for steam-boilers. If its use is imperative, a considerable quantity of carbonate of soda should be added to the water before it goes into the boiler in order that the hydrochloric acid may be kept in the boiler in the harmless form of chloride of sodium. The other gases usually present in steam in small quantities—viz., ammonia and carbonic acid—may be considered harmless unless for special purposes, where they might be objectionable.

It is very important that no oil should be allowed to enter the boiler at any time or under any circumstances, because oil is of somewhat varied composition, some being mineral and some vegetable, etc., and while a mineral oil might only remain on the top of the water, or might disappear in time by evaporation, still it might cause an explosion of the boiler. An explosion might occur in this way. It has been ascertained by experiment that water, if kept quite still and covered with a layer of oil, can be heated a few degrees above its boiling point (212deg. F), and that when in this state a very slight disturbance will cause it to give off a large body of steam suddenly, and also the temperature of the water to fall to 212deg. F. Men who boil oil are well aware of this fact, and are very careful never to allow a drop of water to enter their oil cauldrons. If any water did enter the cauldron, it would naturally sink to the bottom, and the oil would be blown out by the steam, probably with considerable violence. Most oil does not boil until it is raised to a temperature a good deal above that of boiling water. Vegetable oil might act in the same way upon the surface of the water, but supposing it to miss a favourable opportunity to do so much mischief, then it has another and more insidious way—viz., being naturally a chemical body composed of an acid and a base, and being easily decomposed by the heat and the steam inside the boiler, it forms a scum on the top of the water, and this scum, being acid, eats away the plates of the boiler wherever it touches them—*i.e.*, just about the water-line—and this accounts for the corrosion often seen in steam-boilers about the water-line. Mineral oils are not composed as vegetable oils are, and so are not subject to the same decomposition, but any grease collects dirt, and so tends to form a scum, which is never any good on the surface of water intended for boiling, and, in fact, may become a source of great danger. Hence many boilers are provided with horizontal pipes bored with a row of holes on one side, in order to allow the scum to be blown off several times a day easily. The most dangerous time is when the boiler is left quiet for a little while, perhaps at dinner, when no steam is wanted and the scum can spread evenly over the surface of the water, and the furnace being active the water is raised above its normal boiling point for the pressure in the boiler. Then a valve is opened to use a little steam; this disturbs the equilibrium, the water gives off a volume of steam to relieve its excessive temperature, and if the boiler is not strong enough to withstand the sudden addition of pressure an explosion occurs.

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With a view to avoiding this risk many boilers are arranged so that the feed water falls on to the surface of the boiling water, in a series of jets, to prevent its becoming quiescent. It is most essential to safety that no grease should enter a boiler. Before going further, it should be mentioned that the temperature of the water and the steam inside the boiler increases as the pressure increases, and that one cubic inch of water is capable of being converted into one cubic foot of steam at 212deg. F. Much more interesting information may be found in the numerous manuals on steam.

(To be continued.)

STARTING RESISTANCES.*

BY ARTHUR E. GOTT.

(Concluded from page 131.)

Modern Starters.—Present-day commercial starters are frequently divided into about three groups of sections of different gauges, such that the product of the resistance, current capacity, and time factor will enable the manufacturer to construct the coils of similar dimensions. Each group is again subdivided equally into two or more sections, and in this way a more or less graded resistance is produced which at the same time lends itself to rapid manufacture. A close approximation to this type of resistance is shown in Diagram 4, which is drawn for a motor of 12 h.p., as before. The ratio of the sections to each other are as 6, 6, 4, 4, 2, 2. Light load is assumed, as before, and although it will be seen that the final peak is improved, the normal current is more than doubled. Many thousands of starters

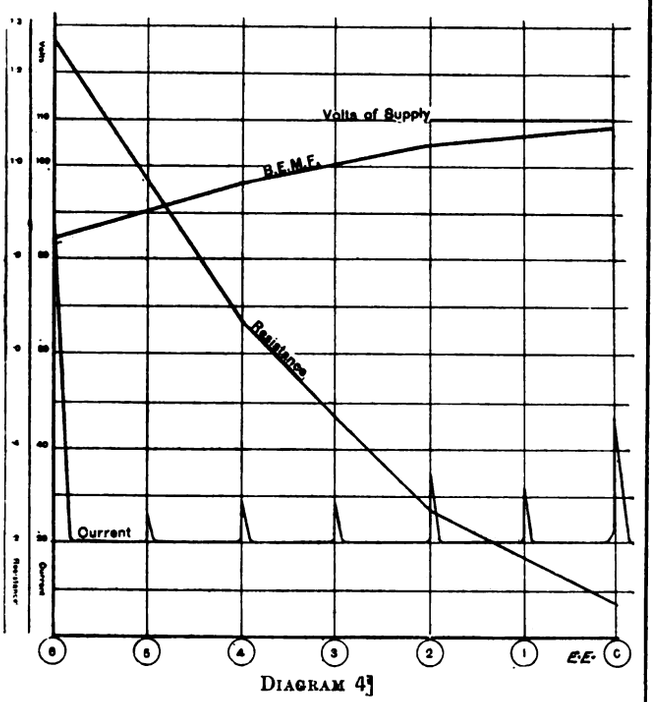

DIAGRAM 4.

constructed on these lines are in use, and where the powers are small and starting load light they are not at all unsuitable for their work. It must be pointed out that the ratio of the momentary current to the normal running current is constant at any load, and in the example before you it is not convenient to more than double the current at full load in moving starting switch to last contact, particularly when the increase in this case would be about 145 amperes. Such starters introduce fuse troubles, and have led to the development of *time* fuses and *time* overload circuit breakers, designed to open the circuit only when the overload current exceeds a predetermined interval of time. Diagram 5 shows the same total resistance with a contact on switch between every coil. This also is a practice much adopted, and the only argument in favour of it is that it lends itself to standardisation, as all the coils are alike. The peaks at the last steps still exist, and are only reduced in degree. Multiplicity in steps is not a great improvement unless the resistance is very carefully divided, and with an accurately designed resistance a smaller number of steps will usually give a more perfect result.

Generally speaking, the division of the resistance must be "geometrical" with armature resistance as one extreme and total resistance as the other extreme. Certain modifications are required, however, as suggested by considerations of voltage, number of steps available in switch, and conditions of manufacture. Many manufacturers seem to be unaware even of the principle, and modern starters are only a very rough approximation of what is really required. A large number of starters at present on the market owe their success entirely to the fact that the motors to which they are applied start under light load and are belt driven Even when motors are coupled direct or geared to a machine, the current demands in starting may be modified by the nature of the load.

Conditions of Load.—The author classifies the various starting conditions to which motors are subjected into a list of five—thus: (1) no load; (2) load increasing with speed; (3) load constant throughout, but no inertia; (4) full load and great inertia; (5) inertia so great as to outweigh all other considerations. An example of the first is in the use of fast and loose pulleys, clutches, etc.; second, ventilating and exhaust fans; third, boiler feed pumps. In the first three classes an average commercial starter will work more or less satisfactorily, particularly with series and compound wound motors. The fourth class is well represented by a web printing machine, to which motors are usually direct geared. Owing to the amount of energy which must be accumulated in the revolving cylinders before the top speed can be reached, it is most important that the resistance be so divided that the momentary current in moving the switch from one contact to the next shall not exceed a predetermined percentage. An ammeter placed in circuit will frequently show the peaks as calculated, and with shunt motors the observed increments may even exceed the calculated amounts. With a direct-geared motor it is also important that the predetermined current increment shall not be excessive, as gears may and have been stripped owing to sudden and violent stresses imposed by the starter.

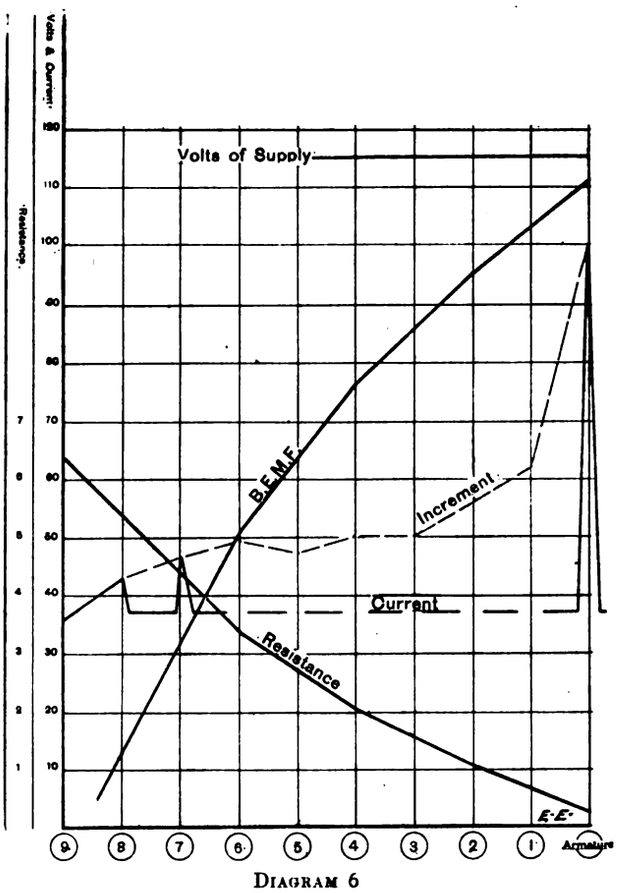

DIAGRAM 6.

The fifth and last condition is one not often met with, and the author begs to state that no commercial starter as at present manufactured will deal satisfactorily with the case, and enable the motor to start up without undue stress on itself or the starter. This condition exists when the accumulated energy in the driven machine is out of all proportion to the power required to drive the same. The best, or, rather, the worst, example of this sort which has come under the author's notice was a case of driving a line of exceptionally heavy grindstones. Let us examine one only of the stones. Its diameter is 6ft. 6in. and width 14in., and it runs at 180 revolutions per minute, at which speed the accumulated energy is approximately 160,000 foot-pounds. Now, if such a stone were driven by itself, a motor of about 4 b.h.p. to 5 b.h.p. would deal with average castings, but to start that stone up from rest to full speed would necessitate the full torque of a 5-h.p. motor for no less than two minutes in order that the motor might not be overloaded in starting. Any attempt to start in less time will cause an abnormal load, and even taking plenty of time, but with a badly-divided resistance, the great increase of current in going from one step to the next on the switch may sooner or later result in damage to the motor or its connections between itself and the driven machine. Too much stress cannot be laid on the importance, under such conditions, of a perfectly-designed resistance, particularly with direct-geared motors; and it must be remembered that as no slip can occur between the motor and the machine, imperfections may cause serious damage to the gear, or even twist the motor shaft right off. Such accidents have occurred, and it is not improbable that the defects have been in the controllers and not in the motors. Many starters are less successful now than they would have been a few years ago, owing to the fact

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, Jan. 13.

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that motor efficiencies have improved and their internal resistance is much reduced.

We will now consider a motor, say, of 10 h.p. started up by a fair sample of a modern manufactured type of starting switch. The motor resistance selected is a near approximation to present slot-wound armatures, and the starter selected is one of the best of its class. The subdivision of the resistance is obviously carried out from considerations mechanical rather than electrical, and there is still room for a very great improvement. The current demands are less excessive than in the previous examples, and when operating under conditions 1, 2, or 3 the excess currents are not prolonged, and the success of such a starter is more or less assured. But put the same starter and motor on to an inert load and assume the full torque throughout, and the effect is seen on Diagram 6. It is understood in each of these diagrams that contact of the starting lever is maintained on any one step until the current has become normal. In the case of an inert load the peak may last long enough to blow the fuse or open the circuit breaker, and if they are strengthened the protection to the motor is removed. Some starters are provided with two levers, one of which is held down by the overload circuit breaker, while the other is moved over the resistance contacts, the object being to open the circuit in the event of the operator cutting out resistance too quickly. If, however, the motor is put on to an inert load, the excess current in going from one contact to another of resistance, particularly the last ones, will open the circuit breaker, and this will be repeated until the operator renders the overload solenoid inactive or ties down the lever so that it will not release; thus the primary function of the instrument is destroyed.

Geometrical Division.—Clearly, then, the resistance must be divided so as to limit the increase of current in going from step to step to a definite amount, and this and certain other objects can only be attained by some modification of geometrical dividing, with the armature resistance as one extreme and the total resistance as the other—thus:

$$a \times f^n = \text{total resistance.}$$

when a = armature resistance; f = common factor; and n = number of sections of resistance. As an example, take the motor concerned in preceding diagram of 10 h.p. at 230 volts, taking 38 amperes at full load with an armature resistance of ·25 ohm as before. The current on moving from one step to next is not to exceed 10 amperes. The percentage increase is therefore

$$\frac{10 \times 100}{38} = \text{say, 26 per cent.,}$$

and the factor to be employed is therefore 1·26. The resistance, including armature to the end of each section, is therefore: $a \times 1{\cdot}26^1$; $a \times 1{\cdot}26^2$; $a \times 1{\cdot}26^3$; $a \times 1{\cdot}26^4$; $a \times 1{\cdot}26^5$; until $a \times 1{\cdot}26^n$ = total resistance decided upon. The difference between these products = resistance of corresponding sections in starter, the first being $(a \times 1{\cdot}26) - a$. The number of sections required can be found in this way, and in this particular instance 14 sections will give a total resistance of 6·3 ohms as before—*i.e.*, $(a \times 1{\cdot}26^{14}) = 6{\cdot}3$.

Diagram 7 gives the characteristic of such a starter, from which it will be seen that the resistance takes a well-known curve and the current increment is uniform throughout. The motor also runs up to full speed quicker, but with a smoothness which must be seen to be appreciated. As, however, it is not convenient to manufacture large numbers of sizes, the number of sections into which the resistance is to be divided may be already fixed by existing patterns, and the common factor (f) must be ascertained to suit the extremes and the number of sections selected. The formula $R = a \times f^n$ must therefore be transposed thus:

$$f^n = \frac{R}{a},$$

$$f = \sqrt[n]{\frac{R}{a}},$$

$$\text{Log } f = \frac{\text{Log } R - \log a}{N}.$$

Having found the factor in this way, the values of resistance, including armature to the end of each section, may be calculated thus: af, af^2, af^3, . . . af^n. This is a long and tedious process, but there is a very simple method for finding these values mechanically on the slide rule, due to E. A. N. Pochin. (See *Electrician*, vol. xxxix., p. 38, date May 7, 1897.) As such a rule is logarithmically divided, all that is necessary is to measure the length in inches between the extremes and divide it into as many equal sections as are required in the resistance. The readings from each section will then give the values of the total resistance, including armature to the end of that section, and the differences, of course, give the resistance of each section. This is done by reversing the slide and placing the left end to correspond with a armature resistance and the cursor at the total resistance. The length in inches on the centre scale must now be subdivided equally into the required number of sections and the values read off at each subdivision. It will also be seen that the common factor can be found at once by measuring the subdivision from the unit. This mechanical method has enormous advantages, for, as will be considered further on, several modifications are necessary in order to effect a compromise, and these are performed with an amount of ease altogether impracticable with formulæ.

We will now take the example shown in Diagram 6 and redivide the resistance by this method, using the same number of sections, and Table A gives the value of each step of resistance. Thus 10 h.p. at 230 volts, total resistance = 6·6 ohms, armature resistance = approximately ·24 ohm. These extremes measure on slide rule 7·2in.

$$\frac{\text{Extremes}}{\text{Number of sections}} = \text{L } \rho \text{ section} = \cdot 8\text{in.}$$

TABLE A.

Section No.	L to section.	Resistance, including armature.	Resistance of section.	—
Armature.	—	·24	—	Further columns may be added for current capacity, time factor, material, gauge, and length required.
1	·8	·348	·108	
2	1·6	·502	·154	
3	2·4	·727	·225	
4	3·2	1·05	·323	
5	4·0	1·52	·47	
6	4·8	2·2	·68	
7	5·6	3·18	·98	
8	6·4	4·6	1·42	
9	7·2	6·63	2·03	
	Total, excluding armature, 6·39 ohms			

Diagram 8 shows the general behaviour of such a starter, and the increment now is only about 16·5 amperes, or 43 per cent., a great improvement when compared with the 160 per cent. shown by the peak in Diagram 6. Similarly, the author has improved a number of commercial starters simply by taking the connecting wires to new points in the resistance frame, and many have in this way been saved from consignment to the scrap heap. It must be remembered that the current increment is strictly proportional to the current taken by the motor, and if the full current is taken by the motor before it moves and maintained constant throughout, the increment will also be constant throughout. Except on very inert loads the calculated increment is greater than the observed, and therefore a starter designed in this way for the worst load you can have will always be satisfactory for any other load. From the foregoing it would seem as if by increasing the number of sections to a high figure you would gain advantages, but for any motor there is a best number of sections in the starter beyond which the increased cost of manufacture over-balances the small advantages (Diagram 9) due to a slightly reduced increment. This is best illustrated by a curve representing the percentage value of the increment for any number of sections with the same extremes. The curve shown gives the approximate values for any motor from abont 2 h.p. to 25 h.p. at 230 volts, from which it will be seen that from three sections to, say, 10, the advantage is enormous, but it falls off rapidly at the bend of the curve, say at 20 sections. The great improvement shown by increasing the lower numbers must be remembered when dealing with barrel controllers.

Difficulties of Construction.—Now this method of geometrical dividing of motor resistance is not without its disadvantages, and these must be considered before any modifications can be made. On referring to Diagram 8, it will be seen that the resistance of the first section to be cut out is ·108 ohm, and the last one next the armature is 2·03 ohms. As both of these must go into the same frame, it will be seen that there are serious practical objections. As, however, the first section will only be used for a few seconds, and the last one may allow for one minute starting, the first coil can be much reduced in section, and this is the regular practice. Many resistances are, however, constructed so as to regulate the motor speed down to one-half with the full current, and the one under consideration will therefore require 3·3 ohms to carry the full current continuously. This amount of resistance extends back from the armature seven sections. These coils will all be of the same section, and the length will be proportional to the resistance, the extremes of which are, in this case, ·98 ohm and ·108 ohm—*i.e.*, we have one coil of nine times the material of another of the same gauge, and every intermediate coil is of a different value. Such an arrangement is not at all conducive to rapid manufacture, and there is a great tendency for the workman to mix the coils and so destroy the grading, unless the greatest care is taken throughout.

Many starters have the resistances so constructed that the connections may be taken off at any point, and there is no reason why this should not be done. The connections are, however, usually arranged something after the manner of Diagram 4, the actual arrangement being after the manner shown on the table, which shows several connections taken off the centres of the resistance material. As this is a regular method with small starters, there is no reason why the grading should not be more accurate. At the same time, it is not with small starters that these defects are so apparent—small power motors having a much larger internal resistance in proportion to the total required than large motors. As the author's experience deals with the largest sizes of motors, it will be interesting to see in the accompanying photo how some of these are constructed. The current capacity in the example shown demands several heavy coils in parallel at the armature end, and the length of the frame to suit the average coil demands the subdividing of the first coils into several sections. The second set of coils are subdivided into fewer sections, and further on each set of parallel coils becomes one section each. Further on still the gauge is reduced, connections become further apart until, at the starting end, a number of small-gauge coils in series form the starting section. Connections are taken from each of these points to a suitable terminal board, and, although it cannot be said that the arrangement is pretty, such a resistance behaves well on any sort of load and does not require scrapping. Now, many of the constructive difficulties disappear on further consideration. In the first place, it is not convenient to manufacture in quantities starters of, say, 50 h.p. to 100 h.p., as the percentage of such motors in use is very small compared with sizes of 3 h.p. to 5 h.p., consequently it is very little more work to measure off varying lengths of resistance material as equal lengths. In the second place, considerations of voltage between the contacts so modify the arrangement that a large number of sections may be made of equal

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resistance, and a further improvement made both in the arrangement and manufacture.

Supply Requirements.—Before the latter case can be discussed it will be necessary to review the various supply rules concerning the current demands of motors. Owing, no doubt, to imperfect starters lowering the volts, many rules have been formulated with a view to compelling the user to limit the current at starting to 10 amperes per section of the resistance and in some cases 5 amperes. Needless to state, this rule in its many forms is only an example of such as are made to be violated, as the correct starters which would comply in every respect *do not commercially exist*. Further, such rules have been made and copied by various supply authorities without any regard whatever as to what they mean. For example, a 30-h.p. motor on 220 volts, taking 10 amperes on first step, and 10 amperes per step until the motor started, and 10 amperes increment until full speed was attained, would require the following minimum number of steps in the resistance under varying load conditions—thus, light (say 20 amperes), 12 sections; loaded full current throughout, say, 50 sections. Considerations of voltage between the contacts would further slightly increase the number of sections, and it would be interesting to know how many such motors are provided with starters in strict compliance with the regulations. Another case taken from actual practice shows the extreme absurdity of the rules, and refers to a motor of 110 h.p. at 225 volts, taking about 400 amperes. Such a motor, to comply with supply rules of 10 amperes per step, etc., would require not less than 350 sections of resistance. As, however, it was for a private installation, the current on first step was made 10 per cent. of the full-load current—*i.e.*, 40 amperes—and the increment was also 10 per cent., or 40 amperes. The number of sections in the resistance was in this way reduced to 60, and a much more practical result attained. The supply rules, however, all point to one fact, and that is, that the station engineers do not object to big currents on motors, but object very much to sudden demands for the full amount. The rules, although badly constructed, simply mean "that means must be provided in motor starters, such that the current is raised gradually to the amount necessary to run the motor continuously, and the excess or acceleration current in starting shall not exceed the running current by more than a certain amount."

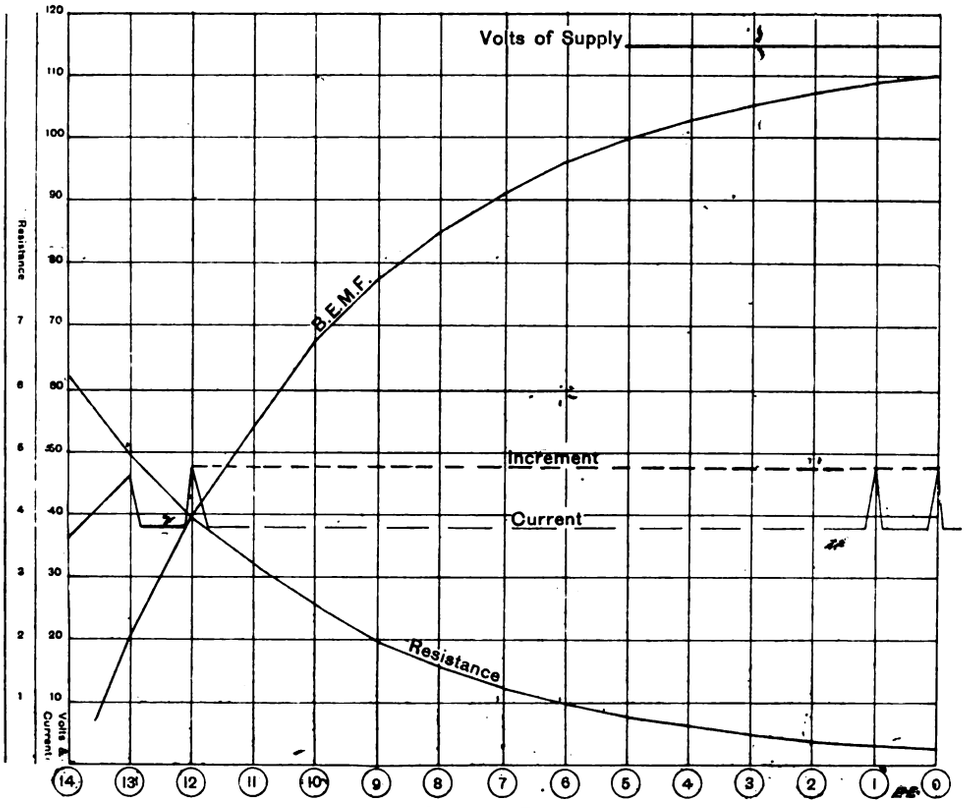

DIAGRAM 7.

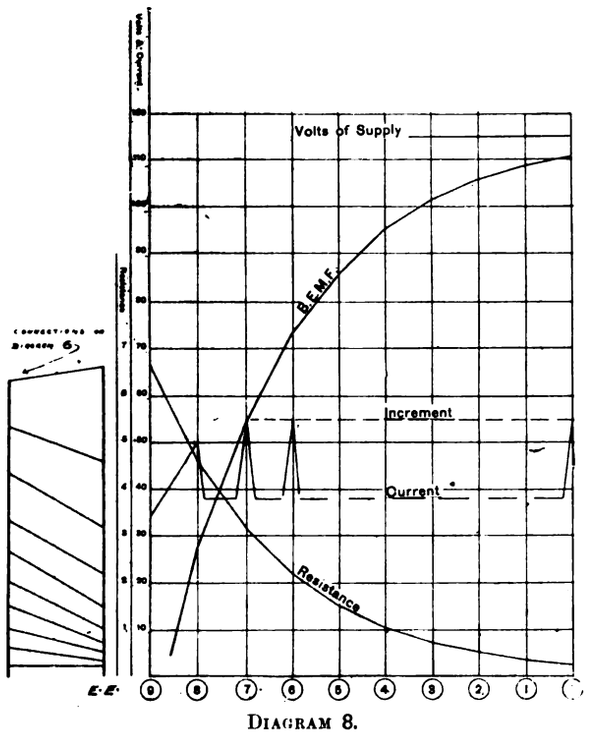

DIAGRAM 8.

Initial Current.—Now some manufacturers, so far from complying with the supply requirements, actually make a virtue of the fact that their starters pass 1½ times the full-load current on the first step, and also make a claim that the motor is certain to start. Many such starters have been refused by supply authorities, and eventually discarded for no other reason than this. Other manufacturers have attempted a solution in the manner shown in Diagram 10, which represents the first few steps of a resistance designed for 50 amperes at 200 volts, the current increasing in 10-ampere steps up to the full current. The total resistance is, therefore, 20 ohms, and the following values up to the full current point are as given in the diagram. We will suppose that the motor does not start until full current is passing. On moving switch arm on to contact A we get 10 amperes, and as there is 10 ohms between 1 and 2, there is a P.D. of 100 volts. On moving on to contact B there is a violent spark, and the current is increased to 20 amperes. The P.D. between the contacts is shown on the diagram, and it will be seen to rapidly diminish towards the armature end. Now consider what happens if the switch arm is moved back. Violent sparking occurs on leaving the contacts, and this to a pronounced degree in going from B to A. It is here possible, if the contacts do not exceed the arcing limit, to draw and maintain an arc of approximately 50 volts by 10 amperes, with only five amperes going round the resistance between A and B, and 150 volts by 15 amperes in the resistance between contact B and motor. Now, some manufacturers, instead of using more sections in the resistance, have separated the contacts further apart to such a distance that the arc cannot be maintained across the gap, and this, being the very reverse of a remedy, has introduced fresh troubles. In the first place, standard slates have been used, and the wider gaps have necessitated fewer sections for more onerous conditions. Secondly, the arcing has not been annulled, and the enamel between the contacts gets burnt off. If the switch is used in a damp and dusty situation—and some must at times be used in such places—the damaged surface of the slate accumulates dirt, with the result that an arc has been known repeatedly to run right across the switch from the first step to the armature end in attempting to start the motor. This effect is, of course, particularly noticeable with high voltage, say 400 to 600. The obvious remedy is to have more sections in the resistance and to divide up in such a way that, even when

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starting under full load, there shall not be an arcing voltage between the contacts. Generally speaking, it is correct to divide geometrically throughout.

High Voltage.—Turning our attention now to resistances for high voltage, one of the objections of strictly geometrical dividing is seen in the fact that although the increment is constant for constant torque, the P.D. between the contacts is high, and causes excessive sparking at the starting end. This is shown in Diagram 11, which represents a starting resistance for 10 h.p. at 500 volts, taking 10 amperes on first step. The full-load current is approximately 18 amperes. The armature and series field winding is 1·8 ohms. This figure is much above the average, as the motor is a slow-speed type, and the current increment is therefore less than it would be with a standard motor. In this case the P.D. between the contacts is 120 volts, and remains so until the motor starts. Considerable sparking results, and if the switch lever is moved back over the contacts, destructive arcing must occur.

It frequently happens in starting motors that irregularities are discovered in the driven machinery just at the moment of starting, and the most natural manipulation by the operator is to move the lever back, contrary to printed instructions supplied with most starters, and rapid deterioration must, of course, result. This can be overcome by limiting the P.D. to a predetermined amount. The author has found that when this figure does not exceed 30 to 35 volts, the amount of sparking, even with currents of 200 to 300

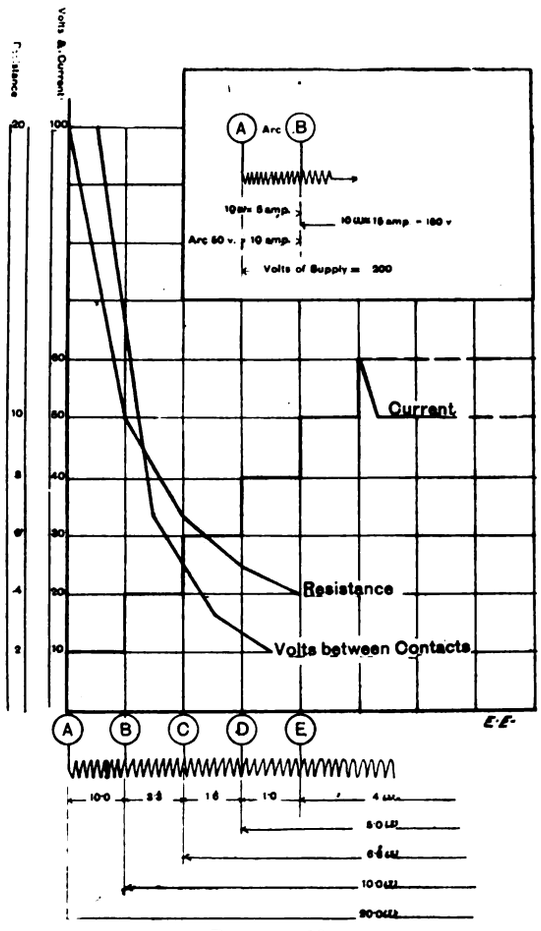

DIAGRAM 10

amperes, is so small that very little deterioration of the contacts takes place. Further, the contacts, instead of being widened apart, may be placed as close as $\frac{1}{16}$in. together, and even when the switch is moved back to reinsert resistance, the arc formed cannot be maintained across the gap. The arrangement of such a switch is shown in the photograph, from which it will be seen that the faces are renewable, but although a large number have been in use for some time no contacts surfaces have been renewed. An actual example of a resistance graded in this manner is shown in Diagram 12 for a motor of 10 h.p. at 500 volts, full-load current approximately 17 amperes, armature and series field resistance 1·8 ohms, total resistance approximately 60 ohms—*i.e.*, half full-load current on first step. Maximum difference of potential between contacts not to exceed 35 volts; 1·8 to 11·4 ohms is divided geometrically on slide rule, using 8in. on lower scale (10in. rule) as factor. At this point the resistance of section 10 is 1·9 ohms, and with the full-load current will absorb 32·5 volts. If the geometrical division is carried further, the P.D. specified will be exceeded, therefore equal sections of two ohms are now taken until 29·5 ohms (the resistance at which the full current only can pass) is exceeded. This completes other 10 sections at 31·4 ohms, the last of which (29·4 to 31·4) measures ·28in. on rule. This, then, is the mechanical value of the new factor with which to geometrically divide up to the total resistance required. The least number of sections is here used for a given current increment and P.D. between contacts, and it will be seen that the resistance is practically divided into three parts (not necessarily equal), the outers divided geometrically, and the centre equally. Under certain conditions it is preferable to use the same gauge for the centre part, and as this ensures uniformity in manufacture a serious practical difficulty is partially removed. On

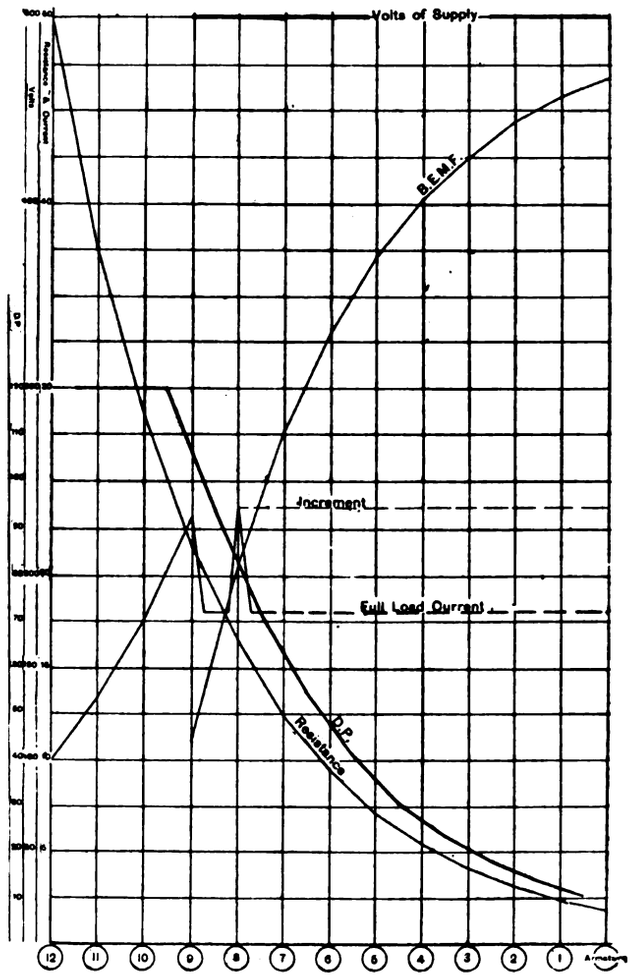

DIAGRAM 11.

the other hand, when the current taken by the motor is very large in comparison with the volts of supply, the P.D. at the full current point with the maximum current increment allowable may be so small that

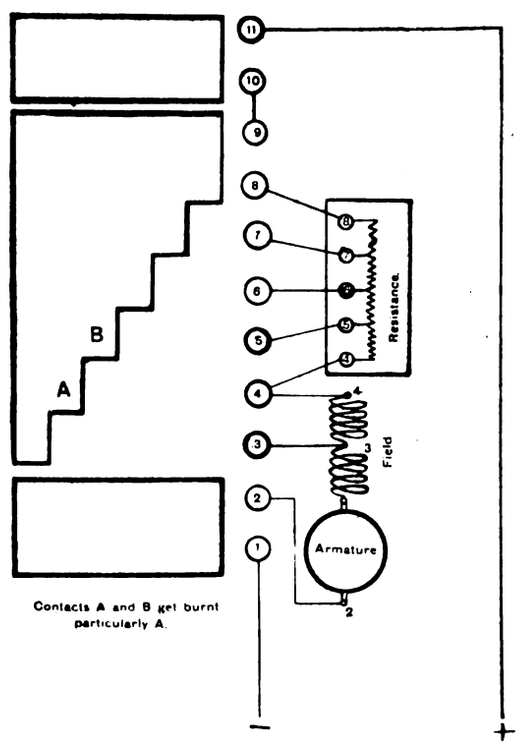

DIAGRAM 14.

it will be found best to increase the common factor gradually so as to maintain the same momentary rise of current until a point is reached at which the P.D. will have increased to the maximum permissible,

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from which point the division is carried on to the total resistance employed, using the new factor as found in a similar manner. An instance of this method is shown in the accompanying Diagram 13, which refers to the 110-h.p. 60-section starter previously referred to. The range of current capacity, gauge, and resistance is extreme in this case, and the workshop diagram of the connections show how these difficulties have been overcome.

Barrel-Type Controller.—These are regarded by many engineers with much favour, and are preferred in many specifications to those of any other type. The author regards the barrel type of controller as the worst type in use. Owing to the diameter of barrel being usually limited to about 6in., the number of steps between off and full speed is usually only six or seven, no matter what size the motor and how high the voltage. Diagram 14 gives the development and connections f a regular manufactured type of single series controller as sent out by he maker for a motor of 6 h.p. at 500 volts. The resistance is divide into four equal sections, with the result that the contacts at A and B are very soon badly burnt, and must be renewed. This has led to making these controllers with renewable and removable contacts

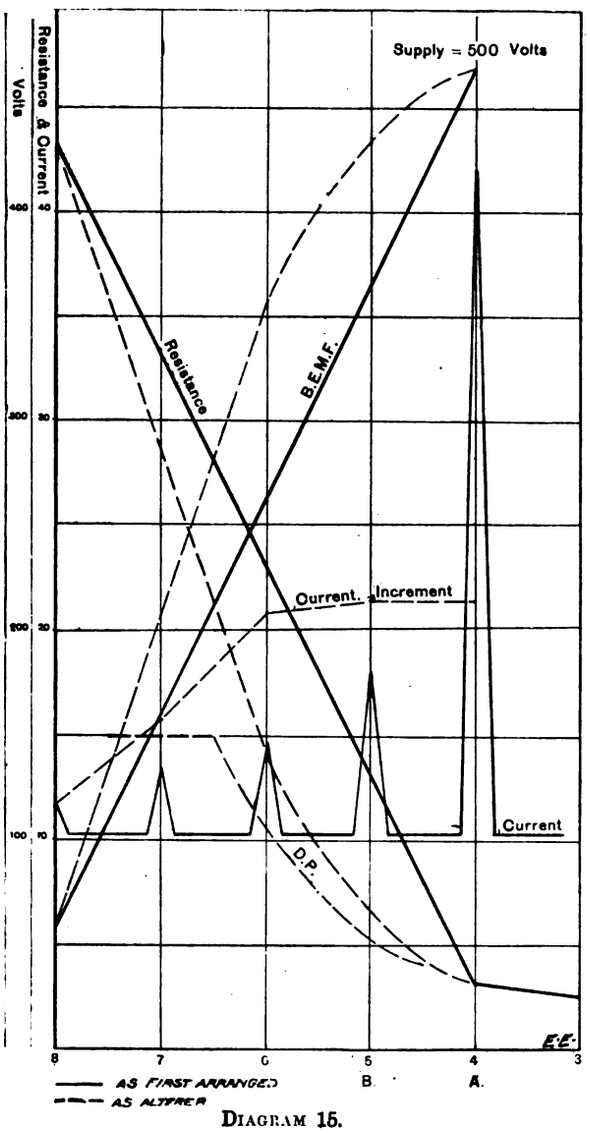

DIAGRAM 15.

The small number of sections will not permit of geometrically dividing, as although the current increment would be equalised, the high volts on the first steps causes serious sparking and burning of contacts. No rule can be given for such onerous conditions, but a compromise can be made as shown in Diagram 15, by reducing the current increment on the first steps (and consequently the voltage), and increasing both at the armature end. The deterioration of contacts is in this way reduced and equalised to a remarkable extent. Diagram 16 gives a better example of compromising, and represents a seven-step controller for 7½ h.p. at 480 volts. Such controllers can only be tested with the motors in the actual machines they are intended to drive, for although it is quite easy to imitate the load in the testroom, it is generally impracticable to imitate the conditions of inertia existing in the driven machine. The current increment shown on the diagram for a series motor is in excess of those observed under any condition with series winding, owing to the fact that an increase of current strengthens the field, lowers the corresponding speed, and consequently the motor gives a higher momentary back E.M.F. than that by which the curve is calculated. In series-parallel controllers, the problem of correctly dividing the resistance is made more difficult owing to the fact that certain sections of the resistance must do double duty, acting first in the series arrangement and, secondly, in the parallel arrangement. It is, of course, necessary to reinsert resistance when changing over from series to parallel, otherwise the effect is practically equivalent to short-circuiting the motor with half the voltage of supply. On the other hand, if too much resistance is reinserted the motor will actually be reduced in speed, and observation points to the correct amount being more a matter of guess work and experience rather than calculation.

The author offers the following method of solution, taking as an example a motor taking 60 amperes at 250 volts with sufficient resist-

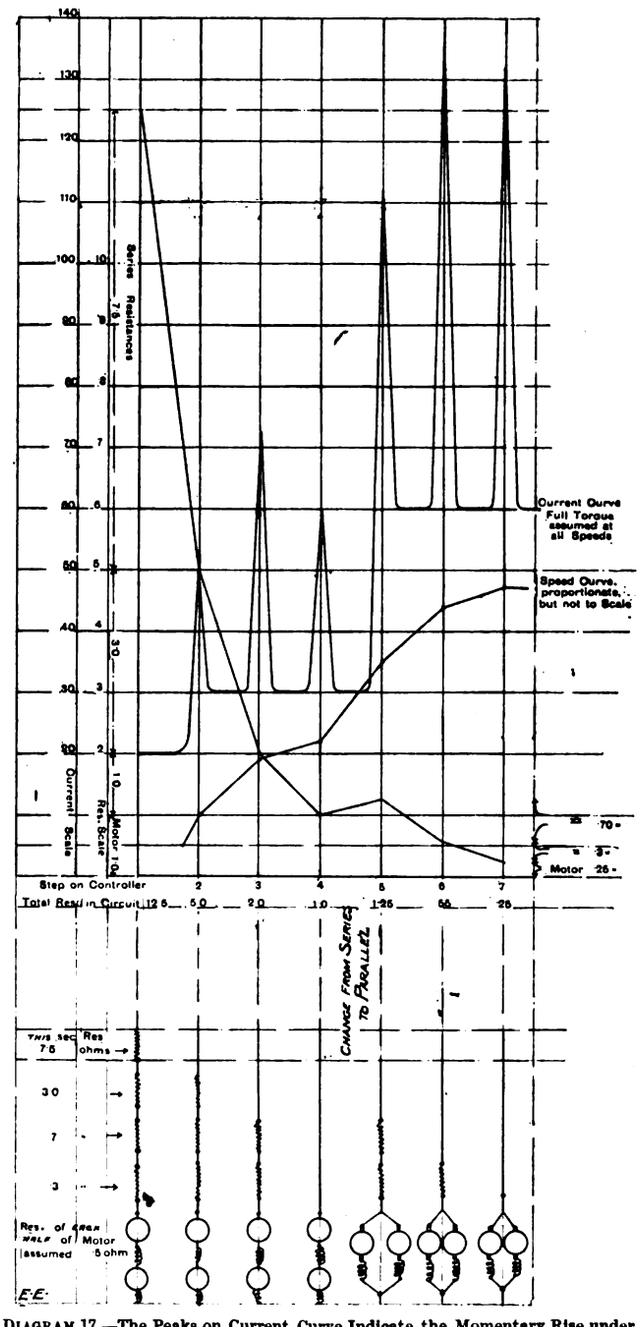

DIAGRAM 17.—The Peaks on Current Curve Indicate the Momentary Rise under Full Load, Neglecting Self-induction and Acceleration.

ance to limit the current to 20 amperes on first step. The internal resistance of the motor is 1 ohm in series and ·25 in the parallel arrangement. There are to be three steps of resistance in the series arrangement, the last of which is to be split into two for the parallel arrangement. For the series arrangement the total resistance required is

$$\frac{250 \text{ volts}}{20 \text{ amperes}} = 12{\cdot}5 \text{ ohms},$$

and with 1 ohm as the armature resistance, the values 12·5, 5·37, 2·32, 1 will give a strictly geometrical ratio (to be afterwards modified). The differences between these figures give three sections of resistance of 7·13, 3·05, and 1·32 ohms, of which the last is to be modified and subdivided into two sections for the parallel arrangement. In the latter case the internal resistance of motor is ·25 ohm, and the total resistance forming the other extreme of the geometrical ratio must be such that in changing over from series to parallel with this amount in circuit, there should be no alteration in speed. Owing, however, to the small number of steps provided in the controller it is imperative to accelerate speed in changing over, and it is therefore necessary to add one to the number of sections required in order to discard the "extreme" necessary for the calculation. Thus: the direct E.M.F. necessary to overcome the internal resistance of the motor when run-

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ning in the series arrangement is 30 amperes × 1 ohm = 30 volts, and the back E.M.F. is therefore 220. In changing over, the back E.M.F. is instantly halved—*i.e.*, 110 volts—and the amount of resistance to be reinserted without change of speed must be sufficient to absorb 60 amperes with the direct E.M.F. available. This is therefore

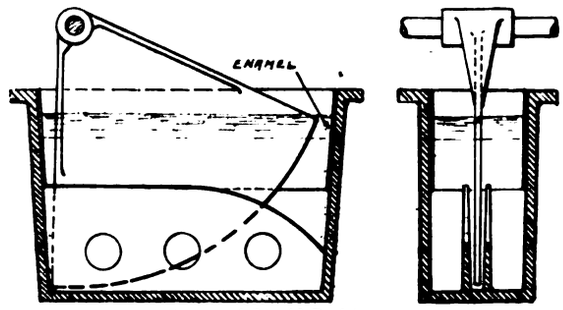
$$\frac{250-110}{60}=2{\cdot}3 \text{ ohms.}$$

Now taking this value as one extreme, the motor resistance as the other, and allowing one extra section for discarding the extreme, we get 2·33, 1·11, ·525, and ·25. Omitting the first value and taking the differences between the remaining three, gives ·585 and ·275 as the values of the two sections of resistance to be employed in the parallel arrangement. The sum, ·86 ohm, is much less than the value 1·32 already determined for the series arrangement, and some compromise is necessary, as these values must be alike. The least alteration should be made to the parallel values, and by making these ·7 and ·3 and the series values 7·5, 3, and 1, a practical subdivision is attained without much interference with the length of the peaks. The characteristic of this controller, which is a standard tramcar type, is fully illustrated in Diagram 17. Any departure from good grading in the resistance results in abnormal current demands and objectionable and violent acceleration, particularly when the car is light. Such controllers are provided with a reversing barrel, thus giving seven speeds in either direction, but the author suggests the necessity of a new type giving, say, 12 forward speeds and only two backward ones, as a means of reducing the current demands to something nearer to the normal rating of the motor. The forward contacts at one end of the car would, of course, be cross connected to the backward ones at the other end of car.

Variable Torque.—Now, it may be argued that the whole system of diagrams, as here shown, is fallacious, owing to the condition of full torque throughout being only assumed. The author, however, desires to reiterate the statement that if the resistance is divided up correctly for the most onerous conditions, it will also be correct for any other condition, and the sparking and current fluctuations will be reduced proportionately with the load and inertia in the driven machinery. It is, of course, difficult to predetermine the exact behaviour throughout in any one application. Diagram 18 shows how the actual conditions of running may be closely approximated. The curve A represents the full-load curve of a motor driving a particular type of printing machine, which takes approximately 100 amperes at top speed and 65 amperes at half speed. Curve B shows the half-speed current throughout, and another similar curve may be drawn between these two, which may be said to represent the true behaviour under the particular condition of load. Similarly, when only a portion of the same machine is at work, another curve may be drawn to represent the lighter load, and from these considerations one can predetermine the maximum current any coil needs to carry, and the gauge can be determined for starting or regulating as required. It is, of course, unnecessary to plot curves for every resistance, as a little consideration will show that the same end may be attained by arithmetical means.

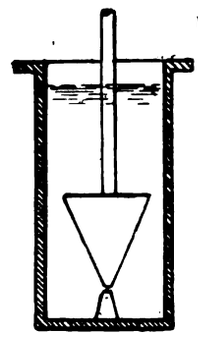
Mechanically-Operated Switches.—Before leaving the subject of metallic resistances, it is necessary to point out a particular modification demanded by starters in which the resistance is automatically cut out by the driven machine while accelerating up to full speed. The various sections of the resistance are cut out at intervals which are inversely proportional to the "instantaneous speed" of the driven machine; and even when the resistance sections form a geometrical ratio, it may happen that insufficient time is allowed between the final steps for the current to become steady before the next section is cut out, and, in consequence, the peaks in the current curve are superimposed, with the result that the final increment is much greater than the initial increment. Where the number of sections is small the minimum increment with a geometrical ratio is necessarily large, and the final superimposed peaks may be large enough to cause serious sparking at the motor, if not also at the switch. This can be compromised by using a diminishing factor from the starting to the armature end, and the superimposed reduced increments at the armature end will tend towards an uniform current increase throughout. (See Diagram 19.) A serious objection to this type of switch is that it is necessary to pass at least the full current on the first stop in order that the driven machine (say, a hoist) may deal with the maximum load, otherwise the machine will not start and resistance cannot be cut out.

Liquid Resistances.—The author now desires to apply the foregoing considerations to liquid resistances. There is no doubt that this type offers the best solution of all difficulties, and when carefully designed affords the most perfect method of control, particularly with reversing motors. Most liquid resistances, however, have at least one of two defects—*i.e.* (1) the current cannot be sufficiently reduced when the dipping plate is just entering the liquid; and (2) the resistance cannot be sufficiently reduced with the plate all in before short-circuiting the starter, and the consequent rush of current seriously damages the switch parts and abnormally stresses motor and machine. Either of these defects may be remedied at the expense of the other by varying the density of the solution employed. A fallacious method of remedying both defects is by making a small projection on the dipping plate touch a similar projection inside the pot, the actual surface in contact being frequently less than a square inch. The intention is, of course, to reduce the resistance gradually down to zero. Owing, however, to the great divergencies in the conductivities of the metal pot and the solution employed this object is not attained, and when the gap is open only a very small amount a large amount of energy became concentrated in a very small space, and arcing and violent ebullition results. A better method of overcoming both defects consists in enamelling the pot halfway down on the inside, and arranging the dipping plate to pass between two other plates cast into the pot. The enamel compels the



Improved Liquid Resistance.

current to pass through a greater length of solution at starting, and gives much better control. The second defect is overcome by the plate arrangement, in which it will be seen that the dipping plate passes close between two others so as to reduce the resistance to a minimum by presenting large surface area to each other. The fixed plates are



Unsatisfactory Liquid Resistance.

provided with suitable apertures to permit free circulation of the solution. Several starters on this principle have been in use on large motors for some years, and give no trouble whatever even on 500 volts.

Regulating Resistances.—Before leaving the subject of starting resistances a few observations on resistances for regulating purposes only will be opportune. In many motor equipments the starting and regulating switches are two entirely distinct pieces of apparatus, although constructed on similar lines with similar materials, the only difference being that the starting resistance is graded more or less correctly, while the regulating resistance is divided into equal sections of resistance and is one gauge of material throughout. Such an arrangement gives satisfactory speed variations, and is generally preferred, although an independent regulating resistance is not without disadvantages, the most serious being that if the switch is moved while the motor is running under load, all the violent current demands previously shown are introduced. For this reason the author strongly condemns the separate regulating switch, and maintains that these should be combined with the starter. No difference, of course, must be made in the ohmic value of the sections, when so combined, the only alteration necessary being in the gauge of the material employed, so as to carry the current continuously without attaining a dangerous temperature. Many of the previous diagrams actually refer to resistances for combined starting and regulating, and with the same number of sections there would be no alteration in the grading for whatever purpose.

Suggested Rule for Starters.—As has already been pointed out, considerable divergence exists in the specifications of consulting engineers and supply companies as to what is required in a starter, and the following suggested rule may prove a base for a more uniform statement—thus: "Current on first step not to exceed 10 amperes, or half full-load current, whichever is least, but for motors taking more than 50 amperes, 20 per cent. of full-load current. The momentary increase of current in cutting out any section of resistance not to exceed 10 amperes, or 25 per cent. full-load current, whichever is least, but for motors taking more than 50 amperes, increment may be 20 per cent. of full-load current." In the interests of the purchaser the following addition may be inserted: "The E.M.F. across any section of the resistance shall be limited to an amount which shall not cause injurious sparking or rapid deterioration of the contacts."

Conclusion.—There are many other details of starters which would be benefited by an open discussion, such as "motor field connections and buffer resistances," "dissipation *versus* absorption of heat in and about the resistance material," "means for using the whole of the material in the final sections and so diminishing the bulk," "quality and capacity of the various materials employed," etc.; but the author hopes that his arguments for better grading alone may bring about a spirited discussion, and draw more serious attention to what is now a mere secondary detail of transmission work.

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NOTES.

Tin-Aluminium Alloys.—The action of stannic oxide on aluminium is very energetic, but the limit of inflammation is reached with a mixture corresponding with Al_4Sn. Mr. Leon Guillet has found experimentally that the product from this mixture, when treated with dilute hydrochloric acid, yields lamellar and filiform crystals of the compound Al_4Sn. Similarly, mixtures corresponding with Sn_4Al, SnAl, and $SnAl_2$ yield lamellar and filiform crystals of the compound AlSn.

Magnetisation of Iron Deposits.—Mr. Chas. Maurain, as the result of experiments on the behaviour of metals deposited electrolytically in a powerful magnetic field, has found that with iron deposits the magnetisation in general does not attain its maximum value until the thickness of the deposit exceeds about 83 millionths of a millimetre, though with very intense fields the normal state is attained with thinner films. Such deposits, contrary to expectation, contain a very considerable amount of permanent magnetism.

American "Transactions."—The *Transactions* of the American Institute of Electrical Engineers for December opens with the discussions on papers by Messrs. Lincoln, Haskins, Davis, and Browne, which were read at the annual convention of the institute at Buffalo in August last. This number further gives the following papers, the first two of which were also read at the August meeting, the remainder being advance copies to come before the institute this month: "The Induction Motor and the Rotary Converter, and their Relation to the Transmission System," by Mr. Chas. F. Scott; "The Contact of High-Potential Systems of Large Power," by Mr. E. W. Rice, jun.; "Street Illumination and Units of Light," by Mr. W. D'A. Ryan; "The Incandescent Lamp of To-day," by Mr. John W. Howell; "A Note on an Acetylene-in-Oxygen Flame," and "The Present Status of the Question of Standard of Light," by Mr. Clayton H. Sharp; and "Electrical Gas Lamps and Gas Electrical Resistance Phenomena," by Mr. P. C. Hewitt.

Precipitation of Colloids by Electrolysis.—Experiments in this matter have recently been carried out in the States by Messrs. W. R. Whitney and J. E. Ober, who have now published their results. It was found, for instance, that when 30 cubic centimetres of a 1 per cent. solution of barium chloride were added to 200 cubic centimetres of a 1 per cent. collodial arsenious sulphide solution, complete precipitation of the arsenious sulphide immediately occurred. This precipitate was shown to contain 0·0152 grm. of barium, and it was also found that an equivalent amount of hydrogen chloride had been produced. By employing an arsenious sulphide solution of half the above strength, it was shown that the composition of the precipitated colloid is independent both of the concentration of its solution and of that of the barium salt. Experiments in which the chlorides of calcium, strontium, and potassium were used showed that the precipitated colloid contained the metals barium, strontium, calcium, or potassium in the proportions of their equivalent weights.

Passive Iron.—Determinations of the polarisation capacity and resistance of passive iron indicate that it cannot be covered by a coating of badly conducting oxide, and the numbers are very nearly equal to those obtained for platinum. Mr. Alexis Finkelstein, according to an abstract in the current number of the *Journal* of the Chemical Society, has found that passive iron does not behave as an iron electrode, but as an oxygen electrode of variable oxygen concentration. The E.M.F, of iron electrodes against various solutions were determined by the author; addition of potassium cyanide to the solutions greatly lowers the E.M.F., and in solutions of mixed ferrous and ferric salts the E.M.F. decreases as the ferrous salts becomes replaced by ferric. The polarisation curves were investigated, and the non-existence of an oxide layer again indicated. The author discusses the cause of the passivity, and shows that it may be accounted for by the assumption that the surface of passive iron consists solely of tervalent iron, the formation of passive iron by oxidising agents and electrolysis being due to the replacement of the bivalent by tervalent iron.

Electrolysis of Ammonium Chloride.—The *Journal* of the Chemical Society for February gives the results of some experiments conducted by Mr. H. Moissan with regard to the electrolysis of ammonium chloride, bromide, and iodide in solution in carefully dried liquefied ammonia. The electrolysis was carried out in a U-tube of glass, platinum electrodes being used. At – 50deg. the iodide was very soluble, the bromide moderately, the chloride little soluble, and ammonium fluoride nearly insoluble in liquefied ammonia. Liquefied ammonia, prepared with care, is practically a non-conductor. When ammonium chloride is dissolved in it chlorine is evolved at the anode, and at – 60deg. to – 80deg. is free from nitrogen. At the same time the liquid becomes yellow from the presence of dissolved chlorine. No chloride of nitrogen is produced. Pure hydrogen is evolved continuously at the cathode. In the case of a solution of ammonium iodide, iodine is deposited at the anode, and does not react with or dissolve in the liquid ammonia at – 70deg. even after 24 hours. If the temperature is allowed to rise the iodine crystals disappear, and a very heavy, dark-coloured liquid is formed, which falls to the bottom of the tube.

Pressure Exercised by Light.—Mr. P. Lebedew has been carrying out experiments in order to determine the pressure exercised by light, which is assumed by Maxwell's theory. His results have been published in the *Annalen der Physik*. The author points out that the obstacles hitherto met with were the radiometer action, which is thousands of times stronger than the action sought for and the disturbing effect of convection. He eliminated the latter by reversing the illumination repeatedly, and the former by the high exhaustion of a large bulb and the exclusion of rays capable of heating the walls of the bulb. To facilitate a rapid equalisation of heat in the radiometer vanes, he made them of very thin aluminium foil suspended torsionally by a glass thread arranged as in the Cardani suspension. The light used was that of an arc lamp, and its incident energy was determined calorimetrically. The surfaces of the radiometer vanes, which were either plain or blackened, were tested with regard to their reflecting powers. The absolute error of the aggregate measurements was 20 per cent. The results agree with the theoretical values of Maxwell and Bartoli within 10 per cent. The pressure is directly proportional to the energy of the incident light, and independent of its colour.

Dissolution of Metals.—This subject has recently been occupying the attention of Mr. T. E. Aurén and Mr. W. Palmaer, who have published their conclusions in the form of a paper. From an abstract of the same we gather that the law of mass action cannot be applied to calculate the velocity of dissolution of zinc in acids, as the values so calculated do not agree with the experimental results. The authors consider that dissolution is purely electrolytic, and occurs solely as a result of local currents. To this is due the slow velocity of dissolution of pure metals. On this assumption an expression is deduced for the rate of dissolution of a metal in acids of any concentration, the

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expression, however, involving an unknown quantity—the resistance capacity. This may, however, be deduced from one set of determinations and the velocity of dissolution under other conditions then calculated. The values so obtained were found to agree well with those determined experimentally. The temperature coefficient between 10deg. and 50deg. was found to be in general about 1·5 to 2 per cent. per degree.. This is far smaller than the usual temperature coefficient of a chemical reaction, but is approximately that of the increase of E.M.F., a result in accord with the theoretical views.

Surface-Contact Systems. — Mr. W. Kingsland, himself the inventor of a system of surface contact for electric tramways, recently gave a lecture before the Birmingham Section of the Institution on the subject. The surface-contact system, he remarked, was steadily coming to the front, and many, like himself, predicted a great future for it. In point of cost, it offered a reasonable prospect of competing with the overhead trolley system, and when it was better known, and had established for itself a good record for practical working, it would compete successfully with the trolley. The vital and crucial point of any surface-contact system lay in the method of switching the studs on and off. As regards the drawbacks which applied to all magnetic systems, in the first place, the continuity of the main current could not always be relied upon, consequently extra apparatus had to be carried on each car. Secondly, the time element required by the switch to perform its function was an objection; and, thirdly, the danger of the switch sticking and leaving the stud alive. Lastly, the nature of switch contact was considered a somewhat serious drawback. It was, he concluded, a matter of first importance in the designs of surface-contact systems that the studs should be solid, that the fixture should not contain any switch operation, and that the switch contact should be a definite contact, quite independent of any mechanical pull.

Street Fire-Alarms.—The Gamewell system of street fire-alarms—an American invention which has recently been introduced into the streets of Bradford by the Fire Brigade Committee—was visited last week by several members of the Sheffield Corporation in order to see the system tested. From information which has reached us, we gather that the alarm boxes measure about a foot square, and are located in different parts of the city. On an alarm being given from any one of these boxes the news is conveyed to the central fire station, and also automatically forwarded to all the sub-stations in Bradford. Each alarm box is numbered, and the recording instruments at the stations indicate the number of the box from which the alarm is given, and also the exact time at which the communication is made. The system further provides for connections with private houses, works, etc. In the event of a breakdown of any one of the underground wires, a bell rings automatically and gives notice that something is wrong. Another ingenious arrangement is that which prevents the alarm boxes being tampered with. We gather from the information before us that each box is fitted with a private telephone for the use of the police. This enables the constable sending the alarm to give verbal information as to where the fire has broken out. While the Sheffield Watch Committee were in Bradford the system was thoroughly tested, and the expedition with which the messages were received and answered is said to have given every satisfaction.

Dielectric Constants of Paraffins.—In a recent number of the *American Journal of Science*, Mr. W. G. Harmell gave the results of some experiments to determine the dielectric constants of paraffins. The experimenter used a modified form of the Blondlot oscillator to obtain the dielectric constants of four commercially different paraffins for 40, 60, and 80-cm. waves. He also made an investigation of the relative velocities of 80cm. waves along magnetic and non-magnetic wires of different diameters. As the result of his work the author reached at the following conclusions. In the first place, for reversals as high as 800,000,000 per second the velocity of electrical disturbances along magnetic and non-magnetic wires of different diameters is the same, thus showing that the magnetic properties of iron are not able to follow such rapid changes. Secondly, the effective field around the Lecher wires, as far as it can be detected by means of an argon tube, does not extend more than 3cm. from the wires, and the effect on the half-wave within this region varies approximately inversely as the square of the distance from the wires. The third conclusion from the experiments is that the dielectric constant of a given paraffin increases with the density of the paraffin. It increases rapidly from a temperature 20deg. above the melting point to a temperature 30deg. below the melting point. Among different paraffins the dielectric constant increases as the melting point of the paraffin increases. Lastly, the dielectric constant increases as the wave-length decreases. It is greater for short light waves than it is for short electrical waves. Cauchy's formula as a means of obtaining the index of refraction for indefinitely long waves does not meet the experimental facts.

A New Monorail Line.—We understand that it is proposed to build a short line of electric railway at the Crystal Palace to connect up the Low-Level and High-Level Stations. This railway, which would lie wholly within the grounds of the Crystal Palace, can, of course, be constructed without parliamentary powers. We believe, however, that the Board of Trade would have jurisdiction over it, especially if any accident were to happen. The line, which would be about 1½ miles in length, would have a rise from the lower to the upper terminus of 100ft. We understand that the permanent way is being designed by Mr. W. R. Smith, and that it is of the monorail type. It differs essentially, however, from the design of the proposed high-speed line from Manchester to Liverpool got out by Mr. Behr, and from the information before us the differences are not improvements. For instance, in this case the single rail is laid directly on the sleepers and the two guide rails are placed at either side of the train at a height equal to the centre of the gravity of the cars. The driving wheels, which run on the single rail at ground level, are flanged to engage with that rail, and small guide wheels are said to bear against the other two wheels. It will be seen, therefore, that with this line the centre of gravity is not approximately at the point of support, as is the case in the Behr system, and it would seem to us that the cost of construction is likely to be considerably more, as two erections are required at either side of the track to bear the guiding rails. We have not heard when the line is to be completed, but it will form without doubt a very interesting adjunct to the attractions of the Crystal Palace.

Induced Radio-activity Excited by Radium Salts.—As a result of careful experiments, Messrs. P. Curie and A. Debierne have arrived at the following conclusions, which are abstracted in the *Journal* of the Chemical Society for the current month. The phenomena of induced radio-activity excited by radium salts are more regular, and the activity is more intense, when an aqueous solution is used instead of the solid salt. The intensity of

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the induced activity is the same for all substances, whatever their chemical nature, under the same conditions, and is independent of the pressure of the gas surrounding the exciting and excited bodies. The induced radiation, like the exciting radiation, consists of some rays which are deflected in a magnetic field and some which are not. Other conditions being the same, the intensity of the induced radiation depends on the free space in front of the excited body; if, for example, several copper plates are placed parallel with one another and about 1mm. apart, they acquire little activity, but if about 30mm. apart, they all become strongly active. The intensity of the radio-activity which can be excited in a given enclosure depends only on the quantity of radium introduced into it in the form of a solution. The glass of the enclosing vessel generally becomes luminous, and the luminosity finally acquired by any part of the vessel is independent of the position of the radium solution. If a radium solution and zinc sulphide are placed in separate flasks connected by a glass tube bent twice at right angles, the sulphide becomes and remains phosphorescent, and at the same time exhibits radio-activity, the intensity of the activity being independent of the phosphorescence and equal to that which would be acquired by any other substance under the same conditions.

Transmission Plant in Agricultural Districts.—An interesting description of an electric power transmission plant at Crottorf, in Germany, has recently appeared in one of our Continental contemporaries. The plant in question is situate in the centre of a very fertile agricultural district. The water power of the Bode River has been utilised to the extent of 500 h.p. in this installation, and the balance of the power is generated by steam-engines, for which an abundant supply of fuel is obtained from the neighbouring coalmines. In the station there are two 500 kilowatt-ampere three-phase generators—the one driven by a steam-engine and the other by steam and water power together. At low load, however, the water power alone is found to be sufficient to run the machine. Current is transmitted at 7,000 volts, the area of transmission being 18 miles in diameter. The generating station is situate in the centre of supply, and there are at present 27 towns which are taking electric light and power. In all the smaller towns, where there is no great use of power, there is a transformer sub-station for supplying the current for lighting and power purposes. The larger towns, which consume not only much light, but also much power at an irregularly varying load for agricultural purposes, have separate lighting and power circuits. The sub-stations in these towns contain storage batteries which are charged by motor-generators. During the day the batteries are charged and supply at the same time current to the few burning lamps. During the night the battery and motor-generator operate in parallel. Power is used in this district especially for thrashing. The motor is placed on a carriage in order to connect it easily with any machine to be driven. To take current from the high-tension circuit on the open field, a portable transformer on a carriage is used.

Telephones on Steamships.—The *American Telephone Journal* for the 18th ult. has an interesting account of the system of telephone communication which is installed on the steamer "La Savoie," one of the largest boats of La Compagnie Générale Transatlantique's service between Havre and New York. Differing in one detail from the practice generally in vogue in hotels, there are on board "La Savoie" four separate switchboards instead of one general exchange, this plan being found better adapted to the requirements of service on board ship. The cabin deck is divided into three sections—forward, 'midships, and aft—each of which has its central telephone office. In the forward section the switchboard consists of 128 drops, representing respectively the two telephones in each of the 64 staterooms in the section. A single plug serves to make connection with whatever telephone may be desired, and the jacks bear the number of the corresponding drops, so that there can be no possibility of error by even the most inexperienced operator. An operator and a messenger are on duty at each station throughout the day and night. The switchboard in the middle office is identical in every particular with that of the forward section, but the after section is smaller, the number of telephones being 72 in 36 staterooms. In order to avoid all unnecessary noise, all the bell gongs on the circuit are of wood, giving a soft note, just loud enough to attract attention. Combined transmitters and receivers are used exclusively, and they are hung at the head of each berth so as to be within easy reach of the occupant. The system in use is that of Pithois, and was installed by the Société Industrielle des Téléphones, of Paris. In addition to the general telephone service on board "La Savoie," telephonic communication is provided between the bridge, the captain's room, the engine-room, and the various places of navigation throughout the ship.

Subway Construction.—Our American contemporary the *Electrical Review*, notes some interesting features of the construction of the rapid transit subway in New York, with which much progress has now been made. The most typical example of subway construction in this work is on the eastern side of the city, where the tunnel is being blasted through solid rock. A concrete arch is being formed as the rock is removed. Iron girders rise to a height of some 20ft., and the wooden false-work centres are arched across. Over these centres the concrete is embedded, having an average thickness of about 2ft. At the river site one of the most interesting features of the work will be undertaken, and a new method of under-water boring will be brought into use. In another locality the tunnel has to be taken through clear earth, which involves a very intricate plan of sustaining the vault prior to the formation of the concrete arching. The general scheme of construction has been to use concrete arching only where the weight overhead has been self-sustaining, as in the rock tunnels, or where a considerable depth underground had to be worked through. Where purely structural work had to be done, the edges of the excavation were faced with a single-brick wall; inside of this a bed of concrete was moulded, next to which was laid a weather-proofing of tar-paper and asphaltum, and in some places asbestos. We gather from the article in our contemporary that great care is being taken by the engineers in charge of the construction against the contingency of accident. In the rock tunnels the drilling is done at night, and the blasting in the early morning. Air-pipes are run into the piercings to rid the chamber of vapours, and after each blast a body of men known as "tappers" make an advance survey, and where a cleavage is discovered it is immediately made safe. Special precaution in safeguarding these points is provided in the subsequent work.

Supply in Bulk.—At the meeting of the Manchester Section of the Institution of Electrical Engineers last week Mr. Hurdman A Earle presented a very interesting paper on the subject of the supply of electricity in bulk. He remarked that although this was at present an undeveloped industry in this country, it was one which was being brought prominently forward by the promotion of a large number of Power Bills having the supply of electricity in

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bulk as their aim. He emphasised the fact that the object of these schemes was not to retail electricity to small consumers, but to supply in bulk to corporations, to authorised undertakers, and to large works which were situate outside any present authorised area and required a supply of power. Thus, they were not to be permitted to compete with any authorised distributors. There was, however, an enormous field open for these power schemes, for, notwithstanding the number of electrical works that were already in operation, the demand they were supplying was but a fraction of possible development. The number of electricity works in operation in Great Britain and Ireland amounted to about 200, and besides these some 270 other provisional orders had been granted, but not more than half had found it desirable to commence the erection of works. Quite apart from the supply of power, therefore, there were large numbers of smaller towns which, although they had obtained an order, found their cost of production on a small scale would be too high to ensure a good return on money spent. Mr. Earle concluded his paper by a reference to some of the power schemes already sanctioned by Parliament. Incidentally, he mentioned that of the Yorkshire Electric Power Company, whose area of about 1,800 square miles comprises the manufacturing portion of the West Riding. The discussion which followed the reading of Mr. Earle's paper, which was cordially received, is reported elsewhere. The author states the number of electricity works to be about 200, but 400 is more nearly the figure.

Steam-Turbines.—This subject was discussed by Mr. F. J. Warburton in a paper which he read before the North-East Coast Institution of Engineers and Shipbuilders at the last meeting of that society in Newcastle. The author first explained some of the earlier forms of steam-turbines, and remarked on the shape of the steam-nozzle and of the wheel vanes, which latter should be as nearly as possible semi-circular. Single-disc turbines, he proceeded, must revolve at enormous speed, and be geared down for driving ordinary machinery. Thus, a 10in. De Laval turbine working at 70lb. pressure makes 14,000 revolutions per minute. The multiple-step steam-turbine was devised as a means of reducing the speed of rotation and driving machinery direct. This idea was first developed into a marketable commodity by Parsons during 1884-7. The earliest Parsons parallel-flow turbine was a collection of zigzag nozzles, whose walls were formed by projecting rings of blades intermeshing, and so arranged that the "zigs" were fixed to the inner circumference of a stationary hollow cylinder, and the "zags" to the outer circumference of a rotatable cylinder. The modern Parsons turbines, apart from improvements in mechanical and constructional detail, differ from the earliest only in the alteration of the contour of the steam passages or nozzles from a zigzag to a sinuous shape. Instead of turning sharp corners the steam now traverses flowing curves, and the cross-sectional area of steam channels increases in nearly exact proportion to the growing volume of steam as it expands to the exhaust pressure, the collective areas at each stage fulfilling more closely the conditions for a perfect nozzle as previously mentioned. Prof. Curtis, of New York, has designed large steam-turbines which follow Parsons very closely in theory, but are differently worked out mechanically, and Prof. A. Rateau has worked out a multiple-step impulse steam-turbine consisting of a number of Pelton or Laval wheels arranged in series on a shaft, each wheel revolving in a separate chamber. Distributing nozzles convey the steam to the wheel vanes, and the whole of the expansion is accomplished within the fixed nozzles. The steam leaves the chambers at almost the same pressure at which it entered, the wheel vanes merely receiving the impulse due to the velocity of its particles; there is, therefore, in this case no tendency to leakage and no necessity for fine fits or clearance. The author mentioned, in conclusion, that a machine of this type has been built of 1,200 b.h.p., and one is now in hand of 1,800 b.h.p., from which a steam consumption of 12½lb. brake horse-power per hour is expected.

Forced Lubrication.—The members of the Ashton-under-Lyne Society of Engineers had an interesting subject expounded to them at their last meeting, when Mr. Chas. Day, one of the directors of Ferranti Limited, lectured on "Forced Lubrication of Bearings." The lecture was the outcome of a visit which the members of this society made last summer to the works of Messrs. Ferranti at Hollinwood, when the method of lubricating the bearings of the electrical machinery at these works came in for special attention. In response to the invitation of the society, therefore, Mr. Day consented to lecture on the subject at one of their meetings. He prefaced his remarks with a brief description of what was meant by the term "forced lubrication," pointing out that it did not refer to the method in which a pump was used merely to lift oil to a distributing box over the bearing. He then shortly referred to the advantages of forced lubrication. The most important of these was the interposition of a film of oil between the bearing surfaces at every reversal, and the clearing action of the oil in washing dirt away from, rather than into, the bearing. The absence of any sort of tap or regulating valve rendered the method one of extreme simplicity, while another important consideration was that with forced lubrication the oil could be used over and over again. He also referred to several disadvantages of the system, but these, he said, could be entirely surmounted by careful design. Concerning the application of forced lubrication to engines in general, the lecturer pointed out that it was not likely to be satisfactory in the ordinary type of horizontal mill engine, as, owing to the oil being supplied to the bearings under pressure, there would be a great amount of splash, making it essential that the engine should be entirely enclosed. As an illustration that the method could be used in engines of the largest size, he mentioned that Messrs. Ferranti were applying forced lubrication to four engines of 2,500 h.p. each, which they have in hand for the London County Council tramways. At the conclusion of the meeting Mr. Day was accorded a unanimous vote of thanks for his lecture.

A Portable Accelerometer.—In a recent paper before the American Society of Mechanical Engineers, Mr. Corey described a portable accelerometer, which may be used for securing direct readings of acceleration and retardation of moving cars and trains. We gather from an abstract in the *Electrical World* that the principle of the instrument is very similar to that devised by Mr. Kapp. Its action depends upon the inertia of a small mass of mercury contained in a horizontal passage, the ends of which are in communication with two short vertical columns of mercury. Thus the flow induced in the horizontal passage produces a difference of level in the vertical columns, which difference of level is wholly dependent on the horizontal component of the acceleration in the plane which passes through the axes of the two vertical columns. Upon this difference of level, or rather upon the change of level of either column from a given zero position, must depend the indication of the instrument. In a small instrument, however, this change of level is very small. Therefore, coloured alcohol or other liquid of low specific gravity is introduced into the spaces above the mercury columns, to which spaces the reading tubes are connected. The reading tubes

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are of comparatively small diameter. Thus the ratio of the cross-section of the mercury column to the cross-section of the reading tube becomes approximately the multiplier of the changes of mercury levels. The upper ends of the two reading tubes are connected so as to prevent evaporation and spilling of the liquids. The reading scale is provided with vertical adjustment to facilitate the proper location of the zero point. If the accelerometer be set to the zero position when the car is either at rest or moving uniformly on either a level or gradient, the indications will be accurate only as long as the car remains on a track of constant grade. When the grade changes, the accelerometer must be readjusted or the proper correction made. When the resetting cannot be done at the time of testing, it should be set at zero on a level track, and the car run over the road and brought to rest on all grades to be measured. In this way the instrument becomes a gradiometer. The instrument may also be combined with a recording device. A feature of the instrument is the accuracy with which it follows rapid changes without excessive and sometimes without perceptible oscillation due to the inertia of the moving liquids. The best results are obtained when the cross-section of the passage at the bottom of the mercury columns is so proportioned as to give the proper damping effect.

Ultra-Violet Rays.—The current number of the *Lancet* contains an article on the ultra-violet light from a rapid oscillation high-tension arc for the treatment of skin diseases. The experiments which form the subject of the article were carried out by Dr. Hugh Walsham, the assistant medical officer in the electrical department of St. Bartholomew's Hospital, with a view to proving that the apparatus he used gave out the necessary ultra-violet radiation for practical trials in the treatment of lupus at the hospital. He decided to adopt the electrical method of testing the rays—viz., letting the rays impinge on a piece of bright metal, such as zinc or aluminium, connected with the leaves of a gold-leaf electroscope charged with negative electricity. The leaves of the electroscope are charged till they diverge a certain distance, then the rays of the lamp are directed on to the ball or plate, and the time is taken before the leaves fall together. In this way the following facts were demonstrated. In the first place, two pieces of quartz, about 22mm. thick and separated from one another by a space of 10mm., stopped 60 per cent. of the rays that affected the instrument. When the space between the two discs was filled with water, from 10 to 15 per cent. of the remainder were stopped. Again, a film of transparent gelatine 0·04mm. thick stopped the whole of the rays, which conclusion, the author points out, is in practical agreement with Dr. Strebel's result, that gelatine 0·5mm. thick stopped all rays below 257 $\mu\mu$. A block of ice 6in. thick offered scarcely any more obstruction than the same column of air. When the arc was formed between iron points the effect was double that due to zinc. The iron arc, however, was visibly the larger of the two. Lastly, the least film of iron oxide on the surface of the quartz stopped the effect of the rays almost entirely. Unfortunately, iron oxide is given off rather freely, and on this account it is not advisable to work with the quartz too close to the arc. On the whole, the experimenter found that iron seemed the most practical of various metals tried. The extraordinary transparency of ice to the rays seems a fact of much importance. Hitherto, in order to render the part to be treated anæmic, pressure has been the only means resorted to, but the author sees no reason why ice to produce cold should not also be employed. Further on in the article he remarks that at the present time it is somewhat hard to tell whether the X-rays or the ultra-violet rays are better in cases of lupus, and he seems to incline in favour of the latter, although, as he points out, the distinction between the two is not great. He concludes from about two months' treatment of lupus patients at St. Bartholomew's, that the curative action of the light given off by the apparatus used in the above experiments is satisfactory.

Goods by Electric Trolley.—Mr. Alfred H. Gibbings, engineer-in-chief of the South Lancashire Electric Traction and Power Company, read a paper before the Liverpool Engineering Society on the 29th ult. on "The Conveyance of Goods on Electric Trolley Lines." The author's remarks were practically confined to an outline of the proposed scheme for the conveyance of merchandise by means of electric tramways between the docks at Liverpool and some of the more important manufacturing centres in the South of Lancashire. At present the scheme is in a very crude state, and before such a system could become an accomplished fact much negotiation would have to take place, and many details, from both an engineering and administrative point of view, would have to be discussed and settled. There can be no doubt, however, that the beneficial effects of a scheme such as that proposed would be enormous, and from the manufacturers' and traders' aspect its importance would be of the greatest. The author explained that there would be no difficulty in laying electric lines on the dock sides in order that the trucks should be loaded direct from the ships or depôts. As each pair of trucks was loaded it would proceed right away to its destination, the average speed contemplated, after allowing for all stoppages, being six miles an hour. The form of truck he proposed was either one on the lines of the Pittsburg express goods car, or one after the principle of that used on the Lancashire Colliery Railway, having a detachable top provided, with facilities for removal by means of cranes. The motor trucks would be of the double-bogie type, with an extension at either end for the motorman and controlling gear. As regards the question of how to reach the districts, mills, warehouses, etc., which were yet some distance from any existing or proposed tramway, in a few instances no doubt it would be profitable to lay down special lines and sidings, but in many others some alternative method would have to be adopted. He suggested that steam-propelled road lorries might replace the electric trucks in order to reach isolated places, but the use of such rolling-stock would be entirely auxiliary, employed only for distribution in bulk. The all-important question of the charges per ton-mile was next considered by the author. He stated that careful calculations had been made, and it was found possible to charge for full loads only 50 per cent. of the present railway charges, and then leave a sufficient commercial profit. The immediate advantages of the introduction of such a system of goods conveyance would undoubtedly be an increased ratable value of the districts concerned, an increased value of land, and a tendency to increase the already large number of industries and manufactures in South Lancashire. The principal public benefit, however, would be the great relief of the streets from heavy lorry traffic. In the course of the discussion which followed, attention was drawn to a supposed difficulty—that of collecting merchandise at the docks and placing it on the line of communication, and at the other end delivering it from the line to the various mills or warehouses. The author, however, did not look upon this difficulty as insuperable, especially in these days of constant improvement in engineering methods. He was afterwards tendered a hearty vote of thanks for his paper.

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THE LORAIN SURFACE-CONTACT SYSTEM.

We have this week been allowed to inspect, through the courtesy of Mr. Earl P. Wetmore, the first sections of the Wolverhampton Corporation tramways, which are being equipped on the above system. Mr. Wetmore is the European representative of the Lorain Steel Co.'s system of electric traction by surface contact. There is now completed at Wolverhampton a full mile of double track complete, with cross-overs and turn-outs leading into the car sheds. Under the terms of the agreement there is to be shortly made a 30-day trial on the line, working under normal condition and carrying passengers. On the successful completion of this 30-day trial the equipment for 11½ more miles of track will be put in hand, so that the bulk of the Wolverhampton trams will then be worked electrically Extension lines are also under consideration. We found on our visit that the cables for the further 11½ miles of track mentioned above are being laid at the present time with loops for the surface contacts while the track is being relaid. This being so, it will not take long to add the contacts and open up the lines. We have before now described a large number of experimental equipments for demonstrating various systems of electric traction working with surface contacts. In nearly all of these the details were not such as commended themselves to a practical engineer, and it must be remembered that the most perfect system, as far as principles are concerned, is after all dependent on detail for practical success. The above remarks do not apply to the Lorain system as shown to us at Wolverhampton. This is so because the system has been constructed on a practical scale, and also because the details of the contact switch and the general arrangements show evidence of most careful design throughout.

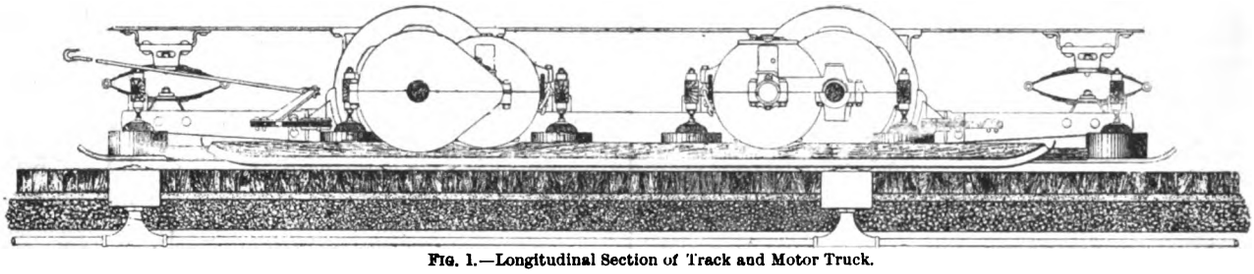
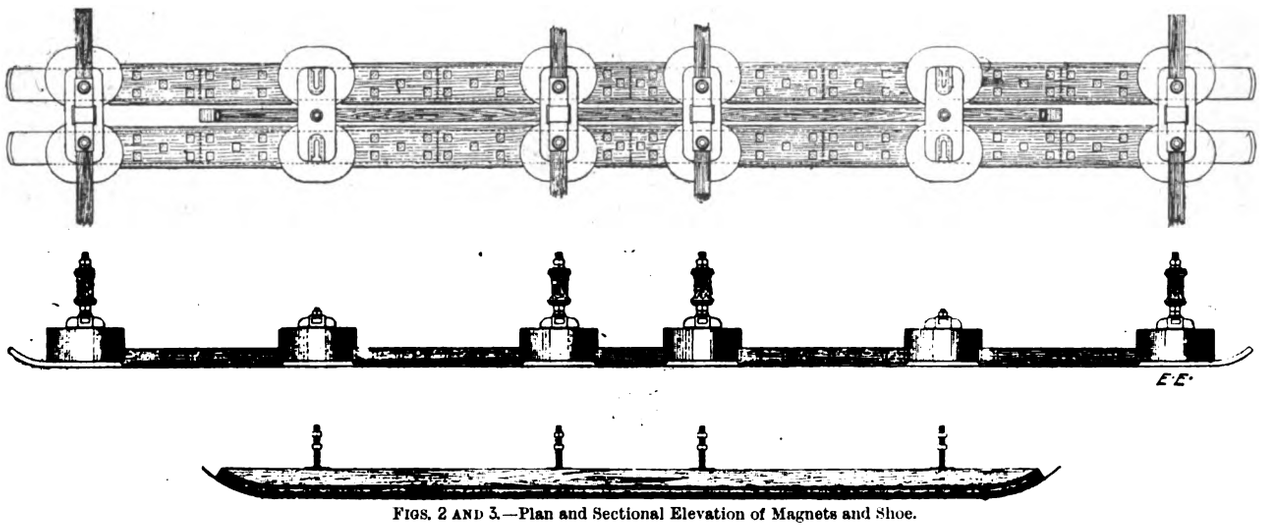


FIG. 1.—Longitudinal Section of Track and Motor Truck.

The system is a magnetic one, in that the switch gear under each contact is controlled by electromagnets carried on the car. Each box is, therefore, quite self contained and independent, and it is an essential to a contact being alive that the electromagnet under the car shall be over it. Any failure, therefore, of the system cannot leave a contact plate connected to the main after the car has passed. In Figs. 1 and 2 we give in plan and elevation the arrangement of electromagnets used to actuate the switch, which will be described afterwards, and also the contact shoe, which collects current from the contact. It will be seen that there are two long magnetic poles placed longitudinally under the car. Between these are connected six electromagnets, all magnetising in the same direction, so that the one magnet pole becomes a north pole and the other a south. In between these two is the contact shoe, which is shown in detail in Fig. 3. It projects, as can be seen in Fig. 1, about 1in. below the magnet poles. It consists of a strip of phosphor bronze secured on to a length of hose-pipe, which is in its turn fastened on to a wooden support. This gives the required flexibility, as the collector goes over the projecting contact. An essential feature which should be noticed is that the magnet poles are considerably longer than the collecting shoe. At Wolverhampton this difference in length was about 18in. at each end, and it is required for two reasons, the first and most important, in our opinion, being that the carbon switch in the contact box is never allowed to break the main current, as the switch is held up for an appreciable time after the contact shoe has left the street contact. In the same way the leading end of the magnet poles pulls up the switch and make the incoming contact plate alive before the contact shoe reaches it. An interval of time has to elapse between the arrival of the magnet poles over the contact block and the lifting of the switch. We were informed by Mr. Wetmore that when running at 30 miles per hour the extra length of 1ft. 6in. in the magnet poles is just enough to allow of the contact being closed as the contact shoe reached the plate. In the case of Wolverhampton, the magnets and also the contact shoe are carried from the car axles, and not from the car bodies.



FIGS. 2 AND 3.—Plan and Sectional Elevation of Magnets and Shoe.

We now come to the question of the street contacts with their magnetic switches. In Fig. 4 is shown the relative positions of the two magnet poles and the collecting shoe over the contact, and Fig. 5 gives a sectional view of the same with a diagram of the magnetic flux distribution. Some more information can be obtained from the sectional view in the other direction (Fig. 6). These illustrations show what has been done at Wolverhampton, with the exception that the cables there are laid on the solid filling-in system instead of on the drawing-in system.

Dealing with the magnetic circuit first, it will be seen that the contact plate, L L, exposed on the surface of the street consists of three parts, the centre being non-magnetic. An inspection of the plates would hardly reveal this fact, and their mechanical strength would make it appear that they were of uniform material. As it is, the central portion

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is of manganese steel, which is non-magnetic and exceedingly hard, while the two outer portions are of cast iron,

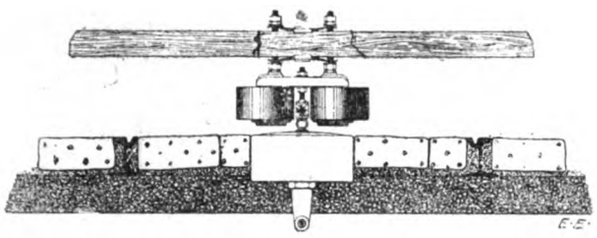

FIG. 4.—Section of Track with Magnets and Contact Shoe shown above.

and are burned on to the steel. The magnetic lines, therefore, leaving one magnet shoe enter into one of these cast-iron blocks, and cross over to the other shoe by means of an iron strip, A A, contained within the insulating cup. This iron strip normally lies as shown by A′ A′ (Fig. 5), and it is

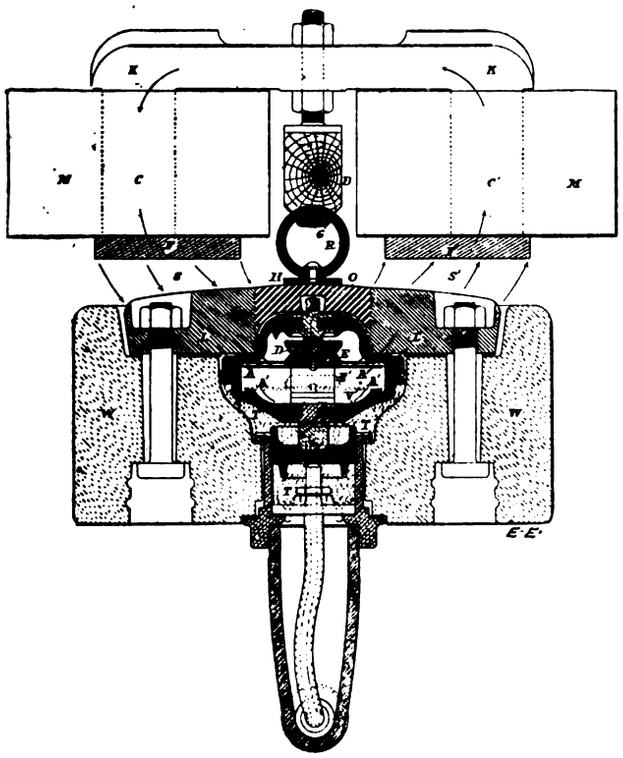

FIG. 5.—Section of Contacts, showing Distribution of Magnetic Lines of Force.

drawn up into position, A A, when the magnet shoes are over the contact. On the upper side of this iron strip a carbon contact, E, is securely attached, and when the plate (which is about 4¾in. long, 2in. wide, and $\frac{1}{16}$in. thick) is drawn up, this carbon block makes contact with another, marked D in the illustration. This then forms the magnetically-operated switch, and it remains to be seen how the details of the same (Fig. 7) are worked out, and how they are insulated from earth.

The main support for the contact blocks in the street is made of moulded reconstructed granite, a material which was fully described in our issue of April 26, 1901, p. 581. In this space is a conical recess to receive the switch cup and the incoming connection. The two bolts which secure the contact plate into the rectangular recess in the reconstructed granite block are, when placed in position, filled in with a bituminous compound, as is shown in Fig. 6. As mentioned before, this illustration shows the cables drawn into pipes. At Wolverhampton they have been laid by the

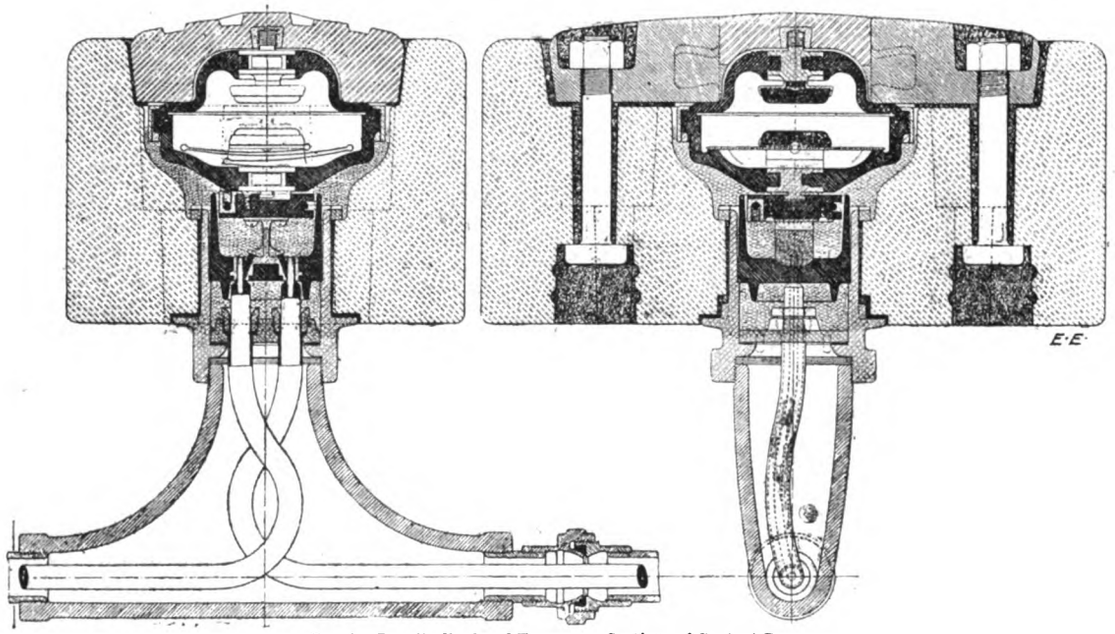

FIG. 6.—Longitudinal and Transverse Sections of Contact Box.

Callender Cable and Construction Company on the solid filling-in system. Where the loop of cable comes up to the contact box, a Y casting, not unlike that shown in the illustration, is placed over the cable and on to the wooden troughing. This casting is then filled up solid, leaving about ¼in. free between its upper surface and the flanged casting, which is secured as a mouth piece into the reconstructed granite. This Y

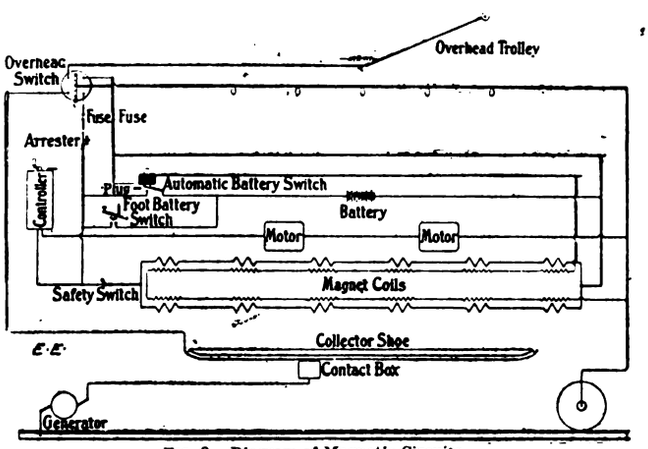

FIG. 8.—Diagram of Magnetic Circuits.

casting is filled in with bitumen, and after the cable has been soldered into the contact tongue, the space round them is filled in with box compound. This compound comes up to the vulcabeston support of this tongue. The rest of the apparatus is attached by a screw to the under side of the composite steel and iron contact plate. It is contained in a vulcabeston cup made in two sections, V and V′, which are hermetically sealed by means of solution applied to their edges, and also secured together by a gasket and annular screwed ring. The under half of

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the cup carries a contact on its inner side, which is connected to the iron plate mentioned above by means of a long copper strip. This strip (seen in the left-hand section, Fig. 6) is broad and thin, and it offers practically no resistance to the rising of the iron armature. At the same time it exerts a certain constraint on it to all but vertical motion. This ingeniously-bent spring, in conjunction with the carbon contacts, practically overcomes the difficulty which other inventors have to solve by the use of mercury contacts, which are so unsatisfactory. The under side of the contact in the lower half of the cup is put into the space below, so as to effectually seal the various parts against the intrusion of moisture. The overall dimension of this iron contact is 11¾in. long by 6¼in. wide. It is deeply grooved on the surface to give a good foot-hold for horses stepping on the same, and the outer surfaces are rounded to afford a minimum obstruction to the street traffic.

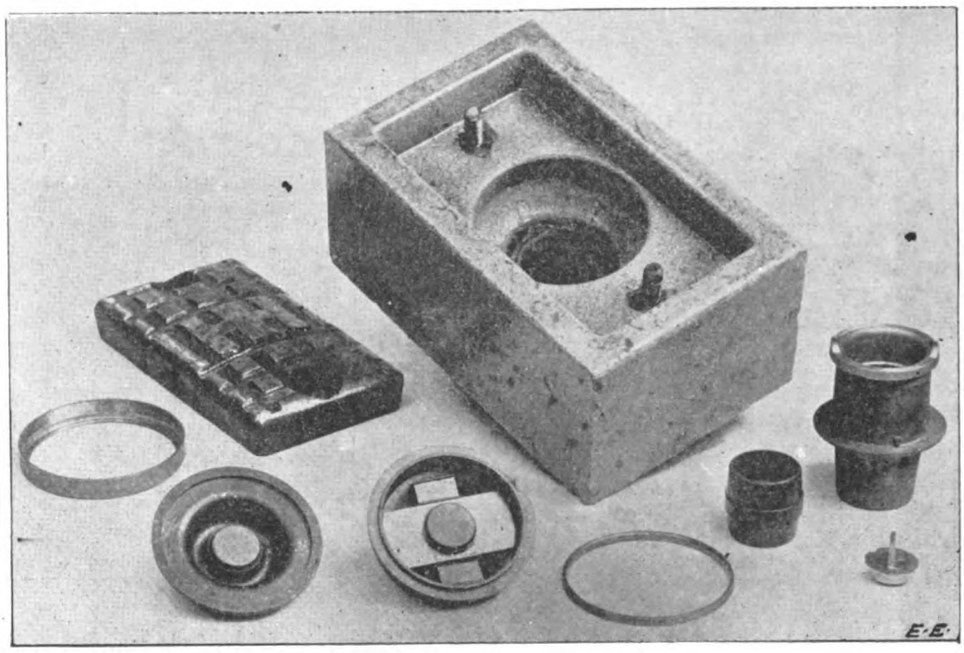

FIG. 7.—Photograph of the Component Parts of the Lorain Magnetic Switch and Street Contact.

Having now described the street contact, we have to revert to the magnets under the car. The actual distance between the magnet poles and the iron blocks is about 1in., and from the under side of these iron blocks to the iron armature there is a further gap of about ⅞in. when in the off position. When, however, the armature has been lifted the magnetic path is considerably shorter, and it must be remembered that the surface exposed by the iron blocks, L L, is very considerable. This travelling magnet is energised by two different windings—the one being in series

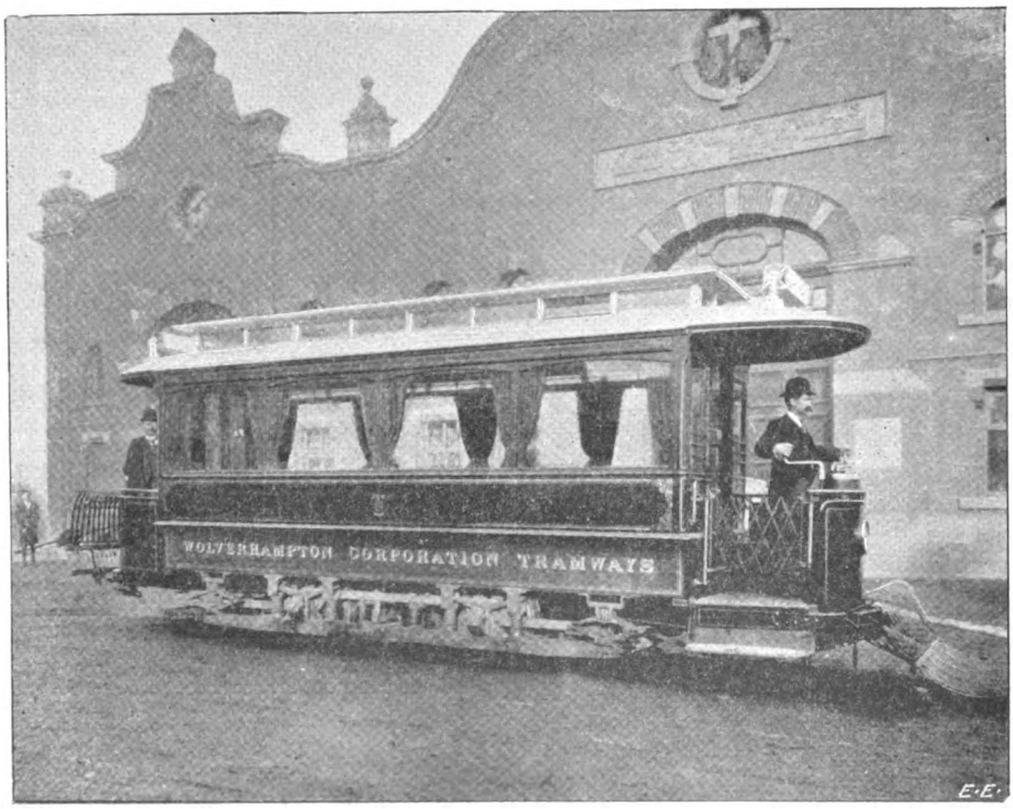

FIG. 9.—An Electric Car by the New Tramway Depot.

terminates in two springs, which engage round the tongue to which the cables are soldered. These springs make the connection automatically with the tongue as the contact plate, with the cup attached, is lowered into the recess in the reconstructed granite block. Before being so lowered, a thick insulating oil of greater specific gravity than water

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with the motors, and the other a 550-volt shunt across the line—as shown in Fig. 8. The series winding strengthens the field when heavy currents are passing, and hence give a greater pressure between carbon blocks. In order to pick up the contact in the first instance, a small six-cell storage battery is temporarily connected across the series winding by means of a foot switch in reach of the driver. It is worthy of note that this Lorain contact system can be installed with a minimum available depth of 9in. under the street surface.

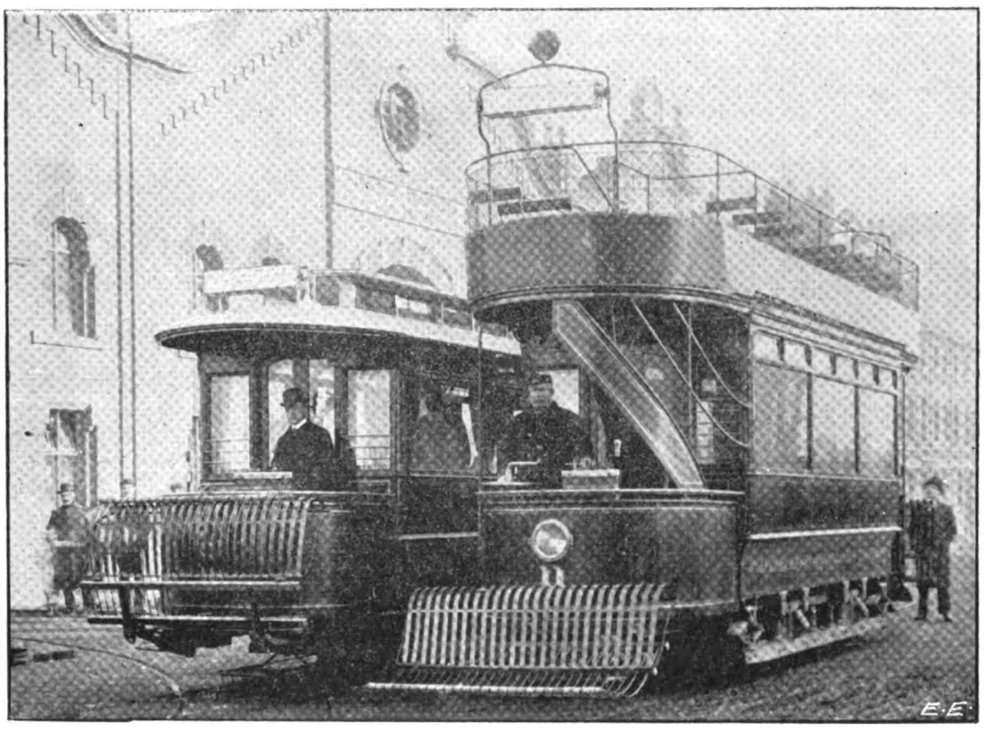

FIG. 10.—View of Two Types of Cars on the Wolverhampton Tramways, showing the "Providence" Fenders.

When we were at Wolverhampton at the beginning of this week, the cars commenced to run at three o'clock in the afternoon and continued running regularly until we left at 6 p.m. The day was one which was most unfavourable to the system, as the streets were covered with liquid mud, and in some cases the contacts were practically under water. The only difficulties we noticed were the following: On the first trip the groove in the rails was so filled with grit and stones that the car wheels once or twice failed to make contact with the earth return. This would have been equally experienced with the trolley system. The other trouble also got over on the first run of a car over the line was due to sheet-iron cuttings, which in Wolverhampton are sometimes removed as trade waste on open trolleys. Thus quite a considerable quantity of iron is dropped, and is picked up by the magnets on the first journey, and these scraps on one occasion gave a slight connection between the contact shoe and a rail at a crossing. The street can hardly be looked upon as the fit place at which to deposit these sheet-iron cuttings, which are exceedingly dangerous to cyclists' tyres, and even to horses. The first car in the morning would, of course, collect any such fragments of iron, but we have no doubt steps will be taken by the Corporation to enforce the carrying of such scraps in

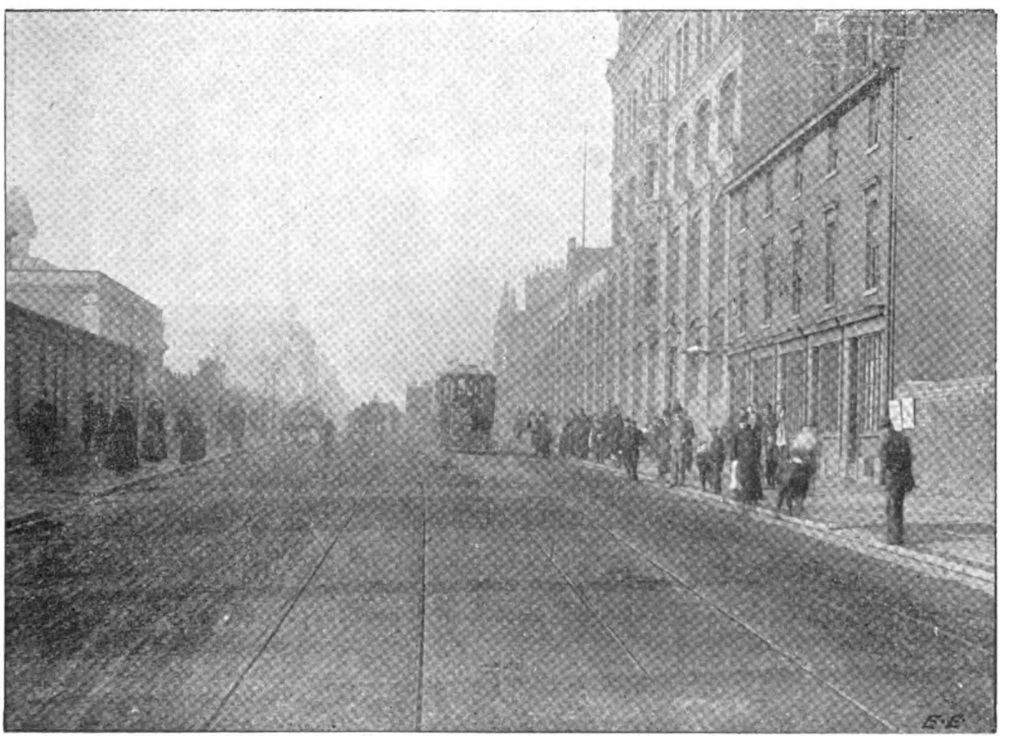

FIG. 11.—View of the Street at Wolverhampton equipped on the Lorain System. The Contacts barely show in spite of bright sunshine.

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ordinary carts or vans. Another point which strikes one on inspecting the apparatus is as to how far the carbon contacts will carry heavy currents without damaging themselves. To try this, an experiment has been made of using one car to push another car along the lines with all brakes on, so that 150 amperes was passed through the carbon contacts. This trial passed off satisfactorily. It must be remembered that any sparking at the carbon contacts can only be due to breaking what small leakage current passes over the edge of the reconstructed granite block as the main circuit is broken at the iron contact surface. This break only takes place after the shoe has come on to the next contact in front. As regards this leakage current to earth which has to be broken, it varies from nothing in dry weather up to an appreciable amount in wet. Experiments made at the Corporation central station on this point were conducted with the contact under a strong brine solution, and we understand that the results did not show any bad wearing of the carbons. It must be remembered that the leakage referred to only occurs when the car is over the contact. In any case, the insulation of the whole system is high.

Figs. 9 and 10 show two views of the Wolverhampton cars. These were manufactured by Messrs. G. F. Milnes and Co., while the trucks, motors, and controllers are of the Lorain Steel Company's own make. The arrangement of the controllers is somewhat novel, in that no resistance is used except in the first three steps; after that the current is kept down in the next positions—*i.e.*, the fifth and sixth—by means of counter E.M.F. The cars have at present both mechanical and electrical brakes, and provision is made in the double-decked car for a slipper brake as well, but this was not added when we inspected the same. What strikes one in the illustrations, and when inspecting the cars, is the car fender employed, which is of the Providence type, as introduced into this country by the Imperial Electric Supplies, Limited, of 86, Charing Cross-road. The fender is seen in Fig. 10, both in the up and down positions. In the ordinary way the front of the fender is about 3in. from the ground, but in the event of anyone being in the way, the driver, by putting his foot on a knob, can drop the fender on to the ground. The curved springs which cover the front of the car are a great safeguard, as they save the direct and often deadly blow of the ironwork of the car on a man caught by the fender. The width of the fender at Wolverhampton, while giving greater security, causes them to project considerably on curves, but we understand that this width is to be reduced somewhat. The fenders, which seem ugly at first sight, are largely employed in America, and, to use Mr. Wetmore's forcible expression, "they are not corpse catchers." In other words, they effectually prevent anyone getting under the car and there being mangled. In Fig. 11 we give a view of the track taken when the surface contacts were in position and the cars running, and it is not the fault of the photographer that contacts do not show, as the plate was exposed on a bright and sunny day. It remains to wish the Lorain surface-contact system the success it deserves in Wolverhampton, and which the carefully worked out details go far to assure.

Just as we were going to press we received a telegram from Mr. Wetmore stating that the Board of Trade approval had been obtained.

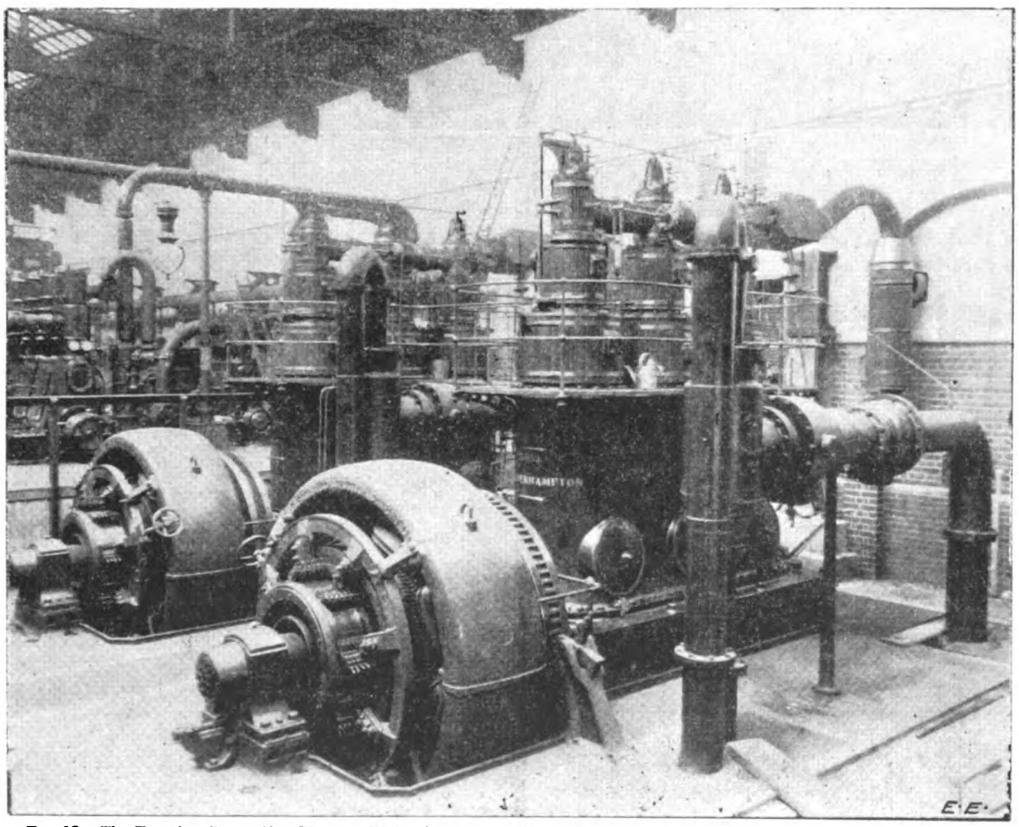

Fig. 12.—The Traction Generating Plant at Wolverhampton—Willans Engines and Electric Construction Company Dynamos.

SOUTH SHIELDS CORPORATION ELECTRICITY WORKS.*

BY JOSEPH A. JECKELL, A.I.E.E.

(Concluded from page 159.)

House Connections and Meters.—The service cable used for house connections is twin rubber cable covered with steel armour. This is a very convenient method of taking a connection into a house, because when the cable is brought into a house it can be clipped up to the wall, just as if it was gas-piping. The cable is laid in a wood trough filled in with sawdust soaked in tar, just in the same way as gas services are done. This has the advantage of preserving the armour, and men who take up streets are now fairly accustomed to meet with gas services and treat the same with a certain amount of respect, so when they come across an electric light service they treat it with some respect, and have no occasion, therefore, to put a pick into it to find out what it is, which cause in the past has been the source of no inconsiderable number of faults. A double-pole disconnection fuse is mounted on a teak board. The teak board is insulated by means of insulators from the wall. A meter and demand indicator are also fixed on this board. The Brighton system of charging is in vogue, and Wright's demand indicators are used everywhere. These indicators, though a fault does occasionally occur in them, give on the whole great satisfaction. Thomson-Houston meters were used at first, but owing to the salt sea air and the soot in the atmosphere, the commutators very soon

* Abstract of paper read before the Newcastle Local Section of the Institution of Electrical Engineers.

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gave trouble. Chamberlain and Hookham meters have been used latterly. These meters have certainly the advantage of being enclosed in a convenient case, with a handle by means of which they can be lifted; whereas the Thomson-Houston meters are enclosed in a thin tin case, with no means of carrying them. Moreover, the Chamberlain and Hookham meters have provision for mounting them on insulators. Some of these meters are inclined to hum, and several customers thought that if the meter hummed it was registering, which, of course, is not necessarily the case. Of course, Thomson-Houston meters are used on inductive circuits. The following shows the progress of the undertaking:

Date.	Lamps connected.
September, 1896	1,083
September, 1897	5,969
September, 1898	11,319
September, 1899	22,876
September, 1900	30,544
March, 1901	34,149

Unfortunately, from March, 1897, to March, 1898, practically no lights were connected, as the plant which had been on order did not come to hand. The following is an account of the units generated and sold during the three complete Board of Trade years:

Date.	Units generated.	Station units.	Loss in distribution.	Sold to consumers.	Street lighting.	Total sold.
Mar. 31, 1898	153,338	6,487	22,950	82,172	41,729	123,901
Mar. 31, 1899	391,637	11,268	72,261	200,808	107,300	308,108
Mar. 31, 1900	634,464	16,417	116,208	393,839	108,000	501,839

All the current is metered as it leaves the machine, so that all the energy generated is accounted for. The number of units lost in distribution, perhaps, looks rather high, but it should be borne in mind that the loss in distribution goes on for the 24 hours, and at no time in the 24 hours does the loss in the transformers amount to more than 2½ per cent., and the loss in the mains may be taken at top load as 5 per cent., thus the largest loss is only 7½ per cent. Of course, with low-tension stations the loss at top load is very often considerably greater than this, when in the aggregate the loss may be less at the end of the year, and the cost of the units lost will be in proportion to the loss at top load, seeing that as it is to compensate for this loss, that more plant has to be installed at the station. The 2½ per cent. magnetising watts practically cost almost nothing to generate, because if the plant has to be turned round this extra amount on it will make practically no difference; therefore, on reckoning the loss on different systems, not only should the aggregate amount of units lost be considered, but the cost which these units take to generate. It has not been found advantageous to disconnect transformers, because the Saturday night load is nearly the same any part of the year, and, as mentioned before, watts lost in magnetising cost very little to generate. Fig. 11 shows the units generated per week for the different years, while Fig. 12 shows the Christmas Eve load. It wi be noticed that there is a very small rise between the '96 load and th '97 load. This was accounted for by the fact that during this yea very few lamps were connected, as the plant contracted for had no been delivered. '98 load shows a nice level curve. The more peak load of '99 is accounted for owing to the Empire Music Hall bein connected at this time. The still more peaky load of 1900 is owing t the Theatre being connected as well as the Empire. Unfortunately, fogs are not known in South Shields—at any rate, fogs which affect the lighting station There are some towns where about 10 o'clock in the morning it is not unusual to have top load on. Fig. 13 shows the works costs per unit sold; this is got out each month. The enormous rise in the price during the summer months is very apparent. Compared with places in the South of England, the days in South Shields are three-quarters of an hour longer in the summer and shorter in the winter; thus in the summer time there is hardly any current sold at all. The rise in the cost during the last year is accounted for by the great increase in the price of coal. It will be noticed that the costs fell during April, 1900, but this was because the coal used during that time had been bought previously to March 31 of that year. On April 1 the price went up 70 per cent., therefore it was only natural that as much as possible was got in prior to the increase. The works costs are got out every week, the total costs every month, the weeks being carried forward to the month, the months to the quarters, the quarters to the half-years, and the half-years to the year. Thus at the end of the year the returns are ready, as this book is made to correspond with the Board of Trade returns. This sheet is also practically a balance-sheet showing the financial results of the working, and when an estimate is made out it is entered under the heading for it. The following table shows how the cost of manufacture comes down as the output increases:

Year ending.	Units sold.	Works costs.	Total costs.
March 31, 1898	123,901	2·676	4·337
March 31, 1899	308,108	1·377	2·161
March 31, 1900	501,839	1·073	1·701

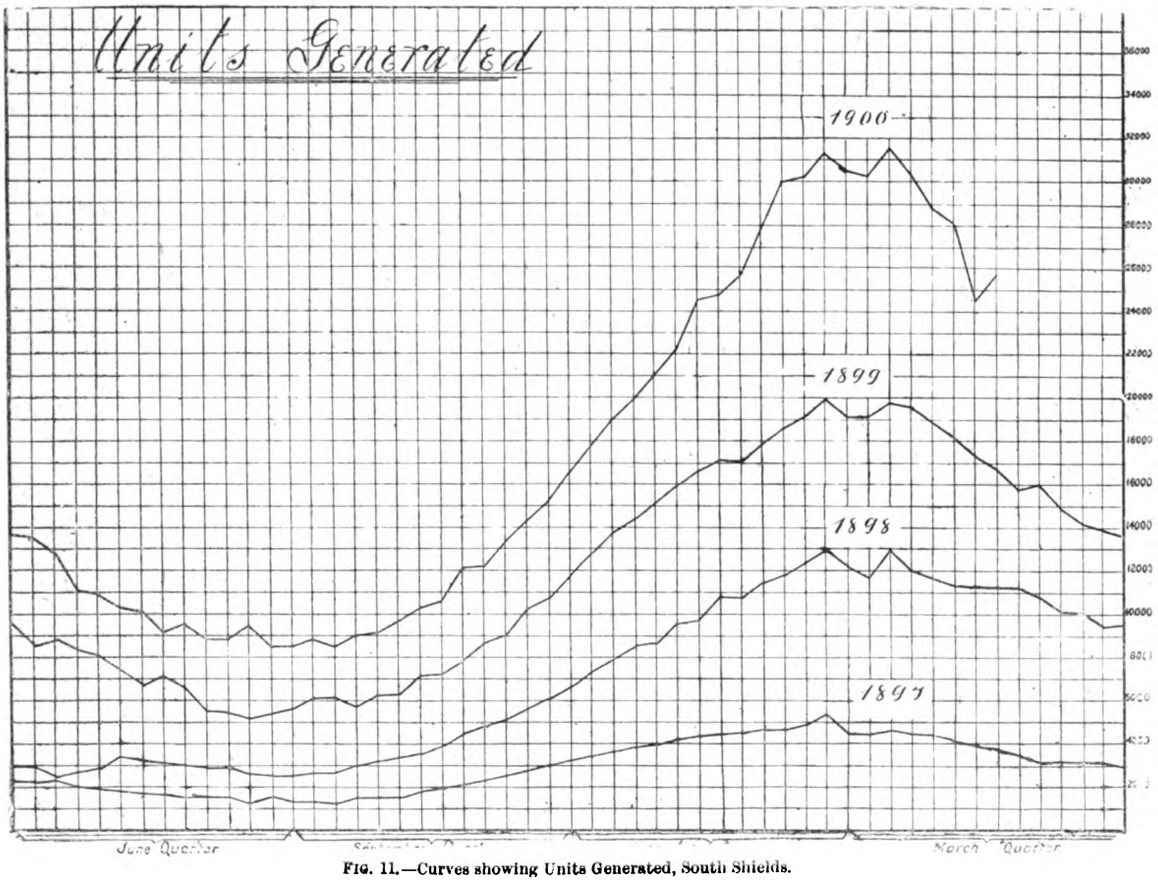

FIG. 11.—Curves showing Units Generated, South Shields.

The cost of labour and material in trimming the public lamps and running the rectifiers is not included in these figures. With regard to the particulars at the foot of the log-sheet, the load factor is what is known as the generated load factor—viz.,

$$\frac{\text{Units generated} \times 100}{\text{Maximum load} \times \text{hours in the year}}.$$

The selling load factor is the

$$\frac{\text{Number of units sold} \times 100}{\text{Maximum load} \times \text{hours in the year}}.$$

The maximum load is the maximum load observed at the station. With regard to the coal, the best we have done is 5·69lb. of coal per unit generated for month ending Dec. 31, 1900. It should be mentioned that the works have always been in a state of extension, therefore there has always been a certain amount of loss, which can materially be reduced when these extensions are finished and the station is working normally. It is obvious that in the hurry and rush there must always be while plant is being put in with the endeavour to keep pace

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with the demand, that stores, etc., cannot be cut as fine as when the normal state of work is reached. The coal used was ordinary Durham unscreened, which is, of course, not nearly equal to Welsh steam coal. As giving some idea of the percentage increase in the size of the station, it may be noted that the original plant installed at starting, in September, 1896, had a capacity of 240 kw. The plant at present

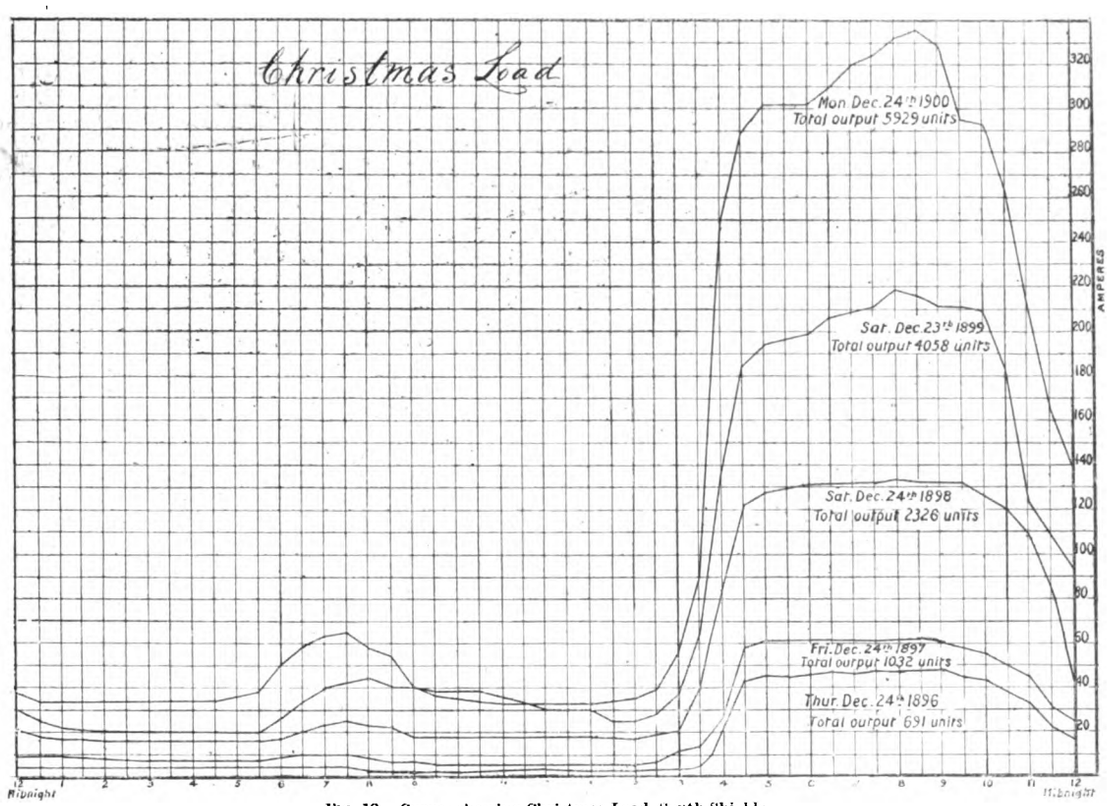

FIG. 12.—Curves showing Christmas Load, South Shields.

nstalled has a capacity of 1,920 kw. The running costs per unit sold, which is calculated to be

$$\frac{\text{Winter works costs} - \text{Summer works costs}}{\text{Winter units sold} - \text{Summer units sold}},$$

is the amount which it costs to generate current once the plant is turning round, that is to say, it represents the amount of coal, oil, etc., which it is necessary to expend in order to actually generate the current after the plant is turned round at full speed. The total running costs will be the running costs per unit multiplied by the number of units sold. The total standing-by charges, which equal the total charges to revenue account, less total running costs, as before mentioned, is the total amount which it costs for coal, oil, wages, capital charges, etc., which is a standing item quite irrespective of the amount of current sold, and would be the same whether the plant had a load factor of 1 per cent. or 100 per cent., and is dependent upon the total demand for current at one particular time, which is the maximum load on the station. The sum of the consumers' maxima in kilowatts—this is the addition of the maximum demand of all the consumers. Of course these maxima do not all fall at one and the same time, and the greater the divergence between the sum of the consumers' maxima and the maximum demand on the station the better for the station, inasmuch as a smaller amount of plant is required to supply the larger demand from the consumers. The difference between the sum of the consumers' maxima and the maximum demand on the station is called the divergency factor, which is one of the chief factors in the economical production of current. The standing-by charges

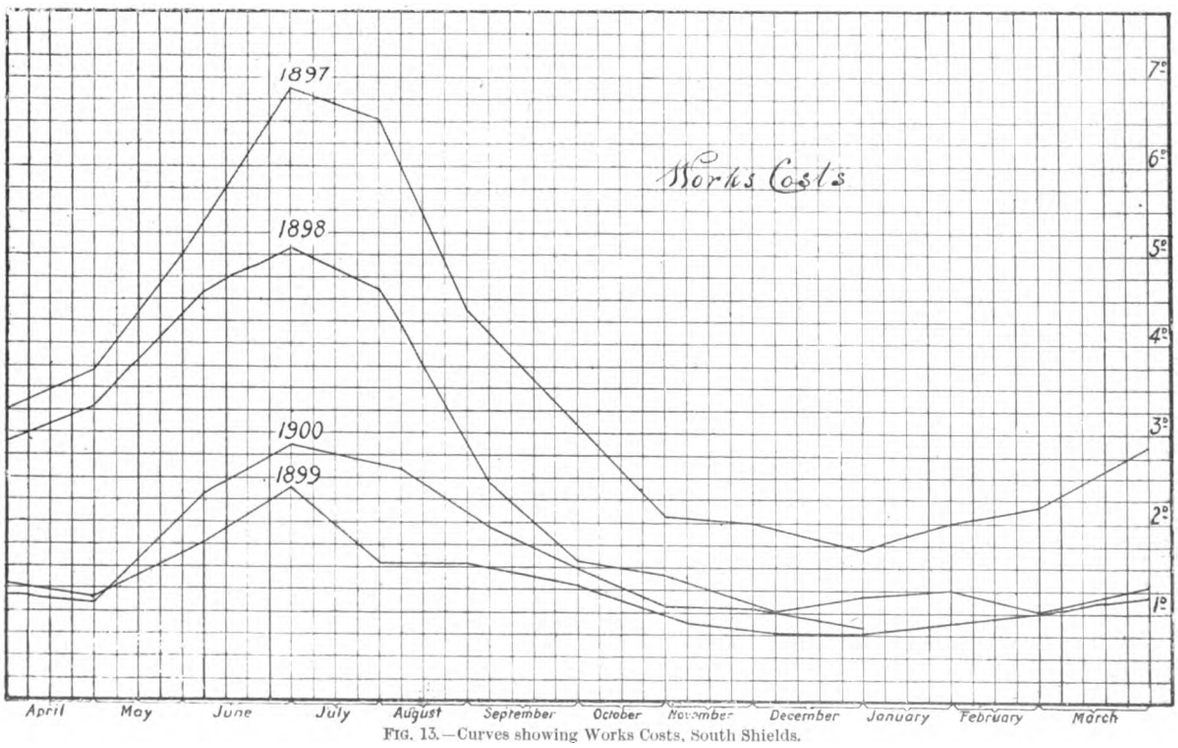

FIG. 13.—Curves showing Works Costs, South Shields.

per kilowatt demanded is, of course, the total sum of the standing-by charges, as mentioned above, divided by the total kilowatts demanded. Therefore the actual cost of generating the current for any one particular customer is found out by multiplying the standing-by charges per kilowatt by the said consumer's demand in kilowatts, and adding to this the running costs of supplying the current—viz., the running costs per unit sold multiplied by the number of units sold to

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him. Thus taking a few instances from last year, when the standing-by charges per kilowatt demanded were £11. 19s. 6d., and the running costs per unit sold were ·4289d., the price charged being 7d. for first hour of maximum demand, and 2d. for the rest.

Description of premises.	Demand in KW.	Standing-by charges at £12 per KW.			Units consumed.	Running costs at ·4289d. per unit.			Total cost of supply per unit.	Average No. of hours max. demand is used per day.	Price obtained per unit.	Loss to station per unit.	Profit to station per unit.
		£	s.	d.		£	s.	d.	d.	Hours.	d.	d.	d.
School	6·82	81	16	9	1,655	2	19	1	12·29	·66	6·11	6·18	—
Shop.....	3·52	42	4	9	1,861	3	6	7	5·87	1·44	4·82	1·05	—
Private house	2·42	29	0	9	1,902	3	7	11	4 09	2·15	4·07	·02	—
Hotel	2·86	34	6	4	7,047	12	11	10	1·59	6·75	2·73	—	1·14
Underground bar	1·188	14	5	1	3,588	6	8	2	1·38	8·28	2·56	—	1·18

It will be seen from this the enormous difference in the value of different consumers, and how visibly better the long-hour consumer is than the short-hour consumer. It practically amounts to the fact that the consumer who is supplied with light for one hour per day throughout the year should pay 8½d. per unit, whereas the energy after the first hour can be supplied at very good profit at 1d. per unit, seeing that it costs ·4289 in South Shields to manufacture it. Of course the running costs will be considerably higher in districts where coal is more expensive, but even then the running costs will not probably ever amount in a well-designed station to more than ½d. per unit. In other words, the man who takes a supply of current equal to his maximum demand for one hour per day should pay 8½d., and the man who takes a supply of current equal to his maximum demand for 12 hours per day can well be supplied at 1·1d. per unit. It need hardly be pointed out that these considerations are only applicable in the case where the commodity to be supplied cannot be stored. In the case of water and gas companies, as they can conveniently and economically store their commodity, it does not materially matter to them whether a consumer takes all his energy in one hour or spreads it over 10, but it is obvious from the previous figures that it is of very material importance to an electric supply station whether a man takes all his energy in one hour or spreads his demand equally over 10 hours, because in the latter case only one-tenth of the plant would be required, and therefore the standing charges would be as 1 is to 10.

It may be noted that at South Shields everything is done in connection with the book-keeping at the electrical works except the collection of the money; it being a principle that the department that makes out the accounts is not the department that collects the money, in the same way that the man who makes up the time should never be the man who pays the wages. All accounts of whatsoever sort or description are entered into the invoice book; the amount is debited to capital or maintenance as the case may be. In the case of stores, when the amount cannot be directly debited to either, it is debited against stock, and it is entered into the stock book and dealt with there. A discount column is inserted, because it would be practically impossible to issue stock in small quantities, less the discount, as the case may be. All the wages go through the wages analysis book, and in that are allocated to the various works orders. The items in the invoice-book are posted to the ledger, the items in the stock-book are posted to the ledger as issued, and the wages in the analysis book are likewise posted to the ledger. An account is opened in the ledger for each works order or heading, as per the Board of Trade accounts. At the end of each half year stock is taken, and a balance-sheet of these books is made. It will appear that this system is simple, and it enables any error to be easily traced. The items in the ledger are posted to the log-book. Any particulars of the log-book can, if desired, be plotted on a sheet. Of course there is a folio number from each book to the others, so that if it is desired to trace any item it can be at once and easily done.

In conclusion, the author would express the hope that there may be some information in this paper that may be of interest and service to others, and should any further explanation be desired on any point, he will be only too pleased so far as lies in his power to give the same.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

453. Mention some conditions and requirements to be taken into consideration in selecting a good oil for (A) cylinder, (B) ordinary lubricating, and give some simple tests which can be carried out in the workshop without elaborate apparatus?—*Z.* A. R.

454. What are the best data for the erection of a tramway overhead trolley line in England in order that the rise and fall due to change of temperature in each span shall be taken up by the dip, the line not to move longitudinally, and the greatest sag to be as small as possible. Materials to be used—$^3/_0$ hard-drawn copper trolley wire, with a maximum span of 120ft., and $^7/_{14}$ galvanised steel span wire, with a maximum span of 50ft.—G. W.

ANSWERS.

Question No. 447.—A shunt-wound motor of 7½ b.h.p., wound for 230 volts terminal pressure, according to makers' name plate runs at 825 revolutions. It is connected to the supply mains of the three-wire system of mains of 230 and 460 volts. I believe that during the day the supply is obtained from the batteries of the station. It is necessary that the speed should be constant for the class of machines driven, but I find that this varies greatly. On the motor is an 8in. pulley; on the driven shaft is a 47in. At 7 a.m. the speed of the shaft is 142 revolutions, of which the motor must give 834·25 revolutions. At 10.30 a.m. the speed rises to 146 revolutions. The motor must then give 857·75 revolutions; and at 3.30 p.m. the shaft makes 158 revolutions—the motor must then make 928·25 revolutions. What is the cause or causes of such rises in the speed? What would be the remedy? Would a 460-volt motor be of more advantage for the work?

Answer to No. 447 (*awarded* 7*s.* 6*d.*).—It is extremely probable that the whole rise in speed is due to the gradual heating up of the shunt winding of the motor. The fact that the speed increases more or less steadily with the time points strongly towards this cause, as the only other reasonably likely explanation—viz., changes in supply voltage would cause more or less erratic speed changes, as the voltage of the ordinary town supply company does not usually vary in any regular way, at least during the day time. In the 8½ hours' run, from 7 o'clock to 3.30, the speed is found to vary from 834·25 to 928·25, or about 11 per cent. Assuming steady terminal voltage, this change in speed can only be due to an 11 per cent. change in flux through the armature. To produce this change in flux the exciting ampere-turns or shunt current would have to vary something like 12 to 16 per cent., according to the state of saturation at which the magnet iron is worked. Suppose a change of 16 per cent. is required, allowing the usual figure for change of copper resistance with temperature—*i.e.*, 21 per cent. per 1deg. F.; this 16 per cent. change would correspond to a temperature change of some 76deg. F. Remembering that the temperature measured on the surface of shunt coils is always about 15 or 20 per cent. less than the true average temperature of the wire as measured by resistance, the temperature of the outside of the shunt, as measured by the thermometer, would only have to change by some 60deg. or 65deg. F. between 7 a.m. and 3.30 p.m. to fully account for the change in speed recorded. Such a change is, of course, quite reasonable, and would be reached on any ordinary motor even if the temperature of the room itself remained unchanged during the day. The usual method of dealing with this increase in speed is to place a small amount of resistance in the shunt circuit when the motor is first started, and gradually cut this resistance out as time goes on, thus keeping the shunt current constant in spite of the changes of resistance of the shunt winding. The speed attained at the end of the longest run likely to occur must be considered as the normal motor speed. In this particular motor this speed would probably be something over 928 revolutions, and in order to maintain the shaft speed at 140 in spite of this increased motor speed, it will be necessary to reduce the diameter of the motor pulley from 8in. to about 7in. or 7⅛in. (or else to increase the diameter of the shaft pulley from 47in. to 53in.). A resistance equal to about 15 per cent. of the resistance of the shunt winding, placed in series with the shunt, would enable the speed of 928 or more to be obtained when the motor was quite cold, and gradually cutting it out would enable this speed to be maintained throughout the day. Instead of changing the

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pulleys, the shunt coils could be rewound for rather more excitation, so that the machine would run at 825 revolutions when hot, with all external resistance cut out, and at the same speed when cold, with the resistance inserted. If there is a considerable amount of spare room on the formers, it would be possible by adding wire to the shunt, without altering the exciting ampere-turns, to considerably reduce the temperature rise. This would reduce, but could not entirely avoid, the changes of speed.

Automatic devices for inserting the necessary resistance to maintain a constant shunt current have often been employed, and one of the simplest is shown diagrammatically in Fig. 1. The small pulley, A, is driven by means of a belt from the motor spindle, and an electromagnet acting against a spring brings one or the other of the wheels, C and D (according to whether the shunt current is above or below the normal), into frictional contact with A. This causes the screwed spindle, E, to rotate in one or the other

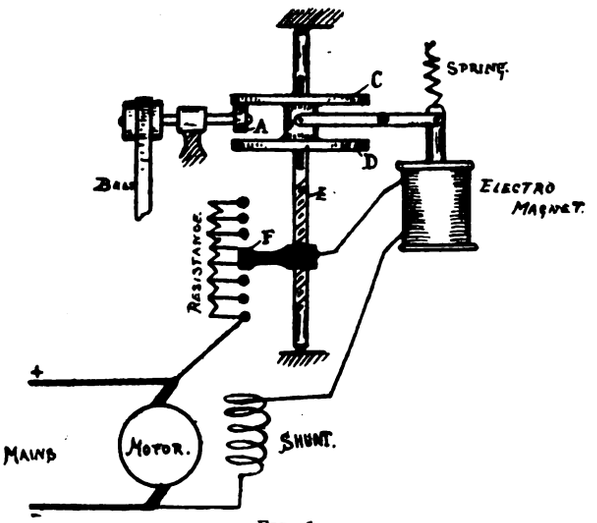

FIG. 1.

directions, and to raise or lower the contact, F, thus inserting or withdrawing resistance until the shunt current attains its normal value again, when the wheels, C D, come to rest. Such devices are, however, liable to give trouble in practice, and a hand-controlled resistance is generally preferred.—Q.

Answer to No. 447 (*awarded* 7*s.* 6*d.*).—The speed of a motor depends directly upon the E.M.F. of the current with which it is supplied, and inversely upon the number of inductors in series upon the armature, and also inversely upon the strength of the magnetic field in which the armature is revolving. Hence any increase in the E.M.F. will increase the speed, or any decrease in either the number of inductors or in the strength of the magnetic field will also increase the speed. Now, we can leave out of consideration any great variation in the E.M.F., as it is most unlikely that this will gradually increase from 230 to 255 without being noticed and the fact mentioned by "J. D." It is also impossible for the number of inductors to alter during the day's run; we must, therefore, look for the reason in some variation in the strength of the magnetic field.

Now, the strength of this field depends upon the permeability of the iron of the magnets and the number of ampere-turns in the field coils. By ampere-turns are meant the number of turns of wires multiplied by the number of amperes which flow through them. The number of coils will remain constant, but the value of the current which flows through these coils may not remain constant, as it will depend upon the resistance of the coils in accordance with Ohm's law, that $C = \frac{E}{R}$. Suppose before the motor is started we find there are 12,000 turns, and that the resistance is 200 ohms, then the number of ampere-turns will be 13,800, for the value of the current flowing through will be $C = \frac{E}{R} = \frac{230}{200} = 1{\cdot}15$ amperes. As the motor is worked, the coils will gradually get warmer, 264·5 watts being continually lost in warming them. This loss is generally called the $C^2 R$ loss, and is equal to the square of the current multiplied by the resistance. The effect of this heating of the shunt coils is to increase the resistance, for if r = resistance of the coils at 60deg. F., the resistance at a temperature t degrees F. above 60deg. will be $r\ (1 + {\cdot}0021\ t)$, so that in the case taken, where the resistance is 200 ohms cold, when the temperature has risen 60deg., the resistance will be 225·2 ohms, and the shunt current will be 1·02 amperes in place of 1·15 amperes. This will decrease the strength of the magnetic field and cause the speed to increase.

No better results will be obtained by putting down a 460-volt motor, as every machine will heat upon being run. In order to overcome the difficulty arising from the variation in speed, the pulleys should be arranged for a speed of 950 revolutions per minute, and an external resistance regulated by means of a multiple-step switch inserted in the main circuit. By means of this resistance the shunt current can be maintained constantly at, say, one ampere, when the motor is started, 30 ohms of external resistance being put in circuit with the shunt; but as the shunt coils heat and their resistance increase, the external resistance must be decreased by cutting some of it out with the multiple switch. So long as $r_s + r_e = 230$ ohms, the speed will be constant, where r_s = resistance of shunt, r_e = external resistance. If $r_s + r_e$ is made greater than 230 the speed will increase, and if less, the speed will be reduced. If the load is always constant a perfectly uniform speed would be obtained by means of a series-wound motor, but it must be remembered that the speed of a series-wound motor will increase as the load is reduced.—M.

Answer to No. 447 (*awarded* 5*s.*).—The causes of speed variation in a shunt-wound motor are: (1) variation of voltage of supply; (2) heating due to length of run; and (3) to some extent variation in load. In a well-designed machine the speed variation caused by (3) should be next to nothing; and, referring to (1), if the variation of voltage of supply be only about 5 per cent., it is possible to design a shunt motor so that such a variation in supply pressure will not affect the speed Cause (2) exists in more or less degree in all electric machinery, and the parts affected in a shunt motor are the armature windings, commutator, and the magnet windings. The effect of the heat is to increase the electric resistance of these parts, the maximum resistance being attained when the amount of heat generated equals the amount radiated. The speed of a shunt-wound motor may be represented by

$$\frac{(E - C R_1)}{W \times F} \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where E represents the voltage of supply at motor terminals;
C the current passing through the armature and brushes;
R_1 the resistance of armature and brushes;
W number of wires on armature surface;
F the magnetic flux passing through the armature.

To deal closely with the problem, it will be advantageous to know the magnetisation curve. Let it be represented by Fig. 1, where O A are the various values of magnetic

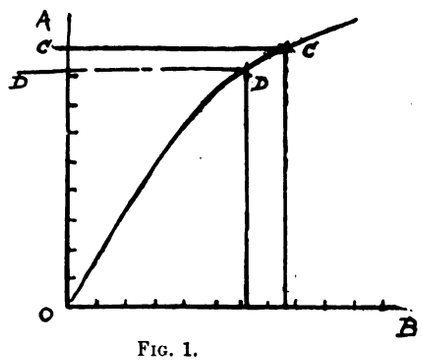

FIG. 1.

flux, F, passing through the armature for respective values of current, O B, in the shunt windings of the magnets. Since W is constant throughout the operations, equation (1) may be written

$$\text{Speed} = \frac{E - C R_1}{F} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

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Now, F varies as $\frac{E}{R_2}$, where R_2 is the value of the resistance of the shunt coils. When starting the motor at 7 a.m. the windings will be cold, and the motor will work on the highest position of the curve, say at C (F = O C), and after $8\frac{1}{2}$ hours the 3.30 p.m. condition, R_1 and R_2, will have increased to a steady value. In a first-class machine the new or maximum values of R_1 and R_2 should not exceed about 1·2 R_1 and 1·2 R_2. Assuming constant terminal voltage, this will mean a reduction in F to value O D; the difference between E – C 1·2 R_1 and E – C R_1 being so small as to be practically negligible, the variation in speed can be written from equation (2), as speed at 7 a.m., $\frac{1}{O C'}$ as speed at 3.30 p.m., $\frac{1}{O D}$; that is, speed at 7 a.m. is represented by length of line O D, and at 3.30 p.m. by length O C. The difference between the two lengths will depend upon the slope of the curve between the two working points on the curve. From similar reasoning, the effect of a variation in E can be obtained, and it will be seen from the equations and curve that if the 7 a.m. working point, C, be sufficiently low on the curve and carefully chosen, a few minutes' variation in terminal pressure would cause no variation in speed.

From the above we deduce that the principal item ruling speed variation when the voltage of supply is fairly constant is the heating of the shunt coils. The variation of E in the case under consideration can be caused by the two sides of the three-wire system not being perfectly balanced; also probably the cables to which the above motor is connected are subject to variable demands of current, and should the motor be fed near the generating station the motor will be subjected to the increased pressure necessary to compensate for the drop in the cables, and, generally speaking, this variation would be the same whether the motor be on the 230 or 460 volt mains, in which case no advantages would be obtained by using a 460-volt motor. The only advantage the 460-volt motor would have is that it would not be subjected to the variations in voltage of supply that are experienced by the out of balance in voltage on the 230-volt main.

The only successful means to obtain constant speed is to work with a variable resistance of fine adjustment in the motor shunt circuit. The motor pulley should have a diameter of $7\frac{3}{16}$in. to give the 142 revolutions per minute on driven pulley when motor is running at 928·25. Fit a pulley of this diameter on the motor. Now measure the resistance of the shunt windings at the 7 a.m. condition and also at the 3.30 p.m. condition. To the difference add about 5 per cent., to be on the safe side, and the result will give the number of ohms required for the resistance to compensate for the rise in resistance of the shunt, and a little more to compensate for slight variation in voltage of supply. Select a regulator switch having many studs, the more the finer the adjustment. Start the motor with nearly all the resistance in the shunt circuit, and as the run is prolonged withdraw or insert resistance as the variation in voltage of supply and increase of resistance shunt demand, and the 142 revolutions per minute will then be obtained at will, and at all times with fairly constant terminal pressure.—*Z.*

Answer to No. 447 (*awarded* 5*s.*).—The rise in speed of a motor after a prolonged run is, of course, due to the heat generated in its windings during the run which extends over several hours, and the rise will go on until the maximum temperature of the motor is reached. How long this will take naturally depends upon the size and design of motor, and also if of the open or enclosed type. It is not necessary in order to deal with the present question to go thoroughly into how the increased temperature affects the speed of the motor, but will be quite sufficient to say that in order to produce the back voltage (back E.M.F.) in the motor necessary to balance the terminal voltage, some alteration must be made to one of the three factors which control this—viz., number of armature conductors, magnetic flux, or speed. In order to grasp this it is only necessary to consider what happens when a dynamo has been run for a number of hours. Owing to heat the terminal voltage drops, and to bring it up to its proper value either the speed is increased or the magnetic field is strengthened. Almost precisely the same thing occurs with a motor, but what was the generated voltage of the dynamo is now termed the back voltage of the motor. What actually happens is that as the heat in the motor rises the back E.M.F. tends to fall, but as the terminal voltage remains constant something must be done to bring the back E M.F. up to its proper value. As the number of armature conductors is fixed, and the field is actually weaker, the speed must rise, and it will do so, as stated above, until a maximum temperature is reached. In modern well-designed motors the rise in speed due to the increased temperature is so small that for all ordinary machine driving it is usually considered as being constant. As regards the motor under consideration, the rise in speed—viz., 10 per cent.—is rather excessive, but not particularly so, taking into account the size of motor. Apparently, however, the variation is too great to efficiently meet the demands of the present case, and, therefore, some means must be taken to obtain better regulation, and thus obviate the difficulty.

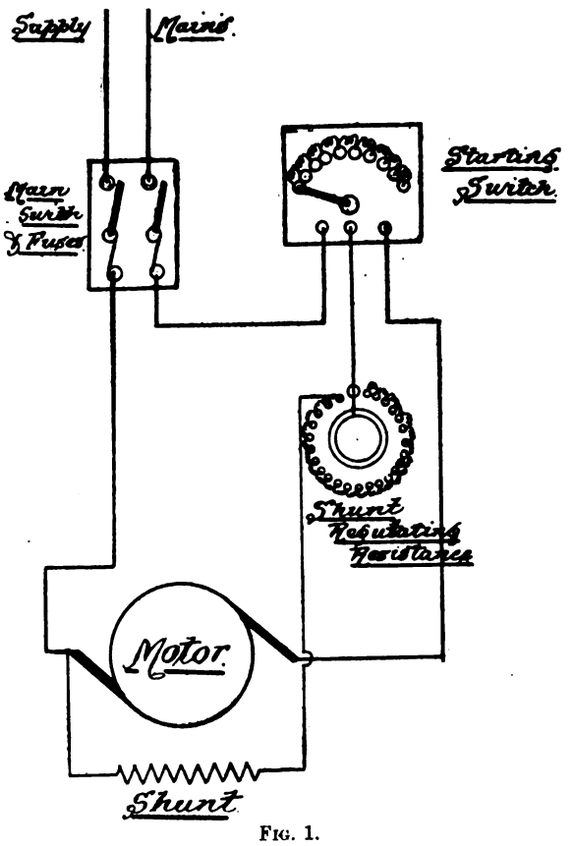

FIG. 1.

There are two ways by which this can be accomplished. The first and most satisfactory, if perfect regulation is required, is to put a regulating resistance in the shunt circuit, and by this means so adjust the strength of the magnetic field as to obtain any desired speed—that is to say, as the heat and consequently the speed rises, the resistance must be gradually cut out of circuit, and the field thus strengthened will bring the speed of the motor down to its initial or any required value within reasonable limits. The method of connecting up resistance is shown in Fig. 1. The second method is to adjust the position of the brushes, and give them a more or less lead as it is required to run the motor faster or slower. If the motors are of the open type and the brushes movable, this can be done quite readily, but care must be taken not to exceed certain limits, or sparking will naturally ensue. It may also be suggested that although a rise in speed of 16 revolutions—viz., 142 to 158—is objectionable, it might be possible to set all the machines suitable for a speed of 150 revolutions, and thus get a variation of eight revolutions up or down. This point has no doubt been considered.

It will be apparent from the foregoing remarks that, adopting a 400-volt motor to replace the present one at

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230 volts, would have no good effect unless, of course, a better designed motor with a smaller rise in speed were obtained; but this applies equally well to a new 230-volt motor. But the remedy for the trouble can easily be found in one of the methods suggested above without this increased cost. Should it be decided to adopt a regulating resistance, it will be best to arrange for the motor to always run at the higher speed and alter the pulley to suit. Then all that will be necessary is to put in sufficient resistance to make it run at this speed cold and gradually cut it out as the motor gets hot. In conclusion, it appears from the figures given that the supply voltage is steady, and the trouble is not caused by a fluctuating voltage.—F. A.

Question No. 448—What in practice are found to be the chief advantages and the chief disadvantages of (1) the moving grate and (2) the sprinkler types of mechanical stoker?

Best Answer to No. 448 (*awarded* 10*s.*).—There is at the present time a great diversity of opinion, and quite naturally so, considering the claims which are made for the different classes, as to what type of mechanical stoker is the best and likely to prove most advantageous under all conditions of working. In order to arrive at any definite conclusion in the matter, consideration has to be given to a considerable number of points. This we will proceed to do after a brief description of the principles of mechanical stoking. There are two methods of stoking: the one is known as coking, and the other the sprinkling, system. The action of the latter stoker is the nearest imitation to that of the human arm in stoking, and consists essentially of a small plate or platform in front of each furnace, on which a fixed quantity of coal is allowed to fall from the hopper above; a shutter or flapper is released and knocks the coal on the fire; by an arrangement of springs and cams the blow of the shutter is made of various intensity, so that the coal is thrown to the front, middle, or back of the furnace as required, and a fire of even thickness obtained.

The principle of the coking stoker is that the coal is pushed by means of a ram on to what is known as a coking plate, placed just inside the front end of the furnace, where it gives off its volatile gases, and is gradually worked by the mechanical action of the firebars to the back end of the furnace, by which time it is practically exhausted of heat and falls into the clinker pit at the back. There is another coking stoker, which is known as the chain or moving grate type. The firebars of this grate consist of short links fastened together to form an endless chain, which revolves at a speed of about 25ft. per hour. The coal drops on the front end, where it cokes, and is gradually carried to the back, where all that has not been consumed falls into the clinker pit. Having thus briefly referred to the essential features of the different classes of mechanical stokers, we will examine in detail the advantages and the reverse under the following heads: economy, smoke and grit, cost, etc.

Economy.—It is a practical certainty that unless the conditions are very unfavourable, the supersession of hand firing by a mechanical method of stoking will result in a considerable reduction in the coal bill. A little consideration of what is required for complete combustion, and consequently greatest economy, will point to the conclusion that this object will be best attained by the adoption of a coking system of stoking. Theoretically this is so; practically also it will generally be found to give the best result in this respect. The principal reasons why the coking stoker is the more economical are—first, that a good thick fire is produced, and a thick fire is admittedly better than a thin one; second, it is better adapted for the construction of a good combustion chamber. A firebrick arch being erected over the fire at the front end of the furnace forms a combustion chamber for the green gases liberated from the fresh fuel as it enters, their complete combustion being thus ensured by the heat from the back end of the arch before coming in contact with the boiler surface. It is impossible to attain a good thick fire with the sprinkler stoker. The moving grate, although a coking stoker, is not quite so good from an economical point of view as the ram type, owing to the fact that the fire at the back end is very thin, and thus admits far too much air for economical combustion. It is very difficult to get reliable figures to prove the statement that the coking system is more economical, as, although a number of tests have been taken with this object in view, the results differ so considerably that a really fair comparison is impossible. When we consider the number of items that are necessary for ensuring economical combustion, such as arrangement of furnace, combustion chamber, flues, chimney, etc., this is not at all surprising.

Smoke and Grit.—By the adoption of a coking stoker with properly constructed furnace and combustion chamber, it is possible to attain a practical immunity from smoke impossible with any other system of stoking. With the sprinkler stoker, owing to an almost continual supply of fresh coal on the fire, there is a constant emission of smoke from the chimey, but of such a light colour as to be almost invisible, and can scarcely be taken exception to. This is, of course, only under normal conditions, for if the boiler is forced, incomplete combustion, and consequently more or less black smoke, will be the result. Perhaps the greatest objection which can be brought against the sprinkler stoker is the production of flue dust or grit. This is due to minute particles of unconsumed coal and ash being carried up the flues and out at the top of the chimney. Especially is this the case where forced draught is employed. It may become very objectionable, and particularly so if the works are in a town, as the grit ejected from the chimney forms a most unpleasant deposit on the streets, and also chokes up the water gutters, etc., on the surrounding houses.

Cost.—As regards first cost, the sprinkler stoker is certainly least expensive; the chain grate is slightly more costly than the ram. The sprinkler stoker will generally be found to cost least for maintenance and repairs, although this naturally depends more upon the construction of the particular stoker than upon its type.

General.—It is in general considerations of adaptability that the sprinkler stoker shows to best advantage. For instance, it is practically the only stoker that can be forced—that this is of no mean importance will be readily acknowledged by anyone who has had experience of what is required by the boilers of a central station in case of emergency. It is, of course, possible to vary the feed of coking stokers, but it takes time, and cannot possibly be called forcing. Again, the sprinkler can be used with almost any class of fuel without affecting its efficient working. It is also lighter and more easily adapted to existing boilers than the other types, and does not take up so much room in front of the boilers as some forms of coking stokers—notably the Vicars, which is very cumbersome, and leave little room for the necessary fittings in front of a boiler. One outstanding advantage of the moving grate stoker is that it can be bodily withdrawn from the furnace for cleaning or repairing purposes. As regards the arrangements made for getting rid of clinkers, this is entirely a matter of arrangement for moving the firebars, and may be made almost identical in any case irrespective of type of stoker. The sprinkler is probably the cleanest and also has the neatest appearance, but as regards noise is perhaps at a disadvantage. All types of stokers have one great disadvantage, and that is having no means of hand firing in case of emergency.

It may be pointed out that one type of stoker has been left entirely out of the question—viz., the underfeed stoker, but this may form material for another question.—F. A.

Answer to No. 448 (*awarded* 5*s.*).—Mechanical stokers may be broadly divided into two classes—namely, those of the coker and those of the sprinkler type. These, again, may be sub-divided into numerous forms or classes, but they are all on either the coking or sprinkling principle. In almost all forms of mechanical stokers the grates are made movable, usually being worked together with the firing gear, and generally adapted for working either by hand or power.

1. For externally-fired boilers the revolving type of grate is largely used, and has met with much success. This grate is made up of a number of cast-iron bars, each about 9in. long, having a series of air-spaces on each side, the whole being linked together in the form of an endless chain, and working over sprocket wheels at the front and back. Suitable means for adjustment of the grate is provided for at the

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front end, and the whole grate is mounted on a movable carriage running on rails, which can be drawn out to allow for repairs, etc. This type of grate is usually hopper fed, but it is adapted for the coker type of stoker only, and can be worked either by hand or power. A water-tube boiler provided with a revolving chain grate is an excellent combination, and is very suitable for quick steam raising. With an unsteady load, however, it requires very careful handling in order to keep a steady steam pressure, and on a heavy load when using a thick fire it not infrequently happens that the coal "misses fire," and if the boiler attendant for any reason is not at hand there ensues a lively half-hour. The writer has also known the attendant to let his hopper run empty and not discover same until there was barely a handful of fire left on the grate. Given a fair quality of fuel, the grate requires practically no "cleaning out," but during or after a run the "cleaning out" of the ashpit is generally considered hard work, the tools which are usually supplied for this purpose being cumbersome and unwieldy—a shovel 15ft or 16ft. long is not the easiest thing to handle at the best of times—and if fine slack is used a considerable quantity always drops through the bars, and this requires removing very often with the long shovel and working up again. Where there are a number of boilers installed side by side, it is always best to have an ash trench provided running the whole length of the battery and under the boiler-house floor. The clinker and ashes work over the grate end in the usual way, and fall by gravity down a shoot, at the bottom of which is provided a door or doors, and the ashes are collected from time to time by means of barrows or mechanical conveyor gear. This method of dealing with ashes does away with a lot of the long shovel and rake business. The renewal of a broken grate bar is often no very easy job, and takes up considerable time if left in the hands of the average water-tube boiler attendant. The form of door used until quite recently with this type of grate left much to be desired. This door was built up of a number of cast-iron blocks, which were found after being in use a short time to warp so badly, and in many instances to be almost burnt away, that it was found advisable to replace the iron door by one built up of fireclay slabs, and protected on the hopper side with an iron casing. This form of door gives much better results than the iron type, but they require opening and closing very carefully owing to the brittle nature of the slabs. The slabs have a nasty knack at times of breaking away from the casing, but as the broken portions are deposited in the ash-shoot, this is generally discovered before any great damage has been done to the door. With the iron type of door, it was a common occurrence for the fuel to catch fire before leaving the hopper owing to the doors being red hot.

(2) In internally-fired boilers the form of grate used for mechanical stoking (either of the coking or sprinkling type) is usually made so that the grate bars may be given a forward and backward motion, this being effected by means of suitable gearing. In one well-known make the grate as a whole is given a forward travel when the fuel is thrown or pushed on the bars, and after a short time the bars are brought back in twos to their original position. In several other makes the action is the reverse, the bars being moved forward two or more at a time, and after a short interval brought back together. By this action of the bars the fire is continually broken up, resulting in a clean grate and a clear, even supply of air. The fire is thus gradually worked forward until it reaches the bridge in a more or less consumed state, when it falls over in the ashpit. The amount of travel given to this form of grate varies with different makes, but is usually from 1½in. to 3in. both ways.

One disadvantage of this type of mechanical stoker is that the fire is sometimes drawn back by the bars, thus leaving portions of the grate uncovered and admitting cold air, resulting in a very unsteady supply of steam. In this type, when applied to Lancashire boilers, the ashpit requires cleaning out very often during a run, as it is apt to become choked up at the bridge end. The feeding and shovel gear sometimes get stuck owing to an extra large lump of coal having found its way into the hopper. In all mechanical stokers, if the moving parts of the driving gear are not encased and cleaned regularly, they are apt to prove troublesome owing to getting blocked up with coal dust, etc. When the number of boilers in use together at any time is large enough to warrant the adoption of machine stoking, then the saving effected in labour may be very considerable. Generally speaking, mechanical stoking requires from about one-quarter to three-quarters the labour required in skilful hand firing. A machine-fired boiler cannot be humoured to variations in load to the same extent that a hand-fired boiler can, and where there are only one or two boilers installed, little or no advantage is gained by the employment of machine over skilful hand firing.—S. L.

Answer to No. 448 (*awarded* 5*s.*).—The advantages and disadvantages are common rather than special to both types, and it is, therefore, difficult to confine oneself strictly to the differences between them. Amongst the general advantages may be stated the possibility of using a comparatively inferior class of coal, and such as could not be fired by hand; the better prevention of smoke, arising from the more perfect combustion; the saving of labour due to the absence of stoking. The common disadvantages are the liability of the somewhat complicated mechanical details constituting the particular apparatus to become deranged in actual working unless intelligently looked after; the inherent difficulty of completely regulating the feed, especially when there is a varying demand for steam.

Considering in particular the moving grate, it should be noted that this type introduces the coal at the mouth of the furnace and slowly carries it towards the back end. In this manner the freshly-admitted coal is first subjected to a moderate heat, and the volatile gases are allowed time to distil off, having then to pass over the glowing coal at the back of the grate, and thus are completely consumed. The residue coal, or, rather, as it now is, the coke, moves gradually backwards, and is more or less fully burned, whilst the ash or clinker resulting are discharged over the ends of the firebars. It is evident that every condition for complete combustion is by this means satisfied; and, further, that the fires are automatically cleaned, so that the furnace door has not to be opened for this purpose.

In the case of the sprinkler type, the coal being thrown over the whole of the fire in imitation of hand firing, it is not improbable that a portion of the distilled gases given off towards the back of the furnace may escape unburned up the chimney. Further, in this type the furnace door must be opened occasionally to clean the fires and clear them of clinker, consequently entailing more labour than with the other type. There is, too, the disability of allowing cold air to rush into the furnace with the usual objectionable results, such as the possibility of cooling the gases below the temperature of combustion and the straining of the furnaces.—E. Y. T.

NEW COMPANIES REGISTERED.

Trafford Power and Light Supply (1902), Limited.—Particulars of this Company will be found under "New Issues."

Vulcan Motor and Engineering Company, Limited.—Capital, £1,000. Objects: to carry on business as engineers, builders of motors and every description of machinery, etc.

Roger Dawson, Limited.—Capital, £2,000. Objects: to acquire the business now carried on at 8, Berners-street, Oxford-street, by Roger Dawson, and to carry on business as electricians, electrical and mechanical engineers, etc.

William Rowland, Limited.—Capital, £10,000. Objects: to adopt an agreement with A. E. Rowland for the business carried on by him at 9, Meadow-street, Sheffield, and to carry on business as steel and wire manufacturers, ironfounders, mechanical engineers, manufacturers of engineering implements and other machinery, etc.

Sanitas Electrical Company, Limited.—Capital, £4,000. Objects: to adopt an agreement with R. and K. Otto for the acquisition of the business carried on by them at 22A, Luisenstrasse, Berlin; to acquire certain inventions in relation to improvements in or relating to apparatus for curing diseases by means of light, electrical and light baths, etc.

C. Akrill and Co., Limited.—Capital, £100,000. Objects: to adopt an agreement between C. Akrill and E. C. Keay for the acquisition of the business now and hitherto carried on at the Golds Green Foundry, West Bromwich, by C. Akrill as C. Akrill and Co., and to develop and extend the same; further, to acquire agreements with J. D. Neal and I. A. Thompson and J. Keeling, and generally to carry on the business of roll manufacturers, iron and steel converters, gas engineers, and electrical engineers, etc.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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BATH ELECTRIC LIGHTING.

A perusal of the many reports which the Bath Town Council have recently had put before them on the electric lighting question will be pleasant reading to the editorial gentlemen who issue special pleaders against the municipal control of all electrical undertakings. These reports occupy some one hundred and twenty-four pages of matter, and include a vast amount of information which is only of importance to the inhabitants of Bath. Thus there is a long and able report by Mr. E. Manville, not only on the failures of the past, both financial and in the supply, but—what is more important—on the best way in which these failures can be avoided in the future. The other two reports are respectively from Mr. F. Teague (the borough electrical engineer) and Mr. J. W. Gatehouse (the electric inspector). This latter gentleman has acted as inspector since 1891, and his report on the various interruptions which have occurred since that date occupies far more space than should be the case in any well-organised undertaking. Dealing first with the question of these breakdowns, we need only remark that the three gentlemen above mentioned do not express any difference of opinion as to the cause underlying the interruptions. These three reports, which are, while exceedingly able, much too long for us to insert in full, justify the following conclusions of the Enquiry Committee of the Town Council:

1. That the recent breakdowns was the result of the defective system in use at the works, and were caused principally by the failures in the mains and switchboard.

2. That the whole of the high-tension mains laid up to the end of February, 1901, are of an obsolete type, the value of concentric cables having been fully established for many years previous to this date.

3. That the switchboards are bad in design, and should have been replaced some time ago.

4. That these failures were not a necessary incident of electric light production, and might have been avoided.

5. That with properly equipped works and capable management electric lighting is a safe and profitable investment, and is being carried on successfully by numerous public bodies in various parts of the country.

The system in use at Bath at the present time is that first installed in 1889 by an electric lighting company. As originally arranged, the incandescent lights are still supplied by grouping feeders to isolated sections of the mains on to single alternators. This involves the use of throw-over switches, so that more machines can be brought into service as the load increases each evening. At the date at which the company laid down the works, and even at the date in 1896, when the works were purchased by the Corporation, there was considerable doubt expressed by certain engineers as to the commercial possibilities of working alternators in parallel. It was presumably for this reason that the Bath Corporation were not advised by their consulting engineer, when taking over the works, to make any radical change in the system employed. Since that date, therefore, some seventy thousand pounds have been expended on a system which for years has been obsolete, and which becomes more and more uneconomical and dangerous as the load supplied by it increases. The process of switching over the loaded feeder circuits from one machine to another is one which is harmful both to the machines and the mains. At the same time, it is obviously impossible without grouping the alternators in parallel to work the various units of plant at even approximately full load. The continued use of this alternate-current separate-circuit

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system has, therefore, had two bad effects. The one is the intermittent character of the supply, and the other that the cost of working has been unduly high, making the financial results unfavourable to the Corporation. This is so in spite of the comparatively high price charged per unit, and especially of the high price which the electric lighting department receive for the public arc lamps. We regret to say that, apart altogether from the system employed, other matters in connection with the station and the supply have to be condemned. Thus we learn that obsolete and unreliable electricity meters, requiring a very high starting current, have been employed, and at the same time it is only some few months since instruments were obtained for the testing of meters at the works. Another bad detail is that the new crane, as at present fixed, is too low to lift the parts of the new engines. The reports above mentioned have been submitted to the previous advisers of the Corporation, and in their replies as printed there is nothing to combat the view that the present system is quite obsolete. It will be remembered that these advisers, the one in London and the other at Bath, had many differences in the past, and that these differences were fought out by partisans both in the Council and in committee. This at the time we condemned, and not a few of the present conditions of the undertaking may be traced to the misdirected energies so employed. The remedy proposed by Mr. Manville, and adopted by the Council, is the conversion of the bulk of the supply to the continuous-current three-wire system at two hundred and twenty volts. The present alternating plant can then supply the outlying districts. To make the change-over a further outlay of about seventy thousand pounds is required, but Mr. Manville shows that this expenditure is warranted by the facts of the case. With a reduced price for electrical energy more consumers can be obtained, and at the same time the new system will give great economy in the working expenses. We are pleased to note that this advice has been accepted by the Council, who were doubtless impressed by the fact that at Taunton, where exactly the same transformation has been made by Mr. Manville in the past few years, good financial results have been obtained and charge per unit reduced.

ELECTRICAL ENGINEERS (R.E.) VOLUNTEERS.

We understand this corps has been asked if they can furnish a sixth detachment for active service in South Africa. Examination and provisional selection will take place probably on Saturday, Feb. 15. Intending applicants for enrolment should send in their names at once to the Officer Commanding Electrical Engineers (R.E.) Volunteers, Headquarters, Regency-street, S.W., giving full details as to their technical qualifications, age, height, chest measurement, etc. The regulations as to enlistment and pay are enlistment for the remainder of the war, but should the war terminate within one year, men have the option of completing one year's service or taking their discharge at once. Pay varies according to rank, and engineer pay according to skill, as follows: sapper, 1s. 4½d.; corporal, 2s. 9d.; sergeant, 3s. 6d. a day. Engineer pay in addition to above: fair tradesman, 8d.; skilled, 1s.; superior, 1s. 4d.; very superior, 1s. 8d. a day for days employed. The following gratuities are payable on discharge: volunteer gratuity, £5; War Office gratuity, £5.

WHEN DOCTORS DISAGREE——

The paper read by Mr. Hardman Earle to the Manchester Section of the Institution of Electrical Engineers on Tuesday last week was productive of the largest-attended, the longest, and the most controversial meeting that has taken place this session. The subject, "The Supply of Electricity in Bulk," was dealt with from a purely financial standpoint, the object of the author being to show that this supply would be more successful than by supplying towns with electricity locally generated.

Early on, the paper developed a fighting spirit, directed principally at Mr. Wordingham (the chairman), who, it will be remembered, was a contra-important witness at the parliamentary enquiry into supply in bulk. His figures, as given at the enquiry, were now combatted by Mr. Earle, who was especially down on the contention that coal could be carried cheaper than current could be transmitted to a distance. The ·2d. per unit that Mr. Earle gave as being the increase of cost for transmitting 1¼ millions of units per annum a distance of 10 miles was the red rag that attracted the most horns, Mr. Mountain giving ·06d. as being the equivalent cost for carting coal. This gentleman spoke of the paper as "a dream of Mr. Earle's," which in its turn drew forth the expression of opinion from Mr. John Shaw that people who dreamt such dreams usually lived to fulfil them. Mr. Shaw later on convulsed the meeting by recalling his statement to Prof. Thompson at the Glasgow Exhibition that, polyphase notwithstanding, long after he and Prof. Thompson were dead they would see direct current still in use!

Strong partisanship soon showed itself in the discussion, and, vulgarly speaking, the following were Mr. Earle's seconds—Mr. Fawcus, Mr. Clirehugh, Mr. Highfield, and Dr. Panton. In the opposite corner of the ring Mr. Wordingham was rubbed down and fanned by Mr. Taite, Mr. Shaw, and Mr. Sturgeon. Other speakers were Mr. Pooley, who gave various estimates as to cables, and Mr. Tanner, who referred to the varieties of trenchwork to be met with in various parts of the country. Mr. Metzger, to general disappointment, declined the chairman's invitation.

Throughout the proceedings the controversial spirit raged, and the chairman had to check a general conversational tendency. It might have been remarked that, perhaps, the chairman himself was most inclined to "shove in his oar" during the evening, especially when being baited by the author of the paper; certainly his speech, the longest during the evening, was mostly taken up in vindicating himself in matters not very relevant to the subject. Also, when Mr. Clirehugh alluded to opponents of the power schemes as "persons with axes to grind," it would surely have been sufficient to have merely ordered the remark to be withdrawn (which was done), without the need to publicly explain that he (the chairman) had no axes to grind. As a matter of fact, the worthy chairman was clearly carried away by the spirit of the meeting, and at no time more entertainingly so than when a somewhat tedious speaker (girding at power schemes) mentioned his fear of wearying the audience, and was appreciatively entreated to go ahead by the chairman, to the mingled dismay and amusement of the audience.

Some remarkable figures were given publicity during the discussion. On the subject of cable trenches, Mr. Fawcus mentioned that the Altrincham Company's work was done by a contractor at a uniform rate of 6d. per lineal yard, which included excavation and reinstatement of any surface met with in the town. Mr. Clirehugh instanced the rate charged by the Trafford Park Power Company to the Lancashire Dynamo Company as being ¾d. per unit, which would come out at £1. 6s. per horse-power per annum. Also that the load factor of the Trafford Park Power Company ranged from 45 to 70 per cent. The average price per unit obtained by this company Mr. Clirehugh gave as 1·1d., which, by a singular coincidence, is the exact figure arrived at in Mr. Earle's calculations as the average price in his "dream." Some of the figures obtained on this installation will no doubt stagger the followers of form when the time comes for official publication. Some Mond gas power figures, also given by Mr. Clirehugh, showed that this gas can be made at ½d. per 1,000 cubic feet, which means 20 horse-power hours for 1d. Mr. Shaw also swore by gas plant, and gave ·4d. as cost per unit on a small-sized plant of his. Mr. Pooley stated that a diatrine cable with an insulation thickness of 90 mils successfully

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withstood 60,000 volts as an argument for revision of Board of Trade rules.

Mr. Shawfield advocated overhead lines for feeders, and in unduly distant small towns the supply to be done by a local factory for economy of production. He reminded those who ridiculed power schemes (on the ground of no demand in rural districts), that supply stimulates demand, and that new manufacturing centres would spring up along the lines of mains as towns do on American railways.

In conclusion, a matter for congratulation was the very small amount of time cut to waste in congratulating the author of the paper; the paper itself (as Mr. Sturgeon put it) will be a useful hand-book for promoters of power schemes; and the refreshments provided at the close were quite up to the standard set by the London centre.

FORTHCOMING EVENTS.

FRIDAY, FEB. 7.

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. Paper: "The Electric Passenger Elevator," by Mr. W. J. Cooper.

North-East Coast Institution of Engineers.—Special meeting at Newcastle. Mr. D. B. Morison will read a "Report on Memorandum submitted to the First Lord of the Admiralty on the 16th day of July, 1901, with reference to the present unsatisfactory condition of the Engineer Branch of H.M. Navy."

SATURDAY, FEB. 8.

Institution of Electrical Engineers (Students' Section).—At 11 a.m., and 3 p.m., Visit to the Shepherd's Bush Generating Station of the Central London Railway.

Manchester Association of Engineers.—Ordinary meeting. Paper: "Applications of Portable Machine Tools," by Mr. J. A. Rawcliffe.

MONDAY, FEB. 10.

Institute of Marine Engineers.—At 8 p.m., ordinary meeting at 58, Romford-road, E. Paper: "Some Boiler Defects, and Suggested Remedies," by Mr. C. W. Hansen.

Institution of Electrical Engineers (Newcastle Section).—Ordinary meeting. Paper: "Electrical Legislation and Finance," by Mr. H. W. Hancock.

London School of Economics.—At 6.15 p.m., 10, Adelphi-terrace, W.C., Mr. Lynden Macassey on "Electric Traction on Railways."

Institution of Mechanical Engineers.—At 8 p.m., graduates' meeting. Prof. T. Hudson Beare on "Recent Developments in the Gas-Engine."

TUESDAY, FEB. 11.

Royal Institution.—At 3 p.m., Dr. Allan MacFayden on "The Cell: Its Means of Offence and Defence" (Lecture V.).

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., ordinary meeting. Paper: "Steam-Boilers," by Mr. C. E. Stromeyer.

Institution of Civil Engineers.—At 8 p.m. Paper: "The Port of Dundee," by Mr. G. C. Buchanan.

WEDNESDAY, FEB. 12.

Institution of Electrical Engineers (Birmingham Section).—Ordinary meeting. Discussion of Dr. Sumpner's "Note on Alternate-Current Diagrams," and his paper on "The Testing of Motor Losses," read at the meeting on Dec. 11 last. To be followed by "Some Electric Furnace Demonstrations," by Prof. R. Threlfall.

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "Industrial Redistribution and its Connection with the Overcrowding Question," by Mr. W. L. Madgen.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., ordinary meeting. Paper: "Series-Parallel Control," by Mr. J. B. Langford.

THURSDAY, FEB. 13.

London Electrical Contractors' Association.—At 7 p.m., annual dinner, Hotel Cecil.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Papers: "Researches on the Electrical Conductivity and Magnetic Properties of upwards of 100 different Alloys of Iron," by Prof. W. F. Barrett and Mr. W. Brown; and "On Some Conclusions Deduced from the Preceding Paper," by Prof. W. F. Barrett.

FRIDAY, FEB. 14.

Physical Society of London.—At 5 p.m., annual general meeting. Address by Prof. S. P. Thompson (president), to be followed by an ordinary meeting, at which Mr. T. H. Littlewood will exhibit an Atwood's machine.

SATURDAY, FEB. 15.

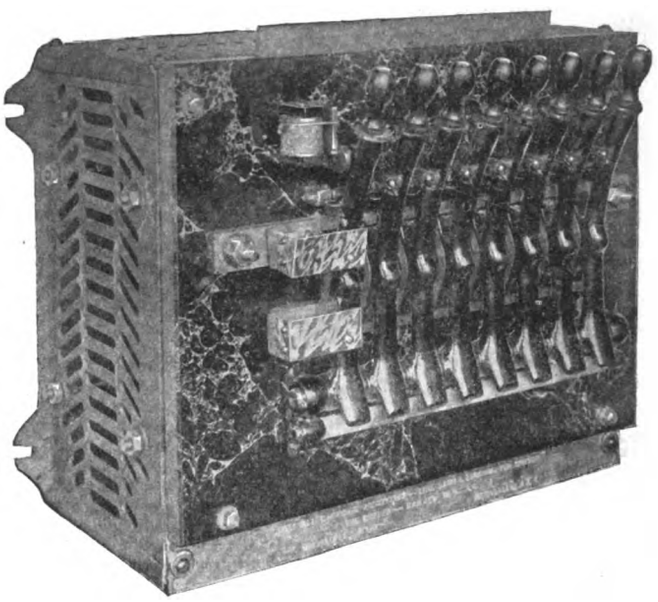
Royal Institution.—At 3 p.m., Lord Rayleigh on "Some Electrical Developments."

British Electric Transformer Manufacturing Co. — The Directors have decided to pay an interim dividend for the half-year ending Dec. 31, 1901, at the rate of 10 per cent. per annum.

TRADE NOTICES AND NOVELTIES.

Sturtevant Specialities.

The catalogue issued by the Sturtevant Engineering Company, Limited, 147, Queen Victoria-street, London, E.C., for 1902 has, we note, been entirely rewritten, while it includes a number of new leaflets dealing with the firm's latest products in the shape of motor-controlling apparatus, etc. To facilitate the addition in their correct positions of further leaflets which may be issued from time to time as other specialities are perfected, the catalogue is arranged on the "unit" system. Sturtevant wares are generally well known, and call, therefore, for no detailed enumeration here, but it may be mentioned that the new leaflets deal respectively with the following, among other, specialities of the firm: iron-clad dynamo field regulators, compound motor-starting and field-regulation rheostats, rope-operated electric lift controllers, electrically-operated lift controllers, W.T.L. circuit breakers, iron-clad dimmers for theatre work, and automatic controllers for electrically-driven printing presses; while modifications of a more or less important nature are introduced into the leaflets relating to multiple-switch starting rheostats for large motors, full reverse motor-starting rheostats, printing-press controllers, automatic solenoid pump-starting rheostats, etc. The illustrations and descriptive matter appear for the most part on the front of each leaflet, prices and dimensions being given on the back. A complete series of semi-enclosed and totally enclosed switches of various standard types is shown. We note that the "Universal" type starting and speed regulating rheostats illustrated are all equipped with D.P. switches of the quick-break pattern, the fuses for 220 volts and 500 volts being of the enclosed non-arcing variety. A piece of apparatus which calls for more than passing notice is the "Sturtevant" C.H. multiple-switch starting rheostat with interlocking switches. This rheostat is designed for handling heavy starting currents, and its construction differs from that of an ordinary starting rheostat in that the sliding contact is



entirely dispensed with, and a system of switches substituted in its place. When sliding contacts are used it is necessary to divide the resistance into a large number of steps, in order to cut down to a minimum the sparking which occurs when the starting lever is moved from one step to another. But even with the resistance so divided there is always some sparking. With the multiple switch system, however, it is claimed that there is no sparking whatever at the switch in starting a motor whether under load or not, while it is not necessary to divide the rheostat into as many sections. The peculiar construction of the contact on these switches is another point which claims attention. Instead of it being necessary to push a knife into jaws before the full carrying capacity is obtained, the contact is made in each switch by a large number of thin leaves of brush copper, which press against a hard-rolled copper surface with sufficient scraping motion to keep the surfaces clean and bright. A switch built on this principle will carry, it is claimed, without heating five times as much current per square inch of contact surface as the ordinary type of knife switch. Attention is also called to the method adopted for interlocking the switches. The switch on the extreme left (see the first of the accompanying illustrations) is held closed by an electro-magnet, while the remaining switches are held closed by latches. In front of each switch is placed a pivoted cast-iron stop, so arranged as to prevent any of the switches from being closed until the switch next to it on the left has previously been closed. When the supply of current is shut off, the first switch on the left opens and breaks circuit. It also allows the latch on the second switch from the left to drop, so that this switch in its turn also opens and releases the third switch, and so on in succession until all the switches are opened automatically. The first switch on the left is equipped with large blocks of carbon, which always make and break the circuit, and consequently take any sparking which may occur. The illustration represents a rheostat of the firm's 100 b.h.p size for 220 volts constructed on the principle described. An automatic overload release, or a time-limit circuit breaker, can be added if required. It is interesting to note in connec-

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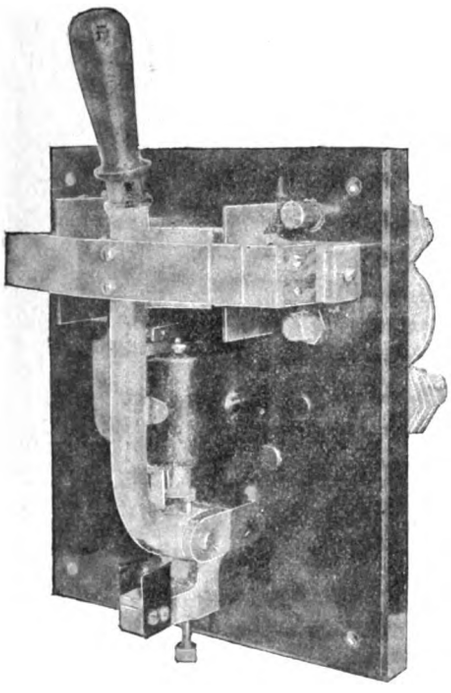
tion with these rheostats that many of them are now manufactured in the firm's London works, Bankside, S.E.

Another interesting piece of apparatus described in the catalogue under notice is the "Sturtevant" circuit breaker, with time limit and magnetic blow-out. This device was exhibited for the first time at the Glasgow Exhibition. The second of the accompanying illustrations gives a good idea of its construction and appearance. The main contacts of these breakers are made of multiple leaf copper strips, which press firmly against brass or copper surfaces parallel to the plane of the switchboard. The arcing is taken from heavy carbon blocks, which are easily renewable, and the opening of the breaker is sufficiently great to break the arc. In addition to this long break, however, two powerful magnets are used to blow out the arc, which they do so effectively that the breakers are guaranteed to open the circuit at their rated capacity 500 times without requiring repairs. The pressure of the carbons and copper leaves is utilised to open the breakers, thereby eliminating extra push-off springs, which would require extra manual exertion to close the breaker. This heavy pressure on the carbons also ensures such a good contact that absolutely no arcing occurs at the copper brushes when they break contact. The breakers are held closed by a hair trigger, which cannot be jarred loose, but will open with a very light blow struck by the plunger of the tripping coil. The time-limit attachment allows the breaker to remain closed during the flow of an abnormal current which lasts but a few seconds, but will open the circuit if this abnormal current lasts long enough to endanger the apparatus. The breaker will open instantly, however, on short-circuits or dangerously abnormal currents. This result is accomplished by shunting a portion of the current around the tripping coil through strips of iron ribbon, whose cross-section is so small that they are heated by the current. As these strips heat up their resistance increases, and more current is consequently



sent through the tripping coil, eventually causing this coil to trip the breaker. It will thus be seen that abnormal currents that last but a few seconds will not have sufficient time to heat up the iron trips, but dangerously abnormal currents will shunt enough current through the tripping coil to cause it to act immediately without waiting for the iron strips to heat. A very large range of adjustment of the breaker is obtained both by varying the lift of the plunger and the number of iron shunt strips, which are made easily renewable. The breaker can also be adjusted so as to make it sensitive or sluggish to moderate overloads as may be desired. These breakers will be known to the trade by the letters W. T. L., which are the initial of the words "with time limit."

Steel Conduits.

We have received from the General Electric Company, Limited, Queen Victoria-street, London, E.C., a copy of their new list of "Union" enamelled steel conduits. It is to be noted that the firm no longer confine themselves entirely to the close-joint light-gauge bedstead type of tube, although this is listed for those who care to use it in the Colonies and dry positions generally. The General Electric Company have made a speciality of a superior form of brazed-joint light-gauge tube for butting. A heavier-gauge tube, with screwed gas thread brazed joint, can be supplied where a perfectly water-tight conduit is preferred. The latter is recommended as a very good type of conduit specially suitable for damp places; but for those who require a draw-through system of a substantial nature, such as for public buildings, etc., heavy-gauge tubing with screwed gas thread welded joints is listed. Close-joint tubing with screwed brass thread is recommended for adoption where it is desired to obtain extra good electrical continuity of the tubing. The firm's "Papristeel" conduit, which is also listed, has the merit of being very light besides having an interior lining of paper insulation. Fittings for all forms of conduits are illustrated in the list, special attention being drawn to the firm's switch and ceiling rose boxes, and also to their junction boxes.

Electrical Measuring Instruments.

Messrs. Geipel and Lange, Westminster, have been appointed as successors to Messrs. H. M. Salmony and Co., the sole agents in the United Kingdom and English Colonies for the sale of the electrical testing and measuring instruments made by Messrs. Chauvin and Arnoux, of Paris. These instruments have for many years been widely used both in this country and upon the Continent, and include ammeters, voltmeters of the gravity, moving-coil, and hot-wire patterns, recording ammeters, volt and watt meters of the D'Arsonval and hot-wire patterns, and portable testing sets of all descriptions. There is also a special line of combinations of instruments enabling any reading over a very wide range to be made by the station engineer at any portion of his system. We learn that already these sets are in use at 20 different stations in this country.

Dick, Kerr, and Co., Limited.

We have received an elegant brochure giving details of the works of the English Electric Manufacturing Company, Limited, Preston. These works were fully described in our columns when they were first started. The present work is illustrated from recent photographs.

Superheaters.

We are informed by Messrs. Easton and Co., Limited, Broad Sanctuary, S.W., that they have now granted sub-licenses to Messrs. Fairbairn, Lawson, Combe, Barbour, Limited (Combe-Barbour Branch), Belfast; Messrs. Bow, MacLachlan, and Co., Limited, Paisley; Messrs. J. Carmichael and Co., Limited, Dundee, to construct engines to work with highly superheated steam on the Schmidt system, they retaining the sole right to manufacture the superheaters required in connection with such engines.

Telescopic Ladder Wagons.

The Battersea Borough Council have just purchased what is practically a light telescopic fire-escape with special fittings for resting against the lamp standards. The apparatus is provided with a rising platform at top, on which the workmen can safely stand with both hands free while putting in carbons, cleaning globes, etc. The machine has been designed and constructed by Messrs. Merryweather, fire-engine makers, who have also recently built nine similar apparatus for the Westminster Electric Supply Corporation.

Acetelyne Association.

We have received a preliminary copy of the book containing the memorandum and articles of this association, with list of the original honorary members and original members of the council. England, although the last to establish an acetylene association, was the first country in Europe to commercially manufacture carbide of calcium, and the development of the acetylene industry in the United Kingdom, though relatively slow as compared with foreign countries, has made enormous progress, notwithstanding the opposition with which it has been met, and which everything new has to encounter in this country.

APPOINTMENTS VACANT.

Draughtsman, Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board, Feb. 11. Full particulars in our advertisement columns.

Principal Traffic Clerk, Manchester Corporation Tramways Department, £150 per annum, Feb. 8. Full particulars in our advertisement columns.

General Traffic Manager, Wolverhampton Corporation Tramways, £250 per annum, Feb. 15.

Assistant Electrical Engineer, Stalybridge, Hyde, Dukinfield, and Mossley Tramways and Electricity Board, Feb. 11. Full particulars in our advertisement columns.

Temporary Draughtsman, borough of Southend-on-Sea. Full particulars in our advertisement columns.

Assistant Engineer, Fulham Borough Council Electricity Department, £104 per annum, rising by annual increments of £6. 10s. to a maximum of £160, Feb. 10. Full particulars in our advertisement columns.

Electrician in dynamo and installation department. Full particulars in our advertisement columns.

Switchboard Attendant, Carlisle electric light and power station, 25s. per week, Feb. 17. Full particulars in our advertisement columns.

Assistant Electrical Engineer, York Corporation, £150 per annum, Feb. 15. Full particulars in our advertisement columns.

Foreman for shop employing female labour. Full particulars in our advertisement columns.

Meter Inspector accustomed to Ferranti, Chamberlain and Hookham, Thomson, and Bastian preferred; wages 30s. per 50-hour week. Full particulars in our advertisement columns.

Borough Electrical Engineer, Croydon Corporation, £400 per annum, rising by annual increments of £25 to £600, Feb. 27. Full particulars in our advertisement columns.

Resident Electrical Engineer, Stoke-on-Trent Corporation. Full particulars in our advertisement columns. The Maidenhead Town Council will shortly advertise for a resident electrical engineer at a commencing salary of £150 per annum.

Shift Engineer, Bedford Corporation, 30s. per week, Feb. 14. Full particulars from Mr. R. W. L. Phillips, borough electrical engineer, Bedford.

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LEGAL INTELLIGENCE.

THE LIABILITY OF CONTRACTORS.

In the Court of Appeal, consisting of the Master of the Rolls and Lord Justices Romer and Mathew, last week, the defendants in the case of Maxwell *v.* the British Thomson-Houston Company appealed from a judgment of Mr. Justice Kennedy, at a trial with a special jury at the Leeds Assizes in March last year. The action was brought to recover damages for personal injuries caused, as alleged, by the negligence of the defendants, and the question arising on the appeal was who was responsible—the defendants, the Leeds Corporation, for whom the defendants were carrying out a contract at the time in connection with the electric tramways, or Messrs. Blackwell and Co., independent sub-contractors under the defendants. It appeared that on June 10, 1899, the plaintiff, Miss Agnes Maxwell, was a passenger on the top of a horse-car in Cookridge-street, Leeds, and Messrs. Blackwell's workmen were engaged in erecting the apparatus in connection with the overhead work of the electric tramways. The iron bars on a derrick extending over the tramway came in contact with a number of passengers on the car, including the plaintiff, who was struck in the throat and seriously injured. The jury found that there was want of reasonable care in the use of the derrick, and upon that Mr. Justice Kennedy entered judgment for the plaintiff against the defendants for an agreed sum—namely, £850. Hence the present appeal of the defendants.

On the conclusion of the arguments in support of the appeal, their Lordships gave judgment without calling upon counsel for the respondents.

The **Master of the Rolls** said the case raised a nice question. In connection with the work of electrifying the Leeds tramways, appliances had to be used which were in themselves a dangerous obstruction to the highway, unless all proper precautions were taken. Therefore there was a special duty imposed on the contractor who undertook the work to see that proper care was taken, and that the public were safeguarded against accident. The contractor by employing a sub-contractor could not delegate that duty, and if he failed in his duty he was liable. The appeal would, therefore, be dismissed.

Lord Justice Romer, in concurring, said the first point taken by the defendants, that the Corporation were responsible, could not be sustained, because the defendants, in taking over the work from the Corporation, also took over all the duties that that work imposed upon them.

The appeal was dismissed, with costs.

FERRANTI'S ELECTRICITY METER.

In the Chancery Division of the High Court on the 29th ult., **Mr. Justice Swinfen Eady** delivered his reserved judgment in the case of De Ferranti *v.* the British Thomson-Houston Company, which was an action for alleged infringement of the plaintiff's patent relating to improvements in electricity meters. Mr. Justice Swinfen Eady said: "This action was commenced on Dec. 12, 1900, and was brought to obtain an injunction to restrain infringement of letters patent No. 701 of 1887, and for damages. The term of the patent expired shortly after the issue of the writ, and the action was, therefore, treated as one for damages only. The defence is a denial of the infringement and the plea of the invalidity of the patent. The patent relates to improvements in electrical meters. Previous to the year 1887 the plaintiff had invented an electrical meter, in which the current to be measured was made to pass through a bath of mercury in a magnetic field, so disposed that the mercury was put into a continuous rotary movement by the passing of the current, the movement of the mercury being recorded by means of a float or disc, with recording mechanism. The plaintiff said that such a meter, patented by him in 1883, was used commercially to the extent of a few hundreds, but that the business of a central-station supply in those early days of electric lighting being exceedingly limited, very few meters were required. That meter was designed for use with a continuous current, and with a solid magnet made of cast iron the residual magnetism of the cast iron seemed to assist in causing rotation of the mercury, and was sufficient to enable the meter to start even with only a small number of lamps in use. In order to adopt that meter for use with an alternating current, it was necessary to employ pole-pieces which did not retain residual magnetism, and laminated iron was substituted for solid cast-iron magnets. Then, in order to effect the object previously attained by the residual magnetism, and so enable the meter to start and register correctly with a low load, some contrivance was necessary. The plaintiff in 1887 determined to achieve this result by employing an additional coil of an insulated conductor which would act as an electric magnet and thus compensate for the loss of residual magnetism arising from the abandonment of solid cast-iron magnets. This invention formed the subject of the letters patent in 1887 upon which this action is brought. The question at once arises, What is the true construction of the plaintiff's specification?—for the defendants contend that on one construction of it they have not infringed, and on another construction that the patent is invalid. The argument as to the construction of the specification has been principally directed to two points: (1) whether the invention is confined to electrical meters in which the current passing through the additional coil does not pass through the mercury bath or other armature of the meter; (2) whether the plaintiff has limited his invention to current meters properly so called as distinguished from energy meters." His Lordship then proceeded to deal with the plaintiff's specification in detail, and continued: "In my opinion, the expression 'current to be measured' in the plaintiff's specification means the lamp current which is made to pass through the mercury bath, and to the exclusion of the current passing through the additional coil. In other words, it extends only to a current meter, and does not include the case of an energy meter, which measures and records the product of two variants, the quantity and the potential, without measuring separately either variant. This being in my opinion the true construction of the plaintiff's specification, I pass to consider what the defendants have done. The original Thomson-Houston meter before the introduction of the additional coil, which is the infringement now complained of, is shown in an exhibit. The continuous movement of the meter, which is connected with a recording index, is obtained by the interaction of the force derived from the shunt current passing through the armature, and that derived from the lamp current passing through the series coils. When no lamp current is passing through the series coils (as is the case when no lamps are illuminated) there is no risk of movement in the meter, as the shunt current alone cannot set up any movement of the meter. So far, no complaint is made by the plaintiff of the use by the defendants of this meter, but the defendants have introduced into it an additional coil, and this gives rise to the present claim. The defendants, in order to increase their magnetic field, introduce a coil into the shunt passing through the armature; the effect of this is to have a constant standing field interacting with the rotatory fields, and so to give a torque to the meter, even when no lamp current is passing. The defendants lead the current through the armature, which, upon my construction of the plaintiff's specification, a person is told by the plaintiff not to do. The meter is thus rendered more sensitive, with a tendency to revolve, and it responds to a feeble lamp current, and registers when only one lamp is lighted. In the defendants' meter, however, the torque is always constant, whether lamp current is passing or not, while in the plaintiff's meter the initial torque when no lamp current is passing is zero, and for a time the torque increases proportionately to the number of lamps. The question is, Does this application to a Thomson-Houston meter of an additional shunt coil constitute an infringement of the plaintiff's patent? In my judgment it does not. The defendants have made use of an old contrivance—an additional coil—and have applied it in a manner which is not within the plaintiff's specification and in which the plaintiff told persons not to do it. The defendants, therefore, have not infringed. Moreover, they have applied it to an energy meter, and not to a current meter. The action therefore fails, and must be dismissed with costs."

Judgment was entered accordingly.

A GALVANIC BATTERY PATENT.

On the 31st ult., in the Chancery Division, Mr. Justice Buckley gave judgment in the action by the Patent Exploitation Company, Limited, against Siemens Bros and Co., Limited, in which the plaintiffs sought to restrain an alleged infringement by the defendant company of a patent assigned to the Exploitation Company on July 9, 1900, for improvements in galvanic batteries. It was explained by counsel that the principle of galvanic batteries had been well known prior to the invention of the plaintiff company, but the serious difficulty had always been to apply the principle in an effective manner. The Exploitation Company claimed that by its patent for a dry-cell galvanic battery it applied what were well-known principles in a manner never invented or used before. Messrs. Siemens denied the infringement and pleaded that the patent was invalid by reason of anticipation, and that the Exploitation Company was not the registered owner at the date of the issue of the writ.

His Lordship held that there was no novelty in the invention as claimed, and that the patent was invalid. He accordingly dismissed the action and entered judgment for the defendants, with costs.

AUTOMOBILE MANUFACTURING COMPANY.

Before Mr. Justice Byrne on Thursday the petition of the Clipper Pneumatic Tyre Company was heard for the compulsory winding up of the Automobile Manufacturing Company.

Mr. Ramer, for the petition, stated that it was opposed by certain debenture holders on the ground that their debentures covered the whole of the assets of the petition, and a receiver and manager having been appointed, no useful purpose would be served by a winding-up order. The petitioners were creditors of the company for goods supplied, and their contention was that the debentures referred to were bad by reason of non-registration, and, further, that they were a fraudulent preference.

Counsel for the debenture holders and the company said that an action had been instituted to test the validity of the debentures.

Mr. Justice Byrne directed the petition to stand over for a week.

NATIONAL TELEPHONE CLAIM.

A curious case at the instance of the National Telephone Company was heard in the Surrey County Court before his Honour Judge Martineau. The defendant, Scott, a solicitor, who formerly lived in Dorking, was sued by the company to recover the sum of £8. 18s. 1d. for the use of a private telephone from July 23, 1898, to June 23, 1899. According to the defendant's case, he signed the agreement on the understanding that he would not only be able to communicate between his residence and his local office, but also with London on paying 3d. for three minutes' conversation. For more than a year, however, the company were unable to complete communication with London, and they asked the defendant if it would suit his purpose if they put him up a private wire from his private house to his office, on the understanding that directly they could put him on the exchange they would do so. He ultimately agreed to this, and it was done. He made enquiries, and found that at that time there were only six subscribers in Dorking, and the company having broken their concurrent agreement, he contended that that entered into by him was null and void. He put in two letters written in 1899, in which he

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asked the company to remove the wires and instruments, as he had sold his house, telling them that he had no intention of paying the year's rent for the telephone.

His Honour said it was clear that the agreement in regard to the private wire was only of a temporary character, and the company having failed to carry out their contract, judgment would be given for defendant, with costs. Leave to appeal was refused.

AN IMPORTANT POINT TO CONTRACTORS.

At the Uxbridge County Court, before his Honour Sir Alfred Marten, K.C., William Froude, an ex-police-sergeant, sued the Uxbridge and District Electric Supply, Limited, and Callender's Cable and Construction Company, Limited, for damages sustained through an explosion of gas on Nov. 25, alleged to be due to the defendants' negligence. The case raised an important question as to the liability of electrical companies for damage caused by gas in carrying out street works in connection with the laying of electric light cables.

It appeared from counsel's opening statement that Messrs. Callender were laying some electric light cables for the Uxbridge Electric Supply Company last November, and, according to the plaintiff's case, in the course of this work a gas-main was fractured. An explosion resulted, and the whole of the plaintiff's shop front was blown out. It was alleged that the defendants were liable for the damage done on the ground that the escape of gas which resulted in the explosion was caused by the negligence of their servants, and evidence was called to support this contention.

For the defence it was argued that the plaintiff had failed to show any negligence on the part of the defendants' servants, and that a company with parliamentary powers was not responsible for any injuries which might result from their operations unless negligence was shown.

His Honour, in giving judgment, held that there was negligence on the part of the contractors. It was the business of the defendants to find out where the gas-main was. With regard to contributory negligence, it was difficult—nearly impossible—to say what was the actual cause of the accident. Plaintiff's daughter said that she lit the gas and then went out of the room, and shortly afterwards there was an explosion. He did not think she acted improperly in lighting the gas, and he decided that there was no contributory negligence on the part of the plaintiff. He therefore gave judgment for the plaintiff, assessing the damages at £22, with costs.

NEWCASTLE ELECTRIC SUPPLY WORKS.

Ejection of Steam.

On the 24th ult. the Newcastle-upon-Tyne Electric Supply Company were summoned in the local police court, at the instance of the Newcastle Corporation, for having unlawfully discharged, so as to be an annoyance to the public, certain steam, ejected from the condenser of the fixed steam-engine at their electric lighting generating station at Pandon Dene, contrary to Section 99 of the Newcastle-upon-Tyne Improvement Act, 1899. The case had been adjourned by the Bench from last December with a view to the company doing what they could to mitigate the nuisance.

Mr. W. S. Burton, for the company, contended the nuisance no longer existed. He had strong evidence to that effect. When the case was before the Court in December, the company were running a load of 1,425 kw., which had been reduced to 700 kw. The steam consumption had been reduced from 57,000lb. per hour to 30,000lb. per hour, while there had been also a reduction in sprays from 77 at 15lb. pressure to 24 at 4lb. pressure.

Mr. Roberts (clerk): Are you losing trade?

Mr. Burton replied in the negative. In December the company completed the connection of the Manors sub-station, which made a reduction of one-third of the work they were doing in December last, and now they had completed the connection with the Jesmond sub-station. He suggested that the summons should be adjourned for a further period. He blamed the Corporation for the present nuisance, as he averred they had prevented the company from getting further forward.

The Bench eventually adjourned the case for a week.

BRIGHT'S LIGHT AND POWER COMPANY.

In the matter of Bright's Trustees *v.* Morino and Bright's Light and Power Company, last Friday Mr. Eve, K.C., applied to Mr. Justice Swinfen Eady for an injunction to restrain the defendant, Morino, from voting at any meeting of Bright's Light and Power in respect of certain shares standing in his name on the register of the company.

The application was granted.

ELECTRICAL ENGINEERS AND THE EMPLOYERS' LIABILITY ACT.

In the Exeter County Court on Monday the case of Wallage *v.* Rippon came again before Mr. Lush-Wilson, K.C., on a point of law. As reported in our issue of the 10th ult., the plaintiff was successful in getting a judgment against the defendant, an electrical engineer, for £175 damages in respect of personal injuries received by him while working for the defendant in connection with the renewal of the electric light wires in some large premises at Exeter. His Honour, however, reserved his decision on the question as to whether the plaintiff was entitled to sue under the Employers' Liability Act. The defendant contended that the action should be at common law, in which case the county court could not award more than £50 damages.

His Honour now decided the point in favour of the defendant. He held that an action did not lie under the Employers' Liability Act on the ground that the case did not come with the section of the Act referring to works. The damages must, therefore, be awarded in accordance with common law, and he made an order reducing the amount of £175 to £50.

COMPANIES' MEETINGS AND REPORTS.

CAMBRIDGE ELECTRIC SUPPLY.

Directors: D. Munsey, Esq. (chairman), Meadowcroft, Cambridge; A. A. Campbell Swinton, Esq., M.I.C.E., M.I.E.E. (managing director), 66, Victoria-street, S.W.; P. W. Latham, Esq., M.D., Trumpington-street, Cambridge; the Hon. C. A. Parsons, F.R.S., M.A., M.I.C.E., M.I.E.E., Wylam-on-Tyne; John B. Simpson, Esq., M.I.C.E., Bradley Hall, Wylam-on-Tyne. Manager and engineer: H. B. Harvey, A.M.I.E.E. Secretary: John H. Taylor.

Report of the directors (with abstract of accounts) to be presented to the ordinary general meeting of the Company to be held at the offices, Thomson's-lane, Cambridge, on Feb. 12, 1902, at 3 p.m.:

The directors have pleasure in reporting that the progress of the Company continues to be satisfactory. During the year 1901 there has been added to the Company's mains the equivalent of 3,737 8-c.p. lamps, making the total 34,723. The number of units supplied has been 382,224, an increase of 24,789 units. The Company after paying all charges, and placing £750 to depreciation account, has a balance of £5,019. 10s. 4d., which, added to £38. 10s. 10d. brought forward from last year, makes £5,058. 1s. 2d. An interim dividend of £1,518. 16s. 10d. and interest on temporary overdraft and loan (£340. 5s. 3d.) have already been paid, leaving a net balance of £3,198. 19s. 1d. Out of this the directors recommend the payment of a dividend of 4½ per cent., making, with 2½ per cent. already paid, 7 per cent. for the year. This will absorb £3,080. 0s. 7d., leaving a balance to carry forward subject to fractional adjustment of income tax of £118. 18s. 6d. The Hon. C. A. Parsons and Mr. Simpson retire by rotation; both are eligible and offer themselves for re-election. The auditor, Mr. Arthur Rutter, also offers himself for re-election.

REVENUE ACCOUNT.

Dr.	£	s.	d.
Generation of Electricity.			
Coal, including dues, carriage, unloading, storing, etc.	1,225	18	0
Oil, waste, water, and engine-room stores	196	1	4
Proportion of salaries of engineers and officers	131	2	2
Wages at generating stations	732	12	10
Repairs and maintenance	398	5	9
Distribution of Electricity.			
Proportion of salaries of officers	15	0	0
Wages to linesmen, fitters, labourers	104	12	5
Rents, Rates, and Taxes.			
Rents, rates, and taxes	415	2	7
Management Expenses.			
Directors' remuneration for year 1901	210	0	0
Salaries of manager, engineer, secretary, etc.	292	4	2
Wages of clerk and messengers	109	14	9
Sundry expenses, including stationery, printing, etc.	180	2	6
Auditor of Company	10	10	0
Board of Trade auditor	22	2	6
Law expenses	6	16	6
Depreciation of leasehold works, buildings, plant, etc.	750	0	0
Insurances, etc.	63	15	9
Total expenditure	4,864	1	3
Balance carried to net revenue	4,991	2	1
	£9,855	3	4

Cr.	£	s.	d.
Sale of current	9,371	19	9
Public lighting	23	0	4
Rental of meters	373	6	4
Transfer fees	2	0	0
Cash discounts and sundry receipts	84	16	11
	£9,855	3	4

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	71,792	0	0
Sundry creditors	281	6	8
Net revenue account, less interim dividend	3,198	19	1
Depreciation fund account	2,190	11	1
Loan	5,000	0	0
Workmen's deferred pay	340	19	5
Unpresented cheques	24	14	4
	£82,828	10	7

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	72,782	1	9
Stores on hand	4,602	9	7
Sundry debtors	4,852	2	0
Cash in hand	5	13	9
Cash at bankers	435	9	6
Work in progress	150	14	0
	£82,828	10	7

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St. JAMES'S AND PALL MALL ELECTRIC LIGHT.

Directors: Eustace J. A. Balfour, Esq. (chairman); Walter Leaf, Esq. (vice-chairman); Sir John H. Morris, K.C.S.I.; Bennett Fitch, Esq., M.I.C.E.; Marlborough R. Pryor, Esq. General manager and secretary: Frederic J. Walker. Chief engineer: Sydney T. Dobson, M.I.C.E.

Report of the directors (with abstract of accounts) for the year ending Dec. 31, 1901, to be submitted to the shareholders at the ordinary general meeting to be held at the offices of the Company, Carnaby-street Central Station, Golden-square, W., on Feb. 11 at 3 p.m.:

The extensions of Carnaby-street station were completed in readiness for the winter season, and supply was made on a total of 211,827 8-c.p. lamps, being an addition of 25,480 in the past 12 months. The high price of coal, and the large addition to the rating of the Company's property, have raised the cost per unit of electricity generated, but, owing to the growth of the business and to further economies, the result of the year's trading has not been injuriously affected. Considerable progress has been made in the works of the Central Electric Supply Company at Grove-road, and the trunk mains connecting with this Company's system have been completed. By a resolution of the extraordinary meeting held on Feb. 12, 1901, confirmed at a subsequent meeting on March 5, the articles of association of the Company were altered in order to bring them into conformity with the Companies Act, 1900, and the present constitution of the capital of the Company. By an order of the Chancery Division of the High Court, made on June 15, 1901, the memorandum of association of the Company was altered, in conformity with a resolution passed by an extraordinary meeting of the Company held on May 6, and confirmed at a subsequent meeting on May 21, to enable the Company to guarantee the repayment of principal moneys and interest secured by debentures, mortgages, stocks, or obligations of certain other companies. This Company has guaranteed jointly with the Westminster Electric Supply Corporation the payment of the principal and interest on an issue of £250,000 4 per cent. guaranteed debenture stock of the Central Electric Supply Company, Limited. For the information of shareholders, an abstract of the accounts of that company is enclosed. The interest charged on advances made to the Central Electric Supply Company, Limited, and credited to interest suspense account at Dec. 31, 1900, has now been received. This interest, amounting to £2,569. 16s. 7d., after the deduction of income tax, has been transferred from the suspense account to the credit of capital reserve fund, the balance on which now amounts to £69,089. 1s. 10d. The net earnings of the Company for the year 1901, and balance brought forward from 1900, amounted to £38,434. 4s 8d., which after payment of interim dividends of 7 per cent. on preference shares and 10 per cent. on ordinary shares, left an amount now to be dealt with of £24,934. 4s. 8d. The directors propose to divide this amount as follows: (*a*) by payment of a dividend at the rate of 7 per cent. on the preference shares for the second half of the year, £3,500; (*b*) by payment of a dividend on the ordinary shares for the second half-year of 7s. 6d. per share, and a bonus of 2s. per share, making, with the interim dividend paid on Aug. 1 last, a total distribution of 14½ per cent. for the year, £19,000; (*c*) amount to be carried forward, £2,434. 4s. 8d. The chairman (Mr. Eustace J. A. Balfour) and Mr. Marlborough R. Pryor are the directors who retire, and, being eligible, offer themselves for re-election. The auditors (Messrs. Deloitte, Dever, Griffiths, and Co.) also retire, and, being eligible, offer themselves for re-election.

Revenue Account.

Dr. Generation and Distribution of Electricity.	£ s. d.	£ s. d.
Coal, including dues, carriage, etc.	£20,938 18 5	
Oil, waste, water, engine-room stores.	1,530 3 8	
Salaries of engineers and officers	2,965 15 5	
Wages at stations	5,168 8 6	
Repairs and maintenance of buildings and plant	3,277 1 2	
Attending, etc., public lamps	411 4 7	
Repairs and maintenance of mains	2,330 4 10	
Miscellaneous expenses	107 7 4	
		36,729 3 11
Rents, Rates, and Taxes.		
Rents payable	101 0 0	
Rates and taxes	6,021 5 0	
		6,122 5 0
Management Expenses.		
Directors' remuneration	2,500 0 0	
Salaries, etc.	4,360 1 7	
Stationery, printing, etc.	253 16 7	
General establishment charges	489 2 9	
Auditors of Company	157 10 0	
		7,760 10 11
Law expenses		180 0 10
Special Charges.		
Insurance	450 9 8	
Fees for testing meters	20 12 1	
Board of Trade audit	80 0 0	
Trustee for debenture stockholders	52 10 0	
		603 11 9
Depreciation.		
Depreciation on buildings	797 8 11	
Depreciation on plant, etc.	12,476 19 2	
		13,274 8 1
		64,670 0 6
Net loss on sales of old plant, materials, etc.		119 19 10
Balance carried to net revenue account		40,123 13 6
		£104,913 13 10

Cr.	£ s. d.	£ s. d.
Sale of current, after deducting provision for bad and doubtful debts (at 6d. per unit less rebates)	£99,327 16 10	
Ditto under contract	627 0 0	
Public lighting	1,863 6 8	
		101,818 3 6
Rental of meters on consumers' premises		2,519 1 7
Rents receivable		288 16 8
Transfer fees		35 16 6
Discounts on purchases		174 17 4
Sale of old materials, stores, etc.		30 8 3
Sundry fees, etc.		46 10 0
		£104,913 13 10

Dr. General Balance-Sheet.	£ s. d.
Capital account—amount received	450,000 0 0
Capital reserve fund	69,089 1 10
Lloyd's Bank, Limited, temporary loan, secured	20,000 0 0
Due to sundry tradesmen and others	7,285 0 11
Sundry creditors on open accounts	4,120 12 3
Debenture stockholders for interest accrued	2,471 17 6
Unclaimed dividends	57 14 11
Balance at credit of net revenue account, £38,434. 4s. 8d.; less interim dividends paid, £13,500	24,934 4 8
	£577,958 12 1

Cr.	£ s. d.
Capital account—amount expended for works	423,411 14 4
Central Electric Supply Company, Limited	87,507 13 0
Temporary investments at cost	28,968 14 1
Stores on hand	6,071 4 7
Sundry debtors for current supplied	25,884 5 11
Cash at bankers and in hand	6,115 0 2
	£577,958 12 1

Statement of Electricity Generated, Sold, etc.

Board of Trade units generated			6,387,107
Quantity utilised	Private supply	5,700,348	5,928,393
	Public lighting	142,148	
	Used on works	85,897	
Quantity expended in distribution			458,714
Number of lamps in circuit, Dec. 31, 1901			211,827

LIVERPOOL OVERHEAD RAILWAY.

Directors: Sir William Bower Forwood, Bromborough Hall, Cheshire (chairman); Richard Hobson, Esq., The Marfords, Bromborough, Cheshire (deputy-chairman); John Brancker, Esq., Green Bank, Wavertree; Harold Brocklebank, Esq., 20, Bixteth-street, Liverpool; Sir Edward Lawrence, The Grange, St. Michael's Hamlet; George H. Robertson, Esq., Plas Newydd, Llangollen; Harvey Cecil Woodward, Esq., Northway House, Seaforth. Engineer and manager: S. B. Cottrell, Esq., M.I.C.E., 31, James-street, Liverpool. Secretary: William H. Alexander, Esq., 24, North John-street, Liverpool.

In their report for the year ended Dec. 31, 1901, to be submitted to the shareholders at the twenty-seventh ordinary half-yearly general meeting of the shareholders, to be held at the Law Association Rooms, 14, Cook-street, Liverpool, on Feb. 11, the directors state that the gross revenue receipts amount to £41,766. 16s. 7d., and the working expenses to £29,896. 19s. 11d. The number of passengers carried during the past year is as follows: first-class, 1,430,739; second-class (including tramways), 6,478,967; workmen (special return tickets), 2,905,972—total, 10,815,678. There has been a falling off in the traffics during the past half-year, due mainly to the competition of the tramways belonging to the Corporation, which approach the dock system at several points. The directors have to express their great regret that a serious accident, through fire, took place on the evening of Dec. 23, at the Dingle Station, by which two passengers and four of the Company's servants lost their lives. Every precaution has been taken, in reinstating the station, to guard against the recurrence of a similar disaster. The receipts from passenger traffic, etc., less working expenses, amount to £11,869. 16s. 8d., which after deducting interest on mortgage debentures (£3,400), amount set aside to meet contingencies arising from accident at Dingle Station (3,000), and adding balance brought forward from June 30, 1901 (£3,722. 15s. 8d.), left available for dividend £9,192. 12s. 4d., out of which the directors recommend dividends of 5 per cent. per annum on preference shares (£3,000), and 1 per cent. per annum on ordinary shares (£2,500), leaving a balance of £3,692. 12s. 4d. to be carried forward to next half-year. The directors retiring by rotation at this meeting are Sir William B. Forwood and Mr. Harold Brocklebank, who, being eligible, offer themselves for re-election. The auditor retiring by rotation is Mr. George Nicholson, who is also eligible for re-election.

Dr. Revenue Account.	£ s. d.	£ s. d.
Maintenance of way, works, and stations	4,216 5 10	
Locomotive power	8,212 18 6	
Repairs and renewals of carriages	401 13 3	
Traffic expenses	11,348 9 11	
General charges	2,322 8 1	
Law charges	72 15 2	
Compensation	19 19 5	
Rents, rates, and taxes	3,231 7 3	
Government duty	71 2 6	
		29,896 19 11
Balance carried to net revenue account		11,659 14 3
		£41,556 14 2

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Cr.	£	s.	d.
Passenger traffic.....	40,790	6	3
Parcels, etc.....	55	6	9
Rents	700	17	8
Transfer fees	10	3	6
	£41,556	14	2

DUBLIN UNITED TRAMWAYS.

The half-yearly meeting of this Company was held in Dublin on Tuesday, Mr. W. M. Murphy (chairman) presiding.

The **Chairman** moved the adoption of the report, which appeared in our last issue. He remarked that the working of the tramways during the last half-year was generally regarded with satisfaction by the shareholders. That was the third occasion in succession that they had declared a dividend of 6 per cent., and he had no hesitation in saying the returns now were the best and most promising yet presented. Comparing their position with this time last year, they showed a considerable improvement in every respect. The receipts had not continued to grow as rapidly as they anticipated, but nevertheless they showed an advance of £1,025. The cost of the electric working was £14,990 in 1900, and £6,990 in 1901, a saving of £8,000. This item contained the whole cost of generating and distributing the electrical energy for working the tramcars. It worked out at ·564d. per unit, including the engineers' salaries, and he doubted very much if this could be beaten by any electrical station in the kingdom. The traffic receipts per mile were 8·70d., compared with 8·48d. in 1900, and the expenses 4·728d., as against 5·02d., the proportion of expenses to receipts being 51·88 per cent., compared with 56·09 per cent.

Mr. J. R. Wigham seconded.

After some discussion the motion was carried.

CHARING CROSS, EUSTON, AND HAMPSTEAD RAILWAY.

In the absence of Mr. Yerkes, **Mr. W. T. Potts** presided over the half-yearly meeting of this Company on Tuesday at the offices, Hamilton House, Victoria-embankment, and formally moved the adoption of the accounts, which, he remarked, called for no comment. The report was adopted.

The meeting was afterwards made special, when resolutions were passed approving Bills before Parliament—first, for conferring further powers on the Company in respect of their undertaking, for authorising agreements with the Metropolitan District Railway Company, the South-Eastern and Chatham Railway Company's managing committee, the South-Eastern Railway Company, and the Baker-street and Waterloo Railway Company; and, secondly, for conferring powers on the Brompton and Piccadilly-circus Railway Company, for the construction of new railways and works, and for the use of part of the Metropolitan District Railway, to extend the time for the compulsory purchase of land and the completion of works, and to authorise working and other agreements with other companies.

METROPOLITAN RAILWAY.

Colonel J. J. Mellor, the recently appointed chairman of the Metropolitan Railway Company in succession to Mr. J. Bell, presided over the half-yearly meeting of the shareholders at the Cannon-street Hotel last Friday.

The **Chairman**, in moving the adoption of the report, first referred to the circular signed by Mr. Kitching and other stockholders and sent out to the proprietors just before the issue of the directors' report. He hoped they would discuss the matter in an amicable and fair-minded spirit, with the simple aim and object of doing the best they could in the interests of the Company. The Board had sent out a reply to this circular, which, among other things, urged a fusion with the District Company, and, as a result, between 600 and 700 proxies sent in in favour of Mr. Kitching and his friends had been revoked. Deducting these revocations, the proxies received in opposition to the Board amounted to 1,054, representing £1,511,907 of stock and 130,905 votes. The proxies in favour of the directors were 2,909, representing £3,330,182 of stock, and 274,520 votes, being practically two to one for the Board. To meet the wishes of the opposition, however, the directors were prepared to appoint two of their number to the Board. With regard to the question of a fusion with the District Company, he had always believed that the two companies ought to be fused, but the difficulty had been in arranging terms acceptable to both parties. He thought there ought to be no difficulty, however—and it might be done at once—in arranging a friendly working agreement which would pave the way for a fusion of the two Boards. The directors were prepared to welcome any agreement of that character. Coming to the question of electric traction, he referred particularly to the suggestion of the traction company that the power-house to be erected at Chelsea should supply the current for both the Metropolitan and the District lines. The shareholders, no doubt, had seen the offer which the traction company had made to supply the Metropolitan with current at ·85d. per unit, and also the reply of this Board that they could generate it on their own land at Neasden, and supply themselves at something under ·5d. per Board of Trade unit. The erection of their own works at Neasden would not mean an unnecessary duplication of capital. Their consumption would be so large, and their works would be on so big a scale, that they could produce the current at the lowest possible figure. If this Company did not put down the power plant at Neasden, the traction company must put it down at Chelsea. This Board preferred to put it down for themselves, and get it at ground-floor price. In fact, they had now under consideration two tenders, both of which he believed were based on terms more advantageous than had ever yet been secured by any other company. At Neasden they had any quantity of land, secured some years ago on very low terms, and which would not cost this Company a penny. Then, again, at Neasden the cables would be carried the whole length of the railway, and, in any case, they must sooner or later erect a power-house there for their traffic to Harrow and northern extensions. Those considerations were of the first importance, apart from a great saving in the cost of the current. Their consumption would be so big that even the addition of one-tenth of a penny would cost the Company £29,000 a year. With regard to the proposal of the traction company to guarantee this Company 3½ per cent. on its ordinary stock, he thought they would agree with him that it would have been extremely unwise on the part of the Board to have handed over their valuable properties and their 13 millions of capital to a limited company involved in a variety of speculative undertakings. The tunnels of this Company were far superior to those of the "tubes" now running, and when the line was electrified and the tunnels beautified, London would not know its underground railways.

Mr. C. B. B. McLaren, K.C., M.P., seconded the motion. He thought that if Mr. Perks and Colonel Mellor or himself, or any other director of this Board, were to meet and quietly discuss the matter between this Company and the District, there ought to be no difficulty in laying down some reasonable terms of union.

Mr. A. G. Kitching then stated the case for the committee which issued the circular referred to above. The position which the committee took up in reference to the traction company was that, should an offer be made by a responsible company to equip their railway for electric traction or to lease it on fair and equitable terms, it should be considered, and that the shareholders should be consulted thereon. With reference to the two power-houses, the committee believed, judging from the action of all electric companies in London, that it would be found more economical to have one large central generating station rather than two or three. As, however, a difficulty had arisen as to where the power-house should be located, he thought the best course would be to call in the aid of some unprejudiced firm and ask them to decide which was the best site on which to have the joint station for generating the electricity. The Board had stated that their views and the views of the committee were identical with reference to the working agreement with the Metropolitan District Company in order that a quick and effective service in the Inner Circle should be arrived at under joint management. The committee were very glad to have that declaration. Then the directors had stated that they would be quite willing to meet their views on the electrical question, and, therefore, on those two points they had come to an agreement. The offer of two seats on the Board to two gentlemen whom they might select gave the committee as much influence as they might reasonably ask for.

Several other shareholders having spoken, the report and accounts were unanimously adopted. The two Bills now before Parliament were then approved, and the meeting closed with a vote of thanks to the chairman.

CENTRAL LONDON RAILWAY.

Mr. Hugh Tennant, in the absence of Sir Henry Oakley through indisposition, presided over the general meeting of the proprietors of this Company at the Holborn Restaurant on Wednesday.

In the course of his remarks the **Chairman** explained several of the more important items in the report, which appeared in our last issue, and went on to refer to the question of vibration. As far as the directors knew, the committee which was appointed to enquire into this matter were satisfied with the manner in which the Company met them in their investigations. At present he could only say that when the report was published the directors would give it their very careful consideration in all its bearings. He next announced that that part of last session's Bill relating to the provision of loop lines at Shepherd's Bush and at the Bank end of the line had been abandoned, and only that part of the Bill which gave the Company power to raise £150,000 additional capital for more lifts at Shepherd's Bush Station had been passed. Coming now to the new Bill before Parliament, by which power was sought to construct a line from Hammersmith to the City, he explained that it would be a continuation of the present Central London Railway, with which it would be connected at its eastern end by a curve serving Liverpool-street, and at the western end by a curve from Hammersmith to Shepherd's Bush. The directors were of opinion that the Central London could carry out the provision of a railway from Hammersmith to the City more advantageously than any other company not having the experience and connections which the Central London possess. The proposed new line commenced by a junction with the existing railway at Shepherd's Bush Green, from which point it ran in a westerly direction for one-third of a mile under the Goldhawk-road, turning south under the Grove-road to Hammersmith-broadway. From Hammersmith the railway ran in an easterly direction under the Hammersmith-road, the Kensington-road, Knightsbridge, Piccadilly, Piccadilly-circus, through Leicester-square and King William-street to the Strand, Fleet-street, and Ludgate-circus. From this point the line turned southwards, making a slight detour under Upper Thames-street and into Cannon-street, with the view of avoiding St. Paul's Cathedral. From Cannon-street the line passed up Queen Victoria-street, crossing under the existing railway at the Bank, reaching Liverpool-street by way of Cornhill and St. Mary-axe, and terminates by a junction with the existing railway under Old Broad-street, so completing a circle. There would be stations at Hammersmith-broadway, Addison-road, High-street, Kensington, Albert Hall, Knightsbridge, Hyde Park Corner, St. James's-street, Piccadilly-circus, Charing Cross, Law Courts, Ludgate-circus, Cannon-street, Bank, St. Mary-axe, and Liverpool-street. On the combined undertaking, the Central London and the Hammersmith and City, there would be 28 stations, situated as conveniently as possible in the various localities. In the present Bill

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power was taken to raise £3,000,000 by shares and £1,000,000 borrowing powers. As to traffic prospects, it was from the suburbs that a great deal of the traffic on tube railways was derived, and they might fairly infer that that would be a constantly-increasing traffic. There could hardly be a doubt but that the traffic along the busy thoroughfares the new railway would pass through or under would at least be equal to that on the Central London. Some of the stations on the new line would be contiguous to those of other railways to a greater extent than the Central London. At its City end the line would adjoin the large depôts of the North London and Great Eastern Companies, and there would be stations at Liverpool-street, Leadenhall-street, and Cannon-street. The Central London, as well as the new line, would be advantaged by some of these stations, especially Liverpool-street. Both as regarded the new line and the Central London the fact he had before mentioned—namely, the circular running of trains—was important. Practically there would be continuous services east and west over both the Oxford-street or Central London route and over the new route. He concluded by formally moving the adoption of the report and accounts.

Lord Colville of Culross seconded the motion.

The **Chairman**, replying to shareholders, said that at present the Board considered it would be premature to make any alteration in their present system of fares, though, of course, experience might result in very serious consideration having to be given to the subject. He also mentioned that the ventilation of the "tube" was being made the subject of experiment at the present time.

At an extraordinary general meeting held immediately afterwards a resolution was passed authorising the creation and issue of the share capital and the exercise of the borrowing powers referred to above. The proprietors also approved the New Lines Bill, it being stated that the period named in the Bill for the completion of the proposed lines was five years.

A vote of thanks to the chairman closed the proceedings.

GREAT NORTHERN AND CITY RAILWAY.

The seventh half-yearly meeting of the shareholders in this Company was held at the Westminster Palace Hotel on Wednesday.

Sir Charles Scotter presided, and, in moving the adoption of the report, said he had received that morning a report from Sir Douglas Fox, the Company's engineer, which showed that the line was getting very near completion. He thought he was justified in saying that certainly during this year the line as between Drayton-park and Finsbury-pavement would be completed, and, he hoped, open for traffic. With reference to the subject of electric traction, he remarked that long before the arbitration in the dispute between the Metropolitan and the Metropolitan District Railway Companies, the directors of this Company had decided to adopt for the working of their railway precisely the same system as that recommended by Mr. Lyttleton. He might state that not only the contracts for the power, but also the whole of the work, the carriages, etc., connected with it, had been placed in this country. Provision was made for a three-minute service of trains each way between Finsbury Park and Finsbury-pavement, and, in addition, they would have ample power for contingencies. The carriages would be much larger and more roomy than those on either the Waterloo and City or the Central London Railways. He had on several occasions at their meetings referred to the question of the agreement with the Great Northern Railway Company, and the shareholders would be asked that day to approve the Bill in which this matter was dealt with. On the question of expense, the directors of this Company came to the conclusion that it would be cheaper in the long run for them to have their own independent line under the Great Northern Railway and their own independent station under Finsbury Park Station. The negotiations on the subject were long, but an agreement, which was only signed and sealed this week, had been made by which the Great Northern Railway Company would make a line under their railway and station at Finsbury Park and lease it to this Company for 999 years, they paying to the Great Northern Railway Company 3 per cent. on the capital. He then formally put the motion for the adoption of the report.

The **Earl of Lauderdale** seconded.

The **Chairman**, in answer to a question, stated that by the agreement alluded to, this Company would get under the railway and station of the Great Northern Company at Finsbury Park without any payment for land.

The motion was agreed to.

A resolution was afterwards adopted approving a Bill conferring further powers on the Company, the most important feature of which was a proposed extension of the line from Finsbury-pavement to Lothbury, with subways converging on all the important thoroughfares around Lothbury. A Bill was also approved to empower the Great Northern Company to construct an underground railway in Islington and to lease it to this Company.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Tulcea (Roumania).—The Municipality invite tenders for lighting the town. Tenders by Feb. 25.

Bacau (Roumania).—The Mayor invites tenders for electric lighting of the town by March 15. The estimate is £5,646.

Ghent.—The Municipality require tenders for the electric lighting of the town. Tenders must be posted before March 1, 1902.

Cuellar (Spain).—The Municipality require tenders for an electric lighting installation and working of the same for 20 years, by Feb. 27.

Rockhampton (Queensland).—The contract for the municipal tramways, full particulars of which appeared in a former issue, will remain open until March 31.

Glasgow.—The Corporation invite tenders for the supply, delivery, and erection complete of materials for switchboard extensions. Tenders by Feb. 21. Details in our advertisement columns.

Aberdeen.—The Tramways Committee invite tenders for the supply of steel tramway poles, bases, and trimmings for the same. Tenders by Feb. 12. Details in our advertisement columns.

King's Lynn.—The Corporation invite tenders for the supply and erection of one Lancashire boiler, together with steam and feed pipes. Tenders by Feb. 21. Details in our advertisement columns.

Bournemouth.—The Town Council invite tenders for the following: steel poles, overhead line, section boxes, arc lamps, arc lamp-poles, carriers, etc. Tenders by Feb. 12. Details in our advertisement columns.

Madrid.—The Post and Telegraph Department invite tenders for supply of 3,000 telegraph poles of horse-chestnut wood. The estimate is 7 and 8 pesetas per pole of 7m. and 8m. length respectively. Tenders by Feb. 22.

Bournemouth.—The Town Council invite tender for a motor-generator by Feb. 21. Specification, etc., can be obtained from Mr. F. W. Lacey, borough and tramway engineer, Municipal Offices, Bournemouth.

Hammersmith.—The Council invite tenders for the supply of electrical stores and best Welsh smokeless steam coal for 12 months ending March 31, 1903. Tenders by Feb 12. Details in our advertisement columns.

Rochdale.—The Corporation invite tenders for the supply, delivery, and erection at Rochdale, Lancashire, of one complete traction switchboard and accessories. Tenders by Feb. 25. Details in our advertisement columns.

Birkenhead.—The Corporation invite tenders for Lancashire boiler and mechanical stokers by Feb. 4. Specifications, etc., can be obtained from Mr. W. Bates, borough electrical engineer, Craven-street, Birkenhead.

Edinburgh.—The Council invite tenders for the electric lighting installation, etc., of the third portion of the Colinton Mains Fever Hospital, the number of lighting points being about 600. Tenders by March 3. Details in our advertisement columns.

Shipley.—The Urban District Council invite tenders for the supply, delivery, and erection, at their electricity works, of traction switchboard, boosters and balancers, and alterations to existing switchboard. Tenders by Feb. 10. Details in our advertisement columns.

Redruth.—The Urban District Council invite tenders for lighting the town of Redruth, in accordance with specifications and conditions which can be seen at the office of Mr. Henry Paige, clerk, or at the office of the Surveyor, Station-hill, Redruth. Tenders by noon on Feb. 10.

West Ham.—The Council invite tenders for the supply of engine-room stores, cable, boxes, jointing materials, etc., recording watt-meters, double-pole house cut-out boxes, transformers, and incandescent lamps. Tenders by Feb. 11. Details in our advertisement columns.

Fulham.—The Guardians invite tenders for the supply, delivery, and erection on their premises of two 50-kw. steam dynamos and boosters, four dry-back marine boilers, storage battery, and wiring for about 2,000 lights. Tenders by Feb. 25. Details in our advertisement columns.

Battersea.—The Council invite tenders for the supply of the following materials required by the Electricity Department from March 31 next: coal, oil and engine-room stores, arc lamp carbons, and electric meters. Tenders by Feb. 18. Details in our advertisement columns.

Madrid.—The Department of Agriculture invite tenders for the construction of an electric tramway from Linares to the mines of San Roque and Torilla, in the Province of Jaen. Tenders by Feb. 24. This is the extension of the tender advertised for Nov. 17, but the conditions have been modified.

Croydon.—The Town Council invite tenders for the supply of 10 double-deck double-truck cars, equipped complete with motors, etc., for overhead trolley system. Specifications, etc., can be obtained on application to Mr. E. Mawdesley, town clerk, Town Hall, Croydon. Tenders by Feb. 17.

Manchester.—The Electricity Committee invite tenders for electric overhead travelling crane for generating station, and hand-driven overhead travelling cranes for sub-stations, by Feb. 19. Specifications, etc., can be obtained from Mr. F. E. Hughes, secretary, Electricity Department, Town Hall.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Stuart-street generating station and sub-stations of surface condensers, oil separators, and hot-well, cooling towers, and feed-water heaters. Tenders by Feb. 13. Details in our advertisement columns.

Aberdeen.—The Tramway Committee invite tenders for the electrical equipment of three of their horse-car routes, comprising overhead equipment and bonding (poles and bonds supplied by Corporation), and supply and laying of cables. Tenders by Feb. 15. Details in our advertisement columns.

General Post Office.—Tenders are invited for the purchase of about 25 tons of guttapercha, 60 tons of copper, 50 tons of lead, a quantity of other metals (brass, zinc, and iron), indiarubber-covered

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wire, limed hide pieces, electric glow lamp tops, tarpaulin, felt, jute serving, cabinet work, etc. Tenders by Feb. 12.

Newcastle-on-Tyne.—The Corporation invite tenders for the laying down of about 1¼ miles of single-line tramway and passing places, the rails, fastenings, points and crossings being supplied by the Corporation. Specifications, etc., can be obtained from the City Engineer, Town Hall, Newcastle. Tenders by Feb. 12.

London, S.W.—The London County Council invite tenders for two lots of 50 double-decked double-bogie electric tramcars, equipped with a plough for working on a conduit system, and to be capable of seating about 68 persons. Specification and other particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by March 4.

Walsall.—The Corporation invite tenders for the following works in connection with the construction of the permanent way and overhead equipment of about six miles of single track and 1¾ miles of double track of tramways on the overhead trolley wire system. Specification, etc., may be obtained from the office of Mr. Richard Henry Middleton, borough surveyor, Walsall, and of Mr. Alexander Wyllie, borough electrical engineer, Electricity Works, Wolverhampton-street, Walsall. Tenders by Feb. 21.

RESULTS OF TENDERS.

Warrington.—The Town Council have accepted the tender of H. Ingram, Limited, for wiring the car sheds, at £196. 9s. 6d.

Coventry.—The Electricity Committee have accepted the following tenders: J. and H. McLaren, 1,000-h.p. engine, £4,275; British Schuckert Company, 600-kw. two-phase alternator, £1,580.

London, S.W.—The Establishment Committee of the Fulham Borough Council have accepted the tender of the British Insulated Wire Company, at £27,689. 8s. 10d., for mains, conduits, lamp-posts, and street boxes.

Worcester.—The Town Council have accepted the tender of the Alphons Custodis Chimney Construction Company, of Sheffield, to build one of their patent chimneys at their new electric lighting station, at £825.

West Ham.—The Council have received the following tenders for a travelling crane, to carry 30 tons, span 67ft.: Carrick and Ritchie, Edinburgh, £946 (accepted); Witting Bros., 49, Cannon-street, £970; Jessop and Appleby, Leicester, £1,120.

Oban.—With reference to a note in our last issue giving results of tenders for Oban, we are informed that the International Electrical Engineering Company are supplying the three dynamos, spare armature, etc., to the successful tenderers, J. Howden and Co.

Cardiff.—The Tramways Committee have accepted the tender of J. Musgrave and Son for two 1,600-h.p. engines, at £14,074; and Dick, Kerr, and Co. for two 900-kw. generators, at £5,560. The tender of Dick, Kerr, and Co. was also accepted for a combination road cleaner at £600.

Warsaw.—Paterson, Cooper, and Co. have secured from the municipality contracts for an electric light installation and for electric tramways and local railways, having a total length of 90 miles. The British firm secured the contract in competition with Belgian, French, and American rivals.

Aberdeen.—Mr. P. Tawse has secured the contract for laying the Albyn-place tramway route, the amount of the estimate being £1,636. 0s. 7d.; John M'Adam and Sons have obtained the contracts for the following sections: King-street, £6,134. 9s. 7d.; Holburn-street, £4,192. 15s. 10d.; Fountainhall-road, £381. 7s. 10d.

Middlesbrough.—The Council have received 70 tenders for the supply of additional engine-house plant. The tender of Witting Bros. for £2,833 has been accepted. As also the following: Nalder Bros. and Thompson, switchboard, £470. 13s. 4d.; Mather and Platt, condensing apparatus and pipes, £375; British Insulated Wire Company, main extensions, £867. 8s. 4d.

London, E.—The Poplar Borough Council have received the following tenders for the installation of electric light in the Poplar Town Hall and the Bow and Bromley Vestry Halls respectively:

W. Simmons, 134, The Grove, Stratford, E. (accepted) ...	£398	5	6
Johnson and Phillips, Victoria Works, Charlton, S.E. ...	405	14	0
Barlow Bros. and Co., 237, Shaftesbury-avenue, W.C. ...	459	0	0
Werton and Co., 58, Fenchurch-street, E.C. ...	466	0	0
Jackson Bros., Broadway, Plaistow ...	499	2	6
W. H. Marshall and Co., 270, High-road, Leytonstone ...	530	0	0
A. W. Penrose and Co., 109, Farringdon-road, E.C. ...	642	9	3
C. Peacock and Co., 35, Clerkenwell-road, E.C. ...	718	9	6
P. W. Fellows, Cross-street, Walsall ...	758	15	0
Haselgrove, 113, Station-road, Forest Gate ...	770	2	6
Tamplin and Makovski, Limited, Brighton-road, Redhill	794	12	8
Ryan and Co., Harrow-green, Leytonstone ...	826	18	3

Bilston (North Staffs).—The Midland Electric Corporation for Power Distribution have received the following tenders for electrical plant to be installed in their sub-station at Bilston, Staffordshire:

British Schuckert Company ...	£5,661	15	0
Ditto (alternative) ...	5,976	15	0
Ditto ,, ...	6,531	10	0
Ditto ,, ...	6,528	0	0
International Electric Engineering Company ...	6,225	0	0
Armstrong-Whitworth Company ...	7,900	0	0
Ferranti, Limited ...	8,062	0	0
Brush Electrical Engineering Company ...	8,047	0	0
General Electric Company, England ...	8,171	0	0
Bruce Peebles and Co. ...	8,339	0	0
Lahmeyer Electric Company, Limited ...	8,565	0	0
Johnson and Phillips ...	9,806	0	0
Electrical Construction Corporation ...	10,070	15	0
British Westinghouse Company (accepted) ...	5,850	13	0

Birkenhead.—The tender of the British Westinghouse Electric Manufacturing Company, Limited, Trafford Park, Manchester, has been accepted for the electrification of the Mersey Tunnel Railway between Liverpool and Birkenhead, at £600,000.

Pontypridd.—Nearly 350 tenders were received by the District Council for the supply of plant for lighting and tramways. The following have been accepted: Boilers, Babcock and Wilcox, £5,611. 2s.; engines, Coombe, Barbour, and Co., Belfast, £5,210; dynamos, Greenwood and Batley, £3,401; balancers, British Westinghouse Company, £760; switchboard, etc, divided between Ferranti and Kelvin and White, £2,473; fitters' shop, Newbolds, £594; travelling crane, Chatteris, £455. 10s.; arc lamps, Johnson and Phillips, £788. 5s.

BUSINESS NOTES.

TRACTION.

Luton.—A draft agreement is being prepared between the promoters of the tramway scheme and the Corporation.

Mountain Ash.—Strenuous opposition is being offered to the electric tramway scheme of the Urban District Council.

Lancing.—The Parish Council have agreed to support the Brighton and Shoreham Tramways Company's Bill for new lines.

Denbigh.—The clerk of the County Council has been authorised to negotiate a further loan of £1,500 for the purposes of the Tanat Valley Light Railway.

Torquay.—A memorial protesting against the introduction of electric tramways in the town was received at the meeting of the Town Council on Tuesday.

Berkshire.—A committee of the County Council has been appointed to take the necessary steps for opposing the Windsor and Maidenhead light railway scheme.

Eastbourne.—A deputation attended the Town Council meeting on Monday and presented a petition from a large body of ratepayers in favour of electric trams.

Tipton.—A proposal is before the Urban District Council to promote a Bill in Parliament for powers to construct electric tramways in the district.

Todmorden.—Opposition to the Corporation tramway scheme is being offered by the Rochdale Canal Company and the Lancashire and Yorkshire Railway Company.

Edinburgh.—The tramway company have now paid to the Corporation the balance of the rent of nearly £40,000, about which so much litigation has taken place.

West Bromwich.—Arrangements have been made for running horse cars on the Spon-lane and Bromford-lane tramway until the line is reconstructed for electric traction.

Weston-super-Mare.—The work of laying the electric tramways has now been commenced in good earnest. It is stated that the greater portion of the line will be ready for opening early in April.

Durham.—The County Council have decided to petition against the South Shields and Sunderland District Tramways Bill, unless the promoters carry out certain suggestions of the county surveyor.

Hastings.—A number of the members of the Corporation visited the Isle of Thanet last Friday in order to inspect the light railways in that district. They will report to the Town Council on the matter.

Halifax.—The Town Council have defeated a motion requesting the Tramways Committee to take into consideration the question of the introduction of workmen's fares throughout the whole of the borough.

Glasgow.—Since the beginning of the present financial year on June 1 the tramway revenue has been £423,500, as compared with £328,056 in the corresponding period of last year—an increase of £95,444.

Datchet.—A meeting of the parishioners has passed a resolution to the effect that the introduction of the proposed light railway into Datchet would be detrimental to the interests of the village, and should be opposed.

Hanley.—Proceedings are being taken by the Town Council to oppose the Bill now being promoted by the North Staffordshire Tramways Company and the Potteries Electric Traction Company, as it affects the borough.

Birmingham.—The City Council on Tuesday accepted the recommendation of the Tramways Committee not to include the clause with reference to the construction of tramways in Edgbaston and Harborne in this session's Bill.

The Potteries.—The employés of the Potteries Tramway Company have refused to accept the terms offered by the directors, who had agreed to an increase of ¼d. per hour in the rate now paid to motormen and conductors.

Salford.—It is decided to engage a tramways traffic superintendent at a salary of £200 per annum. Mr. Ernest Hatton has been reappointed as general manager and engineer to the tramways undertaking for a further period of 12 months.

Shoreham.—The Urban District Council, having agreed to support the tramways company in their scheme for extension of lines and adoption of electric traction, are urging the Steyning West Council to come to terms with the company.

Derby.—The Town Council have directed that steps should be taken to oppose the applications to the Light Railway Commissioners for the Derby and Nottingham Light Railway Order, and the Derby, Nottingham, and District Light Railway Order.

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Goole.—The scheme for establishing a light railway between Goole and Selby will, it is reported, be strongly opposed by the North-Eastern Railway Company, who are contemplating the promotion of an extension of their own system between these two places.

Folkestone.—The Corporation have agreed to exercise their powers under the tramways provisional order as soon as they are in a position to do so, and a sub-committee has been appointed to settle the terms as to the working of the tramways between Cheriton and Folkestone.

Poole.—The Town Council have appointed a sub-committee to enquire into the application made to the Light Railway Commissioners to construct a light railway through Parkstone, and to report to the Council the conditions on which they would support the application.

Appointment.—Mr. J. Shaw, general manager and engineer of the Isle of Man Tramways and Electric Power Company, Limited, and consulting engineer to the Douglas Corporation tramways, has been appointed resident electrical engineer to the Mersey Railway Company.

Abandoned "Tubes."—Notice has been given to the Camberwell Borough Council that the following "Tube" Bills will not be proceeded with this session—viz., the Victoria, Kennington and Greenwich Railway Bill, and the East London, City, and Peckham Railway Bill.

Houghton.—A deputation from the Sunderland and District Tramways Syndicate waited upon the Urban District Council on Tuesday, with the result that the Council rescinded their previous resolution, and agreed to the extension of time asked for by the syndicate.

Gloucester.—A special meeting of the City Council will be held on March 12 for the purpose of further dealing with the tramway question. Our readers will remember that the Council have already passed a resolution in favour of acquiring the tramway company's undertakings.

Leeds.—Steps are to be taken to appoint a new general manager of the city tramways, but Mr. Wharam, who is retiring from the position, will, we understand, be retained at his present salary until the end of 1903, so that, whilst being relieved from active duties, he will be in a position to assist his successor.

Blackburn.—The working of the Corporation tramways for the nine months ending Dec. 31, has resulted in a gross profit of £6,510. 9s. 6d. After paying instalments of loans, however, amounting to £4,808. 5s., and interest £6,250. 11s. 4d., there is a deficit during the period mentioned of £4,431. 13s. 11d.

Erdington.—With reference to the tramway scheme which the Urban District Council have in hand the Warwickshire County Council have decided to call for an undertaking to lay a single line of rails over Salford Bridge, and to carry out such widenings of the main roads as the County Council may think necessary.

Canterbury and Herne Bay Light Railway.—This proposal was considered at a public meeting convened by the Canterbury Ratepayers' Association last week. Resolutions were passed approving the scheme, and urging the City Council to support the promoters in their application to the Light Railway Commissioners.

Oxford.—In their report to the shareholders for the past year the directors of the City of Oxford and District Tramways Company state that they consider the time has arrived when electric traction should, if possible, be adopted. They are therefore preparing a scheme which will in due course be submitted to the Corporation for approval.

Walthamstow.—A public meeting of ratepayers has passed a resolution approving the scheme promoted by the Urban District Council for the construction of a light railway in the district, subject to the Council agreeing to purchase the land required for the erection of workmen's houses on areas through which the railway would pass.

North Metropolitan Tramways Co.—The report of the directors of this company for the half-year ended Dec. 31 last states that with reference to the negotiations with the West Ham Corporation and the Urban District Council of Leyton, mentioned in previous reports, the West Ham Corporation have applied to the Board of Trade for the appointment of a referee.

St. Marylebone.—The Law and Parliamentary Committee recommend the Borough Council to petition against the following Bills in Parliament—viz.: Charing Cross, Euston, and Hampstead Railway (No. 3), London County Council (Tramways and Improvements), and the Metropolitan Railway Bill. No opposition is to be offered to the Central London Railway (New Lines) Bill.

Tilbury and Southend Railway Co.—Presiding over the half-yearly meeting of this Company on the 30th ult., Mr. H. D. Browne referred to the Bill which the Company have before Parliament asking for powers to electrify their lines. He remarked that this was only a tentative proposal, but it might be seen to be advantageous to adopt electric traction on their railway as far as Barking.

Birkenhead.—The Tramway Committee recommend the Town Council to apply to the Board of Trade for sanction to borrow £13,642 for the doubling of the tramway track on the New Ferry route in Chester-street and New Chester-road. A suggestion by the Ferries Committee that the tramway system be extended direct to the south end ferries has not been acceded to by the Tramway Committee.

Dunstable.—The Town Council have passed a resolution supporting the light railway scheme provided the company agree to a clause being inserted in the order that Dunstable shall be supplied in bulk with electric current at an agreed price, or in the event of the Corporation erecting their own station the company shall, if required, take their supply from Dunstable for the district included in the Dunstable order.

Tyneside.—The Bill to confer further powers upon the Tyneside Tramways and Tramroads Company for the construction of tramways has been approved by the shareholders. It was stated at the meeting that the contracts for the permanent way, and also for the car-sheds and cars, had been let. The work had been commenced at Wallsend, and the whole of the authorised line they hoped to be able to complete in June.

Dundee.—A report has been prepared by the tramway manager regarding the practice in other large towns in Scotland in connection with the valuation of the tramways for assessment purposes. It appears that the custom is to assess on one-fourth of the valuation of the system as fixed by the Assessor of Railways and Canals. The Tramways Committee have approved the adoption of this system in Dundee.

Scarborough.—The Bill promoted by the Scarborough Tramways Company came before Mr. Campion, one of the Examiners of Private Bills of the House of Commons, on Monday. The Bill seeks to empower the company to construct and manage tramways and to execute certain street works in the borough of Scarborough. Consideration of the Bill, which is opposed by the Corporation of Scarborough, was postponed until next Monday.

Crewe.—An extensively signed petition from the ratepayers of Mill-street and High-street was received at this week's meeting of the Town Council stating that they had heard with deep concern the proposal to omit those streets from the route to be traversed by the electric trams. The Tramways Committee recommended that the route should be between Exchange-street and Edlestone-road, but the minute was referred back for further consideration.

Devonport.—On Thursday last week a workmen's electric car was proceeding down a rather steep incline when the wheels skidded, and the car, which had on board about 30 passengers, ran down the hill at a high speed. At the bottom it jumped the rails and ran with great force against a granite wall which bounds the London and South-Western Railway. The wall was demolished, but the car escaped without much damage. No one was hurt.

Nottingham.—The General Purposes Committee report that they have carefully considered the scheme as to light railways in the neighbourhood of Nottingham, proposed by Sir Bache Cunard, Bart., and Sir James Mackenzie, Bart., respectively. These schemes, in general terms, are in competition with each other. The committee add that they cannot advise the Council to support either of them unless considerable modifications are made therein.

Aberdeen.—The Town Council on Monday approved the committee's recommendations in regard to the adaptation for electric traction of the tramway from Union-street to Queen's Cross *via* Rosemount and Fountainhall-road at a total estimated cost of £11,550. It was also agreed to invite tenders for the supply of 12 electric cars similar in construction to those now in use. The estimated cost of the new cars is £10,350, including the electrical equipment for nine horse cars.

Gravesend.—Under an agreement just concluded, the local tramway company have contracted to take current for the tramways now in course of construction from the generating station which the Corporation propose to erect at a cost of about £35,000. It is arranged that the company shall take not less than 180,000 units per annum, at 2d. per unit up to that amount. The charge for energy between 180,000 and 350,000 units is to be 1½d. per unit, and over 350,000 units 1¼d. per unit.

Chelsea.—The Borough Council are recommended to present petitions against the following Bills: Brompton and Piccadilly-circus (New Lines and Extensions), Metropolitan District Railway, and London United Electric Railway. With regard to the King's-road Railway Bill, which was suspended from last session, the Parliamentary Committee are informed that the Bill is being proceeded with; the Council's opposition to the scheme will therefore be continued on the petition already lodged.

Charlesworth.—Meetings have been held between the Charlesworth and Ludworth Councils and representatives of the electrical syndicate regarding the proposed electric tramway scheme to cover a large area of the outlying districts. Sale is to be the starting point, and the route will include Marple, Marple Bridge, Compstall, Charlesworth, Mottram, Stalybridge, and many other places. It is intended to apply for the necessary powers shortly, and to push forward the work as fast as possible.

Bradford.—On Friday last Major Pringle inspected the new electrically-equipped tramways at Bradford from the Mechanics' Institute to Four Lane Ends, and from the New Inn to Bankfoot. The trial trips were satisfactory. The next day the Corporation took over the whole of the lines worked by the existing companies. On the two above-mentioned routes a frequent service of electric cars is being run. The remainder of the lines will be worked by steam and horse power until the electrical equipment is complete.

Paignton.—At the meeting of the District Council on Monday it was reported that the Kingsland Surface-Contact System Company, who had secured the approval of the Council and had entered into an agreement with them, cannot proceed with their Bill this session. Consequently the Council are negotiating with one of the other companies applying for powers for running electric trams between Torquay and Paignton. The two companies left in the field are the Power and Traction and the Provincial Company, both of which propose overhead wires.

Rotherham.—The tramway proposals for the borough were outlined by the Mayor in a speech on Tuesday evening. There are to be five sections, the total length being five miles, and the estimated cost £11,000 per mile. Roadwork, overhead equipment, and feeders is estimated to cost £8,300 per mile; rolling-stock is put down at £9,750, and car-sheds £5,500. In order to secure a net profit of £3,350 in the original estimate, receipts amounting to 10½d. per mile will have to be realised. The consulting engineer to the Corporation has been instructed to prepare specifications, etc., for the laying of tramways along the Sheffield-road to Tinsley.

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Warrington.—Good progress is being made in the erection of the overhead equipment for the electric tramways. The permanent way has already been completed from Sankey Bridges to Latchford, and it is anticipated that the first car will be run some time in March. The car-shed in Mersey-street is nearing completion, and everything points to an early inauguration of the tramway system. At a meeting of the Tramways Committee it was resolved that the Gas Committee be offered the sum of £1,850 for the purchase of the premises at the old gasworks required for car-sheds.

Oil Service System.—The Richter Manufacturing Company, of Bradford, have just installed a very complete oil service system at the tramway power-house, at Newcastle-upon-Tyne, to the designs of the consulting engineer, Mr. Charles Hopkinson (of Messrs. Hopkinson and Talbot). Four tanks of 200 gallons capacity each are fixed in basement to store cylinder, bearing filtered and dirty oil respectively. Service tanks are provided above the level of the engines to feed all oiling points by gravity. The dirty oil is collected and passed through a Turner's filter for use again. Pumps and piping connections are provided, so that no oil need be carried about.

St. Helens.—The arrangement as to rates for the proposed carriage of goods on the tramway system in connection with the South Lancashire scheme was discussed at this week's meeting of the Electric Supply and Parliamentary Committees. At the last meeting of the Town Council the recommendation of the Electric Supply Committee as to the rates to be charged by the Corporation met with opposition, and were taken back for further consideration by the joint Electric Supply and Parliamentary Committees. On Wednesday the joint committees sat for three hours, and adjourned in order that new terms might be suggested by the tramways company.

Ashby-de-la-Zouch.—An enquiry was opened yesterday by the Light Railway Commissioners with regard to the scheme for the construction of a light railway from Ashby-de-la-Zouch, through Swadlincote, to Burton-on-Trent, where it is proposed to form a junction with the authorised tramways of the Corporation of Burton-on-Trent. The proposed line will be about 10¾ miles in length. It is understood that there is no direct opposition to the construction of the railway, but the local authorities through whose districts the line will pass were represented at the enquiry in order to place their views before the Commissioners for the improvement of the scheme.

Watford.—The Earl of Jersey and Colonel Boughey, Light Railway Commissioners, opened an enquiry last Friday into the application of the Hertfordshire County Council for an order for the construction of a light railway at Bushey, and the application of the Watford and District Tramway Company to construct a line from Watford to the county boundary at Bushey and from Watford to Rickmansworth, and also a slight extension of their scheme which has already been sanctioned from the north of Watford to the end of the urban district boundary in the St. Albans-road. At the conclusion of the day's proceedings the enquiry was adjourned till March 12.

Cardiff.—A number of tenders were accepted at the last meeting of the Tramways Committee for the equipment of the power stations. For the supply of two generators tenders were opened from, among others, German and Belgian firms, but although these were lower than the others received, it was agreed not to consider them, and the tender of Messrs. Dick, Kerr, and Co. was accepted. The Board of Trade have granted sanction to the Corporation to serve notice on the Cardiff District and Penarth Harbour Tramways Company, Limited, requiring the company to sell to the Corporation the undertakings authorised by the Cardiff District and Penarth Harbour Tramways Order, 1880.

City and Brixton Railway.—On Monday this Bill was under consideration by the Examiner of Private Bills. Its object is to enable the City and Brixton Railway Company to abandon part of their original scheme, to reduce capital, and to authorise a working agreement with the City and South London Railway Company. The examiner found that the Bill had duly complied with the Standing Orders of the House of Commons. The company had deposited an alternative Bill for the abandonment of the whole scheme on the ground, as set forth in the preamble, that they had been unable to raise their capital, but this Bill was marked in the examiner's list as "dead."

Hebden Bridge.—The dispute which had been going on for some months between the Halifax Corporation and the Hebden Bridge District Council has now been settled by Major Druitt, inspector to the Board of Trade, to whom the matter had been referred. The Halifax municipality are extending their tramway system to Hebden Bridge, and the lines, a distance of eight miles, are laid. The standard poles are affixed on the west side of the turnpike. When they got to the Hebden Bridge boundary the local authority insisted that the poles should be fixed on the east side, and a deadlock has since then been the result. The decision of Major Druitt is in favour of the Halifax Corporation.

Proposed Monorail in Scotland.—It is reported that a scheme is under consideration for the construction of an electric railway between Edinburgh and Glasgow on the monoline principle. Plans have been prepared and a route mapped out, and these have been, as a preliminary, submitted to the Board of Trade. The promoters of the scheme, it is stated, intend to apply for the requisite parliamentary powers in March, under the provisions of the Private Bill Legislation Act for Scotland. It is proposed to cover the distance between the two cities in 25 minutes, and to run six trains each way every hour. The trains would not carry more than 100 passengers each. There would be no intermediate stations.

London-Brighton Electric Railway.—Mr. Cheesewright, who is engineering this scheme, had an interview with the General Purposes Committee of the Brighton Town Council on Wednesday. He gave assurances on several of the points, and the committee saw nothing objectionable in the project. Brighton's opposition to the scheme in Parliament will, therefore, be only to safeguard the town's interests. Subsequently the committee decided to approach the company to extend the area for the terminus station in Queen's-square by taking in the Quadrant, which would give an open approach from the clock tower. The Bill will come before the Examiners of Standing Orders of the House of Commons next Tuesday.

Batley.—The negotiations between the Batley Corporation and the British Electric Traction Company regarding the tramways in Batley are now nearing completion. It is proposed that the lines should be laid by the Corporation, the system to be afterwards leased to the company for 28 years, at a rental sufficient to cover the interest on the loans, and to provide a sinking fund for the liquidation of t he debt. Electric current will be taken from the Corporation electricity works. It is further stated that a new company is to be formed to run the Bradford-road, Spen Valley, Dewsbury, and Batley trams. The capital would be £300,000, and the company would probably be known under the title of the "West Riding Woollen District Electric Tramway Company."

London "Tube" Railways.—A complete list of this session's "Tube" Railway Bills for London is embodied in the report of the Parliamentary Committee presented at Tuesday's meeting of the London County Council. There are 17 such Bills now before Parliament, under the following titles: Baker-street and Waterloo, Brompton and Piccadilly-circus (new lines and extensions), Central London (new lines), Charing Cross, Euston, and Hampstead (No. 3), Charing Cross, Hammersmith, and District (No. 2), City and Brixton, City and Crystal Palace, City and North-East Suburban Electric (No. 2), Edgware and Hampstead, Great Northern and City, Great Northern (No. 2), Great Northern and Strand, King's-road (Putney Extension), London United Electric, North-East London (No. 2), North-West London, Piccadilly and City (No. 2).

Wolverhampton.—We understand that the Board of Trade have now agreed to grant a year's provisional license for the running of the electric cars on the Bilston-road section of the Corporation tramways, which has been equipped with the Lorain surface-contact system. The original intention was that the license should only be for a 30 days' trial; but the Lorain Company, who have undertaken the whole responsibility for the proper working of their system, which has to be approved by the Corporation before it is taken over, have succeeded in obtaining a license for 12 months. This concession will enable the Lorain Company to give their system a thorough trial at Wolverhampton. On Tuesday permission to open the line on Wednesday was received from the Board of Trade by wire; the formal sanction and the 12 months' certificate will follow in due course.

Newcastle.—There was a decrease in the takings on the electric tramways last week, the amount being £1,344, as against £1,398 the previous week. The lines into Gosforth are now nearly completed for electric traction. In reply to a query from the Tyneside Electric Supply Company, the Tramways Committee have informed the company that it is intended to supply current for these lines from the Corporation power station. The Tramways Committee having decided upon the promotion of a Bill in Parliament in respect to the extension of the tramways, have agreed to oppose the application of the Tyneside company for running powers into Gosforth. It is decided to provide additional storage batteries and boosters required for the power station at an estimated cost of £8,950, and to purchase a motor water-cart, combined with a sweeper and cleaner, at a cost of between £400 and £500. On Tuesday evening the first electric car was run from New Bridge-street to the west end of Byker Bridge.

Bournemouth.—A pamphlet containing a general description of the tramways scheme has been prepared and circulated among the members of the Corporation. The system to be adopted through the centre of the town, from the top of Poole-hill on the west to Landsdowne on the east, and from the Square to the top of Richmond-hill, is the side-slot conduit system; at junctions the side slot is temporarily deflected to the centre in order to simplify the track and conduit special work. At the ends of the conduit section pits will be provided where the plough of the cars may be lifted, and the cars will then bring their trolley arms into use, the whole of the remaining lines being on the overhead trolley system. The average length of time lost in changing from the overhead to the conduit system is said to be about 15 seconds. The estimated cost of the work, including extra cost of street-lighting, additional cost of conduit system, etc., is £276,347, and most of the contracts have now been placed.

Swinton.—Details have come to hand of the Mexborough and Swinton Tramways Bill, which has been introduced into Parliament to incorporate a new company for the purpose of constructing just over five miles of tramways from a junction with the tramway system of the Rawmarsh Urban District Council, which was sanctioned in 1900. The proposed tramways will be worked by electricity from a generating station which is to be erected on certain lands near the Wentworth-road, Swinton, and it is proposed to exercise the powers conferred on the Corporation of Rotherham and the Rawmarsh District Council for the reconstruction of the bridge over the canal of the Sheffield and South Yorkshire Navigation Company, and the bridge over a canal in Greasborough belonging to Earl Fitzwilliam. In consideration of the company undertaking these obligations power is sought to run over and use the tramways authorised by the Rotherham Corporation Act, 1900, and the Rawmarsh Urban District Council Tramways Act, 1900. The capital of the proposed company is to be £150,000, with the right to borrow £25,000 for equipment purposes.

Pontypridd.—Reporting to the District Council on the question of tenders for the electric tramway and lighting scheme, Mr. R. P. Wilson, of Westminster, the engineer, pointed out the inadvisability of placing the contracts for dynamos, etc., with foreign makers. They were, he said, the cheapest, yet he did not think it wise to place the contract with a foreign firm. His reason was that the great difference in price indicated that the German firms must be cutting their profits

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to secure the order, with the probable corollary that they would also cut down the expenditure, and the Council might, therefore, have considerable trouble in getting a satisfactory machine, if they succeeded at all. The machine if constructed in Germany could not be under his continual supervision, owing to the distance of the works. Considerable delay would necessarily take place in business dealings, which would lead to a large amount of extra work and travelling expenses, and, perhaps, trouble. Should any trouble arise involving legal proceedings, the Council could only, he believe, obtain redress in the German courts, and the cost of such proceedings would probably far more than counterbalance the damages awarded in the event of the Council being successful in any action. It was most important that all the plant in the generating station should be of first-class workmanship and material.

Motorcar Legislation.—As briefly reported in our last issue, Mr. Walter Long, the President of the Local Government Board, on Thursday, the 30th ult., received a deputation from the County Councils' Association on the subject of motorcar regulations on highways. Sir John Hibbert introduced the deputation, and said the subject had been under the consideration of the County Councils' Association for at least nine months, and they had avoided coming to any hasty conclusion. The first alteration the association suggested was the most important one. They asked that the limit of speed should be entirely abolished, provided the drivers were made subject to certain regulations. In that way the weight of responsibility would be thrown on the drivers. They also asked that some principle of identification should be adopted, and they were of opinion that the present penalty clauses were insufficient in the case of motorcars. Mr. Long, in reply, said he was heartily in accord with the views of the deputation, but difficulties arose in regard to carrying out details. The present regulations as to speed were ridiculous, and rather a source of danger than of safety. With regard to identification, any system adopted must apply to all cars. He hoped that practical suggestions on the matter would be sent him, and that greater security would be found in strengthening the law in this matter.

Shallow Underground Tramways.—At this week's meeting of the London County Council the Improvements Committee presented a report with regard to the proposal before Parliament to authorise the Council to construct a shallow underground tramway under the new street from the Strand to Holborn. In carefully considering the matter from the point of view of street traffic, one of the points to which the committee have devoted much attention is the proposal for bringing the contemplated underground tramway to the surface in Southampton-row close to the junction with Theobald's-road, and the effect which the carrying out of the scheme will have upon the existing traffic at that and other similar places. The committee state, however, that the subject is so important that there has not yet been sufficient time for them to examine alternative schemes and to have full estimates of the cost prepared, and they feel therefore that as the Council's Bill is now before Parliament it should be proceeded with in its present form on the understanding that before the work is actually undertaken the committee should have an opportunity of considering any suggestions for the modification of the scheme, with a view to further relieving the present congestion of traffic at particular places affected by the proposed tramway. They are not yet in a position to submit any definite recommendation to the Council in regard to any such modifications of the scheme.

LIGHTING AND GENERAL.

Blackburn Telephones.—The municipal telephone scheme stands deferred at present.

Cowpen.—The Urban District Council have consented to the Northern Electricity Supply Company's Bill.

Middlesbrough.—The salary of Mr. H. W. Clayton, electrical engineer for the borough, has been increased by £50.

Gainsborough.—The new central fire station is to be fitted with electrical alarm connections with all the firemen's houses.

Shepshed. — The Urban District Council are discussing the Leicestershire and Warwickshire Electric Power Bill, 1902.

Thornbury.—The District Council have decided to oppose the Gloucestershire Power Bill in order to get protective clauses inserted.

Hinckley.—The Warwickshire and Leicestershire Electric Bill is being considered by the Gas Committee of the Urban District Council.

Pembroke.—Mr. P. C. Cowan has held an enquiry in relation to the proposed expenditure of the sum of £20,000 for electric lighting purposes.

Sunderland.—Colonel Durnford will hold an enquiry to-day into the application of the Town Council for leave to borrow £30,000 for electric lighting purposes.

Lancaster.—The electrical engineer has suggested that the pressure of supply should be increased from 200 to 230 volts, and the necessary alterations are to be made.

Worksop.—The Urban District Council have decided to reduce the charge for electric light from 6d. to 5d. per unit as from the commencement of the current quarter.

Merthyr.—The Refuse Destructor Committee have decided to engage Messrs. Handcock and Dykes, of Westminster, to report upon a system of refuse destruction.

Worthing.—An extension of the electric lighting plant is already found to be necessary, and the Corporation are about to apply for a loan of £11,000 for the purpose.

Farnham.—In regard to the Hindhead electric lighting provisional order, it has been decided that the rate for public lighting should be the subject of an agreement, so it will not be inserted into the order.

Electric Lighting and Traction Company of Australia, Limited.—The directors recommend the payment of a dividend of 6 per cent. per annum on the preference shares of the Company for the year ended Aug. 31, 1901.

Belfast.—Tables have been prepared showing the comparative outputs for the years ending Dec. 31, 1900 and 1901. There was 30 per cent. increase in output, 20 per cent. in lighting units, and 97 per cent. in motor units.

Hull.—The School Board have decided upon installing the electric light in one of their schools. The Electric Light Committee have supplied the Board with estimates for all of their schools, but these have not yet been discussed.

Kensington.—The Borough Council have sanctioned the laying of mains by the Kensington and Knightsbridge Electric Lighting Company in Pelham-street, and by the Notting Hill Electric Lighting Company in Bedford-gardens and Campden-hill-road.

Cheriton.—The District Council on Tuesday discussed the question of dealing with the Cheriton electric lighting order, which was granted nearly three years ago, and which has nearly run out. The Council are opposing the Kent Electric Power Bill.

Warwickshire.—The County Council have asked the promoters of the Leicestershire and Warwickshire Electric Power Bill to insert a clause for the protection of the Council as regards county main roads and bridges satisfactory to the clerk of the Council.

Islington.—The Finance Committee will to-day recommend the following estimates for electric lighting extensions: provision and laying of lengths of low-tension distributing mains in Hilldrop-road and Mercers-road £1,720, and in Hornsey-road £56.

Lincoln.—A circular is to be sent to the residents in regard to the proposed municipal telephones. It is thought that 300 subscribers could be provided for at an outlay of £10,500 and an annual cost of £1,500. A rental of £5. 17s. 6d. would be charged.

Liverpool.—The Council on Wednesday confirmed the following recommendation of the Electric Lighting Committee: "That the sum of £10,000 be transferred to the reserve fund, £6,503. 9s. 1d. to the renewal fund, and £7,583. 5s. 6d. to the general rate account."

Irthlingborough.—The National Telephone Company is being asked to extend the telephone to the town. An impression prevails that the company will place the same at £10 per annum, while it is stated that now £25 is asked. Ten guarantors at £10 have been obtained.

West Bromwich.—Application is to be made for sanction to borrow £8,500 to meet the cost of the extensions and plant at the electricity works necessary to meet the tramway demand. Tenders have been asked for, and those recommended for approval will be laid before the Council shortly.

St. James's and Pall Mall Electric Light Co.—This Company announces that from the beginning of the year the charge for energy for motive purposes is to be reduced as follows: for the first 4,000 units per annum, 3d. per unit; for all in excess of 4,000 units per annum, 2d. per unit.

Camberwell.—The Borough Council have decided to inform the London County Council with regard to the London County Council (Electric Supply) Bill, that the Borough Council is in favour of the general principles contained in the Bill, also that the borough members be asked to support this Bill.

Brompton and Kensington Electricity Supply Co.—The directors announce a dividend at the rate of 9 per cent. per annum on the ordinary shares for the half-year to Dec. 31 last, making, with the interim dividend already paid, 8 per cent. for 1901, carrying £7,000 to depreciation account and £2,961 forward.

Boilers.—Messrs. Cochran and Co. (Annan), Limited, have issued a calendar, on which we notice illustrations of their Cochran patent multitubular vertical boiler. One depicts the works engine leaving the works with a number of boilers for shipment, and another shows a part of an order lately carried out for H.M.'s War Office.

Copper Market.—It appears that the Copper Trust is selling and delivering freely, while its underbidders have been driven out of the market—*i.e.*, the underbidders are oversold, and the improvement is all to the benefit of those having supplies. Consumption is so much stimulated that it is believed that the advance will be easily maintained.

Guest, Keen, and Co. and Nettlefolds.—Meetings of the shareholders in Guest, Keen, and Co., Limited, and Nettlefolds, Limited, were held at Birmingham on Monday, at which the proposals of the directors for the amalgamation of the two concerns under the style of Guest, Keen, and Nettlefolds, Limited, as detailed in our last issue, were carried.

Sheffield.—The alteration in the method of producing electricity at the Corporation's electric light and power station in Sheaf-street, preparations for which have been in progress for some time, took place yesterday. The system was changed over from one of single-phase alternators with a periodicity of 100, to two-phase alternators with 50 periodicity.

Tidal Power.—At Walton-on-the-Naze a scheme is being carried out for utilising the tides in the backwater to generate a current for electrically lighting the town. The engineers estimate that the tides will develop sufficient power for both public and private lighting. A reference to the similar movement in Southend will be found in our issue of the 17th ult.

Broadstairs and St. Peter's.—A letter from the electric tramways and lighting company, urging the Council to sign an agreement with respect to the electric lighting of the district, and stating that, unless the Council at once entered into an agreement on the lines of the draft agreement submitted and approved, the company could not offer the district the electric light this year, is being dealt with in committee.

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Long Eaton.—The Urban District Council, after considering a letter from the Local Government Board in regard to the recent enquiry held by Colonel Coke on the Council's application to borrow £15,000 for works of electric supply, have passed a resolution to the effect that they are of opinion they ought to put down plant for producing the electric energy rather than take a supply from a company.

Eastbourne.—The borough engineer has prepared a report in which the necessity is urged for the abolition of the present old-fashioned destructor works and the construction of an entirely new installation, and a sub-committee has been appointed to enquire into the question and bring up a complete report upon the matter. A special meeting of the Council has been called for to-day in regard to the municipal telephones scheme.

Ripon.—Dissatisfaction on the subject of public lighting has reached the Improvements Association, and they are turning attention to electric lighting. Last year the Corporation obtained a provisional order to carry out electric lighting, but no steps in that direction have as yet been taken. The members of the Improvements Association have accepted an invitation to the Ure Bank electrical works, where Mr. Harrison will explain the subject.

Wolverhampton.—A special joint meeting of the Health and Team Committees of the Town Council was held on Tuesday to consider the desirability of providing destructors for the purpose of dealing with the refuse of the town. It was decided to advise the Town Council to construct two destructors at a cost of about £22,000. One of these will probably be erected with a view of providing power at the electric generating station in Commercial-road.

Pontefract.—The Guardians on Saturday adopted a report of Mr. MacGowan, chairman of the committee, and the prime mover in the electric light scheme, showing the relative cost of gas and electric light on the union premises, from which it appeared that there had been a saving, by the introduction of the electric light, of £15 on the half-year. Mr. MacGowan said he had still hopes of the ultimate saving being £60 per year, as he predicted.

The New Engineering Agreement.—A ballot has just been taken of the members of the Amalgamated Society of Engineers, the Steam-Engine Makers' Society, and the United Machine Workers' Association upon the new agreement offered by the Engineering Employers' Federation as an alternative to the agreement of 1898. Some time must elapse before the result of the ballot is known, especially as it is understood that there has been a heavy poll.

Bath.—The City Council, sitting as an Electric Lighting Committee, on Tuesday adopted the report of the Enquiry Committee as to the conditions of the electric lighting undertaking and its past management. There will, therefore, be nothing more said about the past or the present condition of the works, and every effort will be concentrated upon the future, as to which Mr. Manville, the expert, has made the recommendation that £70,000 should be spent in reconstruction.

Mexborough.—One of the engines has been placed in position ready for running at the electricity station. All the arc lamps in the town have been connected and wired ready for lighting, and the incandescent lamps have also been connected in most of the streets. All going well, the street-lighting will commence in five weeks. With the storage tanks the lighting may be commenced with one engine, and the contractors have promised to deliver the other engine in about a week.

Auckland (N.Z.).—Some two months ago the City Council resolved to employ Mr. Goodman, of the Westinghouse Company of Australia, to report fully on the question of electric lighting, and prepare specifications on which the Council can invite tenders. Mr. Goodman's report to the City Council deals with the question of lighting only, but he is also to make a special report to the Harbour Board on the use of electric power for the wharves, as well as on the lighting question.

Walthamstow.—In proposing the adoption of the report of the Electric Lighting Committee at the Urban District Council's meeting last week, Mr. J. R. Friend, the chairman of the committee, said he felt that at the end of the year a handsome sum would be transferred to the relief of the rates, and that in the view of the growing demand for the light, they proposed to borrow for extension of plant and cable the sum of £40,000. This, he felt sure, would be the finest investment the Council had made on any works.

Edmonton.—The Edmonton District Council have decided to apply for a provisional order to obtain electrical power for Edmonton. At last evening's meeting it was stated that the Council had not pledged themselves in any way by applying, and that the cost of an electric scheme would amount to £70,000. A petition was read out from a number of ratepayers in Edmonton condemning the Council for applying for an order, and demanded the calling of a public meeting. The matter was left in the hands of the chairman.

Kingston (Surrey).—An application having been made requesting the Corporation to supply electric current to a number of houses about to be built in Ham near the borough boundary, it has been decided to approach the Ham Urban District Council whether they had any objection to the proposal, and also to apply to the Board of Trade in the matter. The matter of the erection of 35 additional arc lamps has been adjourned in order that the borough electrical engineer (Mr. J. E. Edgcome) might obtain additional particulars.

New Issue.—The Trafford Power and Light Supply (1902), Limited, which has been formed with a share capital of £150,000 in £1 shares and £75,000 4½ per cent. first mortgage debenture stock, for the purpose of supplying Trafford Park with electric light and power and fuel gas, and to take over the undertaking of the Trafford Power and Light Supply, Limited, are issuing 94,500 shares and £50,000 debenture stock, the latter being redeemable at par on Dec. 31, 1926, or earlier at the option of the company at £105 per cent.

City of London.—At the meeting of the Corporation on Thursday last, it was decided, as anticipated in our last issue, to appeal to the House of Lords against the decision of the Court of Appeal in regard to the contract with the City of London Electric Lighting Company for the eastern district. Pending the litigation, the Corporation will, of course, refrain from entering into any contract with the company, but they will raise no objection to the company continuing the public lighting, as heretofore, without prejudice to the rights of either party.

Tunbridge Wells.—Owing to an appointment in connection with the Corporation telephone system at Portsmouth, Mr. C. M. Gardner, of the Tunbridge Wells municipal telephone department, has just resigned his post. Mr. Gardner's business-like spirit and genial disposition have won him many friends and admirers during his brief stay in Tunbridge Wells. We congratulate Mr. Gardner on his appointment, and trust that he may put Portsmouth in as happy a position with regard to its municipal telephones as he has put Tunbridge Wells.

St. Marylebone.—Notices from the Metropolitan Electric Supply Company have been agreed to as under: to lay 5in. pipes along the west side of Old Quebec-street from Quebec Chapel to the south side of Bryanston-street, along the south side of Bryanston-street from No. 35 to the west side of Great Cumberland-place, and along the south side of Upper George-street from No. 7 to the west side of Seymour-place; along the east side of Wells-street from No. 48 to the north side of Mortimer-street; and along the west side of Eaton-terrace from the north side of Circus-road to Ivy Lodge.

Electrical Combination in Germany.—The negotiations which have for some time past been proceeding between the Allgemeine Elektricitäts-Gesellschaft and the Schuckert Electrical Company, of Nuremberg, have progressed so far that the possibility of an agreement being arrived at in regard to the establishment of a community of interests is considered to be favourable. Members of the Board of the Schuckert Company are expected shortly in Berlin in order to more closely examine the circumstances of the Allgemeine Company, but some time will elapse before the arrangement has been completed.

Trade with Russia.—We are informed that, in accordance with the instructions of the Secretary of State for Foreign Affairs, Mr. Henry Cooke, British commercial agent in Russia, has arrived in this country for the purpose of visiting some of the chief commercial and industrial centres of the United Kingdom, after communication with the chambers of commerce concerned. Mr. Cooke will be at the Charing Cross Hotel, London, during this week, where any communications could be addressed to him. He would be glad, as far as possible, to meet the convenience of chambers of commerce.

Prevention of Accidents.—Notice is given by the Society of Arts that the council are prepared to award, under the terms of the Benjamin Shaw Trust, a gold medal, or a prize of £20, to be given "for any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means." Intending competitors should send in descriptions of their inventions not later than May 1, 1902, to the secretary of the Society of Arts, Adelphi, London.

Gorton.—The Electric and Tramways Committee have not yet come to any decision on the question of handing over the Council's electric lighting order to the Manchester Corporation. Manchester offers to take over the order on condition that Gorton grants a 21 years' lease. This the committee thinks is too long a period, and it is quite possible that the committee may yet recommend the Council to enter into an arrangement with the Lancashire Electric Power Company for the supply of electricity in bulk. This would cost some £4,000 or £5,000, but before the committee make any final recommendation they will obtain an up-to-date report from experts.

Dorking.—The Urban District Council on Tuesday discussed Mr. Trentham's report on offers from Edmundson's Corporation with regard to the electric lighting of the district, and also the offer of Messrs. Handcock and Dykes. It was resolved to inform Messrs. Edmundson upon points upon which the majority of the Council differed from them, and also that the Council absolutely refused to provide the money required for the undertaking unless they were given a proper security, and that the Council's engineer must prepare the scheme. A letter is also to be sent to Messrs. Handcock and Dykes, stating that the Council was not then prepared to accept their offer.

Accrington.—Mr. Clegg has been promoted to the position of assistant engineer. The Electricity Sub-Committee have decided upon the extension of distributor cables in various parts of the borough. The engineer's last report states that the plant generally was working satisfactorily. Units delivered to mains for week ending Jan. 11, 1902, 4,291; units in corresponding week last year, 2,160—increase, 2,131. The units metered on consumers' premises for the quarter ended Dec. 31 last were as follows: for lighting, 15,378 at 5d., 19,289 at 3d., averaging 3·92d. per unit; for power, 413 at 4d., 668 at 1½d., averaging 2·33d. per unit—total, 35,748, averaging 3·84d. per unit.

Gloucester.—Mr. Bache reported to the last meeting of the City Council that enquiries were being made as to the terms on which electricity could be supplied for illuminations at the time of the Coronation of King Edward VII., and suggested that electricity might be supplied at a special rate on that occasion, as the Coronation would take place in the summer, when the ordinary demand is much less than in winter. The Council were recommended to supply electricity for the purpose of illuminations during the Coronation week at 2d. per Board of Trade unit, and the engineer was authorised to arrange for any necessary connections to be made on payment of the actual cost price.

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Presentation.—On the 29th ult. at the offices, 33, Swan-road, an interesting function took place, when Mr. Norman, mains superintendent of the Harrogate Corporation's electricity department, and who is shortly leaving for South Africa, was the guest of the evening, and was presented by the officials of the Corporation and the workmen of the electricity staff with a handsome dressing bag containing all accessories and suitably initialled. The borough electrical engineer, Mr. J. Ridsdale (chief clerk of the department), and Mr. Gray (borough accountant) testified to Mr. Norman's abilities, and to the respect and good feeling which was borne towards him by the members of the various departments.

Stroud.—The Rural District Council have consulted Mr. Percy Still, M.I.C.E., of London, on the proposed Gloucestershire Electric Power Bill. A committee has presented a report upon the clauses which they think affect the Council's interests. Amongst these is Clause 38, which removes the power of local authorities to object to overhead wires; and Clause 48, which allows 10 per cent. as the standard of rate of dividend to be earned by the company, and 3d. per unit as the standard price to be charged, and if electricity were supplied at less than that, a higher dividend was allowed in proportion to the reduction in price. Mr. Still has advised that 1½d. would be a very probable price. The committee asked the Council to oppose the Bill, and this report has been adopted.

Dundee Telephones.—Only 440 favourable replies have been received to the 6,470 circulars sent out asking whether the recipients of the notes were in favour of a municipal telephone exchange. It has now been resolved to employ a special canvasser to make a house-to-house visitation, it being stated that many people were under the impression that they would have to support both the National Telephone Company and the municipality if they agreed to become subscribers to the latter's exchange. The National Telephone Company, through their district manager, Mr. W. Brown, have issued a circular to their subscribers setting forth reasons against Dundee Corporation establishing a municipal telephone service in competition with the existing service of the company.

Wood Green.—At the last meeting of the District Council the Electrical Committee reported that notices of objection to the Council's application to the Board of Trade for a provisional order had been received from the Great Eastern and Great Northern Railways. The companies are opposing for the purpose of obtaining clauses for the protection of their own interests. Later in the evening the Chairman of the Council intimated that the North Metropolitan Electrical Power Distribution Company was making application to supply electricity to private consumers, and was also opposing the Council's application for a provisional order. He stated, further, that the company's canvassers were busy in the district, but expressed a hope that those canvassers would meet with small success.

Blasting by Electricity.—The Upper District Committee of Wigtown have inaugurated a system of dislodging rock in their Balgreggan Quarry by electricity. Fourteen holes about 14ft. deep were drilled at intervals into the rock by an Ingersoll-Sergeant steam rock drill, and about 100lb. of blasting gelatine was afterwards inserted. The electric fuses were fixed up and attached to the cable, and the whole of the holes were on Saturday exploded simultaneously by an electric battery, the result being an unprecedented success, some 3,000 tons of rock being dislodged and well broken up. The explosives were supplied by Messrs. Fleming and Co., Glasgow, and the blasting operations were conducted under the superintendence of Mr. Joseph D. Smith, county surveyor, and Mr. W. Fleming.

Loughborough.—It will be remembered that the Town Council at their December meeting decided that the Corporation should itself exercise the electric powers vested in them, and that steps be taken for the establishment of an electrical undertaking. Since then the Council have been approached by the light railway syndicate, which has obtained an order for the establishment of light railways in the district, with a proposal for the transfer of those powers to that syndicate, the directors of which are also connected with the Brush Electrical Engineering Company. The Town Council on Monday rescinded the resolutions passed in December, and appointed a committee to open negotiations with the light railway syndicate with a view to arranging terms for the transference of the Corporation's electrical powers to the syndicate.

Derby.—The Council have obtained the permission of the Derby Canal Company to lay an electric main over the canal bridge on Mansfield-road, the Corporation paying an acknowledgment of 5s. per annum. The committee have decided to increase the charge for the hire of motors from 10 per cent. to 12½ per cent. on the cost of the motor. This increased charge will include the supply by the Corporation of a registering instrument with each motor over 4 h.p. Application is to be made for sanction to borrow £8,000 for main, services, etc. (£6,000), transformers (£500), meters (£500), two chain-grate stokers and two sets of Meldrum blowers (£550), motor and centrifugal pump (£100), alterations to wall of engine-room, including new girder (£130), alteration to old condenser pump and piping to condenser plant (£100), and sundries (£120).

West Ham.—At the last meeting of the Town Council the electrical engineer, Mr. J. K. Bock, called attention to the very marked improvement over the corresponding period of last year shown by the six months' accounts. The total revenue had very nearly doubled, having increased from £4,835 to £8,834, or £3,999. At the same time the costs only increased from £4,036 to £6,759, or £2,723. The result is an increase in the gross profit of £1,275 over the previous summer six months, and of £460 over the previous winter, in spite of the fact that there is a charge of £505 for changing over lamps in Canning Town, and of £203 for the electrical exhibition. The increase in revenue, he said, was mainly due to the sale of current to private customers, the revenue from this source having increased by £3,226, whereas the increased street-lighting has only added £206.

Huddersfield Telephones.—A meeting convened by Mr. J. B. Littlewood, secretary of the Huddersfield and District Tradesmen's Association, was held last night in the Parochial Hall, Huddersfield, to consider the proposal of the town clerk to establish a service of municipal telephones. A resolution was passed that the meeting, being convinced that an efficient and reasonably cheap telephone is a pressing want for the prosperity of the trade and commerce of the day, earnestly protested against the Corporation giving a monopoly or lease to any company which was likely to maintain high prices. It was also resolved, "That in the opinion of this meeting the time has now arrived when the Huddersfield Corporation are fully justified in proceeding with the municipalisation of the telephones."

Walker.—The Tramways and Electric Lighting Committee reported to the Urban District Council on Tuesday that the Newcastle Electric Supply Company had intimated that they had laid and completed all the distributing cables for private lighting in the Walker district with the exception of Scrogg-road, and could now supply current for light and power from their cables. The company had written stating that they had now the Walker network alive from the generating station; also, that it was necessary for them to erect a sub-station on the site to meet further developments. This sub-station was in addition to the Council's works, and would be at the supply company's cost. At the termination of the agreement the company would remove the sub-station, and any plant and machinery which then might be in the sub-station. It was needed to meet the probable demand for energy by the Newcastle Corporation.

Mansfield.—The new sanatorium in Sherwood Forest will shortly be opened for the treatment of consumptives. The electric lighting is supplied from a small station situated on the north side of the main block. The dynamo is driven by a 16-h.p. oil-engine, the capacity of the dynamo being equal to 70 amperes, 145 volts, and the electricity is stored in a battery of 54 cells, so that the sanatorium, as well as the laundry now being built, will be continuously supplied. The sanatorium has been erected by the Portable Buildings Company, of Fleetwood, under the supervision of Mr. Robert Evans, jun., of Nottingham, and the electric light installation has been laid down by Mr. W. J. Furse, under the supervision of Mr. H. Talbot, the city electric engineer, who kindly gave his valuable help. Messrs. T. Danks and Co., of Nottingham, have been responsible for the heating apparatus, the contract for the foundations, engine-house, roads, and sewerage system having been executed by Mr. C. Vallance, of Mansfield, while the furnishing has been done by Messrs. Smart and Brown, of Nottingham.

Cheltenham.—The electrical engineer's report, presented to the last meeting of the Town Council, states with reference to the National Telephone Company's letter as to interference by the electric lighting mains, that he had had very numerous tests made, and found that some interference was caused by part of the street-lighting. This he was remedying as quickly as possible. As the consumption of coal would exceed 5,000 tons per annum in future, he considered that considerable economy could probably be effected by adding to the present siding and putting down coal-conveying plant. He recommended that sanction be sought to a total loan of £14,000 to cover extensions. He thought only the transformers would be required this year unless tramway extensions were made, but it was possible that later in the year the increasing load might render it advisable to order the boilers. The recommendations were approved, but consideration of the question of constructing additional siding and obtaining plant for coal conveyance was adjourned.

West Cumberland Technical College.—The report of the sub-committee which was appointed to visit similar institutions and to draw up a scheme for a technical college for West Cumberland has been presented to the Technical Instruction Committee of the Cumberland Council. After visiting the technical department of the University College, Sheffield, Wigan, Bootle, the Gamble Institute (St. Helens), the Durham College of Science and the Rutherford College (Newcastle), and the Technical College (Sunderland), the committee estimate that a building suitable to the needs of West Cumberland can be erected at from £10,000 to £15,000, that its furnishing and equipment will cost from £2,000 to £3,000, and that the annual cost of carrying on the college will be about £2,000. Provision, it is suggested, should be made in the college for instruction in physics and mechanics, chemistry and metallurgy, and geology, mineralogy, and mining, and the staff at the outset is recommended to consist of a principal, two assistant lecturers, together with a secretary, etc., the cost of the staff to be about £1,500 per annum.

Private Bills.—The Examiners of Private Bills have dealt with the City and Brixton Railway Bill, the object of which is to enable the City and Brixton Railway Company to abandon part of their original scheme. It is sought to extend the period for the compulsory purchase of land for as much of the railway as is not proposed to be abandoned, and to restrict the share capital to £270,000, with borrowing powers to the extent of £90,000, and to authorise a working agreement with the City and South London Railway Company. The Examiners found that the Bill had duly complied with the Standing Orders of the House of Commons. The company's alternative Bill was marked "dead." The South Wales Electrical Power Distribution Company's Bill has been reported for first reading. In the House of Lords on Feb. 4 a number of private Bills were read a second time, including the City and Crystal Palace Railway Bill, City and North-East Surburban Electric Railway (No. 2) Bill, London United Electric Railways Bill, Medway and Thames Canal Bill, North-East London Railway Bill, Piccadilly and City Railway (No. 2) Bill, North and South Shields Electric Railway, Piccadilly and City Railway (No. 2), and Rhondda Urban District Council Tramways. In the House of Commons on **Feb. 5** the following Bills were read for the second time: Cornwall Electric Power, Erdington Tramways, Gloucestershire Electric Power, Kent Electric Power, Middlesex C.C. Tramways, and Northumberland Electric Power.

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Bridgend.—At the last meeting of the Council a draft agreement with the South Wales Electrical Power Company providing for the supply of electrical power as from August next was approved. The Clerk (Alderman T. J. Hughes) produced figures showing that a considerable saving would be effected by the introduction of electric light, adding that it was intended also to introduce the light into the Paregwyllt and Angelton asylums, and the company had agreed that if the power was supplied through the installation at Bridgend the amount taken by the asylums should be included in the Bridgend total, thus enabling the town to obtain their supply on the company's reduced rates. Some of the members expressed the hope that the introduction of electrical power into Bridgend would be speedily followed by the establishment of an electric tramway system from the town to Tondu, and the towns in the Ogmore, Garw, and Llynvi vallevs.

Electrical Pumping.—Several reports were submitted at a meeting of the South Staffordshire Mines Drainage Commission on Wednesday. On the works of the Tipton district, Mr. E. Howe states that the general manager of the Midland Electric Corporation for Power Distribution, Limited, had waited upon him, and they had discussed the question of supplying electricity to the Commissioners for deep-mine pumping on the basis of the current being taken at a time outside the hours of the maximum demand. Their quotation, however, had not yet been received. The Blakeley wood pits being within a quarter of a mile of the power station would be a suitable site for a pioneer pumping installation. Mr. E. B. Marten, in his report on the surface works, states that in Tipton district the storms led to the need of much ordinary clearing, but the new work for preparing the electric pumps had been pushed on, those at Mosdey Hole and Herbert's Park being finished, and Tibbington and James Bridge nearly so, and others had been commenced at Darlaston, Leabrook, and Rough Hay. It was hoped the electric current could very soon be obtained for working the pumps at some of the places prepared for them near the electric power works at Ocker Hill.

Montrose.—The Council on Tuesday agreed to call upon the electric light company to lay cables in Northesk-road and the whole of the streets and roads in the northern part of the town at present lit with gas. It was reported that the total cost of erecting 20 arc lamps throughout the town had been £300. The following summary of a report from Mr. W. Lackie, electric engineer, Glasgow, acting engineer for the town in connection with the introduction of the electric light, was read: "He has not the least hesitation in saying that the price that should be paid for the street incandescent lamps should be at the rate of £1 per 16 c.p. per 1,000 hours, which makes the charge for the leading lamps where there are two 16-c.p. lamps £2 per 1,000 hours. No average price would be satisfactory to the town or to the company, but the price to be paid per lamp should be proportionate to the amount of current used by the lamp. The present-day 16-c.p. lamp takes 60 watts or uses 60 units of electricity per 1,000 hours. In all the figures submitted by me to you I allowed £1 per 1,000 hours per 16-c.p. lamp. The committee therefore propose that this recommendation be agreed to—namely, that the price for incandescent street lamps be £1 per 1,000 hours per 16 c.p." After discussion, the Council approved of Mr. Lackie's recommendations.

Manchester Telephones.—An application by the National Telephone Company, Limited, for certain proposed extensions of their underground system so as to carry out the removal of bare overhead telephone wires over the Corporation electric trolley tram circuits has been acceded to in so far as the Paving Committee is concerned, subject to the work being carried out under the supervision of the city surveyor, and also subject to the approval of the special committee *re* telephones. The Telephones Committee spent their time on Tuesday in considering the adoption of a scheme of wireless telephony, said to be in process of being installed in Paris and in Glasgow. It was stated that the committee would watch with interest suggested experiments in wireless telephony between Manchester and London. Should the tests prove successful, the committee were in favour of recommending the Council to adopt the system. It remained to be seen, however, how far the suggested tests would affect the joint telephone scheme for Manchester and district, and how far the scheme might be regarded as an infringement of the rights of the Post Office. On Tuesday also, a conference was held of representatives of municipal, urban, and rural district councils exercising authority in the Manchester district telephone area. After discussion, the conference unanimously recommended the constituent authorities to lodge a united petition in opposition to the National Telephone Company's Bill. Representatives of the five contributing authorities to the scheme of the joint Board—namely, the Corporations of Manchester, Salford, Stockport, and Eccles, and the District Council of Stretford were appointed on a committee to conduct the opposition.

Nottingham.—With regard to the Derby and Notts Electric Power Company's Bill the Council have suggested the insertion in the Bill of a clause excluding Nottingham from its operation. In March last the Council resolved that the erection of a 12-cell destructor at Radford should proceed *pari passu* with the erection of the destructor in the Eastcroft. The sanction of the Local Government Board for the raising of the loan for the Eastcroft destructor has only just been received, and those works have, therefore, not yet been commenced. The Health and Electricity Committee have been authorised to proceed with the erection of the electrical power station to be worked by steam from the Eastcroft destructor. The Council are, however, of opinion that it will not at present be advisable to erect a similar power station in connection with the Radford destructor until the results obtained from the station at the Eastcroft have been ascertained. The committee are now of opinion that it would be more economical to have an additional destructor at Basford, and think that a six-cell destructor only should be erected at Radford at present and a six-cell destructor at Basford, when a suitable site can be obtained. Plans of the six-cell destructor at Radford, together with a mess-room, stables, and cart-shed, have been prepared by the city engineer, who estimates the total cost at £10,000. On Tuesday the committee were authorised to construct a six-cell destructor at Radford, together with the above-mentioned stabling, etc. The destructor to be provided with one boiler between two of the cells, and space to be left for two additional boilers for the other four cells, so that the destructor can be adapted for the supply of steam power if at any future time it is deemed advisable to erect an electric power station adjoining the destructor.

Wynberg (S.A.).—An interesting report upon the Cape Peninsula Lighting Company's new power stations and plant appears in a recent issue of the *Wynberg Times*. The original company was formed in 1893 to take over from Messrs. Edlin and Stevenson electric lighting contracts which they had with the municipalities of Rondebosch, Wynberg, and Claremont. The name was then the Cape Town and Suburban Electric Lighting Syndicate, the subscribers numbering five. These had increased in 1889 to 187, when the company was formed under its present title. A contract with the town of Mowbray had been obtained in the meantime. In 1891 there were 328 subscribers in all. To meet increasing demand, and in order to concentrate their plant so as to ensure greater economy of working, the company will erect a new power station at Claremont and a sub-station at Wynberg. With the exception of the accumulators, all plant has been obtained in England. We are glad to see the opinion expressed in our contemporary that "any type of electrical plant can be obtained in England, and at a moderate price too." It is quite time that some people awoke to that fact. The current will be generated at Claremont by a high-tension three-phase alternator, and will be transmitted to the Wynberg sub-station by a three-core underground cable. There three-phase motors coupled direct to continuous-current dynamos will supply current to customers, and will also be used to charge the accumulators for the day service. The other three towns will be supplied from two two-phase generators. A new accumulator is to be laid down for the day service. Three Parsons steam-turbines will be laid down, to be driven with superheated steam at 160lb. pressure. There will be a separate condenser and a 60ft. cooling tower. The switchboards are by Messrs. Kelvin and James White. The new buildings have been designed by H. T. Jones, of Shortmarket-street, Cape Town.

Worthing.—The Council have agreed to a report recommending an expenditure of £11,000 for electric light extensions. The consulting engineers (Messrs. Burstall and Monkhouse) in their report stated that the applications at present received are equivalent to 4,500 8-c.p. lamps, and assuming 1,383 more 8-c.p. lamps are applied for and connected up before the end of the summer, the present plant will then be fully loaded. The engineers think it is reasonable to suppose that the Council will during next winter receive applications equal to another 3,000 8-c.p. lamps, and the Council would need by the end of the winter a further 63 kw. in their plant, making a total of 255 kw. as the probable maximum output of the station at any one time. In view of these facts, the consulting engineers recommended the instalment before next winter of one plant having an output of 250 kw. For this purpose one extra boiler of the same size as those at present installed should be put down, and some additions would also be required to those to connect up the new plant with the present system. Two extra panels should be provided for the switchboard, but only the instruments which are necessary for this first extension should be fixed thereon. One new condenser would be required, with the necessary pipes and connections. It would be necessary to extend the engine-room and boiler-house, and to build a new chimney in connection with the extension, and the engineers recommended that a chimney of such a size be built as would be sufficient to cope with any extensions which might be made within a reasonable time. The chimney they proposed would be one about 140ft. high, having an internal diameter of 7ft. 6in. at the top. It was not possible at present to say in what direction the mains would have to be extended, but it was almost certain they would have to be extended in the near future. This being the case, the engineers included in their estimate a provisional sum of £3,000 for this purpose.

Manchester.—Mr. H. H. Law has held an enquiry into an application made by the Corporation for sanction to borrow £477,000 for extensions connected with the electricity undertaking. Mr. T. Hudson, deputy town clerk, who took charge of the proceedings, described the electric undertaking of the Corporation. Mr. Hudson said the Corporation was responsible for supplying current to Levenshulme, Heaton Norris, Withington, Moss Side, Droylsden, Audenshaw, and Denton, and for working electric tramways in Failsworth, Droylsden, Audenshaw, Gorton, Denton, Levenshulme, Heaton Norris, Stockport, Middleton, Stretford, Withington, and Moss Side. When the tramways system was completed, the length of lines would be something like 150 miles. The first part of the loan related to the completion of Dr. Kennedy's scheme, laid before Mr. Boulnois at a similar enquiry held in 1901. This provided for the construction of plant to give 15,000 h.p. at Stuart-street. The amount now required was £82,000. At the enquiry held by Mr. Boulnois five only of the 10 sub-stations were dealt with, and the present enquiry referred to the remaining five stations and with additional matters. The second part of the loan applied to a proposed new installation at Stuart-street, which had been designed by Mr. Metzger. This would provide an additional 12,000 h.p., and cost £350,000. The third part of the enquiry related to the Dickinson-street low-tension station, where it was proposed to replace four small belt-driven sets by two new turbo-generator sets. The new sets would provide 6,000 h.p., as against 1,600 h.p. provided by the four old ones. The estimated cost of these new sets was £43,861. Existing machinery had cost £13,861, and the Corporation proposed to deduct that and borrow the balance—viz., £30,000. The remaining sum of £15,000 was for additional mains to be carried between Ashton Old-road and the Corporation transforming station at Denton. To show the necessity for the

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proposed additional outlay, Mr. Hudson submitted figures relating to the whole equipment of the undertaking. The existing plant at Dickinson-street provided 12,000 h.p., and the plant at Bloom-street, when completed, would provide 14.000 h.p. Dr. Kennedy's installation at Stuart-street would provide 15,000 h.p., and Mr. Metzger's installation at the same station, which was the subject matter of that enquiry, would provide an additional 12,000 h.p., making a gross total of 53,000 h.p. actually in operation, already sanctioned, or about to be sanctioned. This power was appropriated as follows: The existing private consumers, down to Christmas, 1901, represented 15,000 h.p., allowing a slight margin for reserve; the additional present demand for lighting, also allowing a margin, represented 7,000 h.p.; the additional demand for traction within half a mile of Bloom-street represented 3,500 h.p.; the current from Dr. Kennedy's 10 sub-stations, chiefly for tramways, absorbed 7,500 h.p.; four additional tram routes not provided for in the first figures, 2,500 h.p.; additional requirements for lighting and power, including the General Post Office, 5,000 h.p.; and 10 additional sub-stations connected with Mr. Metzger's scheme and reserves and increased demand, absorbing 12,000 h.p. Dr. Bishop, as chairman of the Electricity Committee, said the progress of the undertaking had been more rapid than the committee could cope with, so much so that during a considerable portion of the last 12 months the committee had had to ask that applications for power should be deferred. On one occasion the committee had some difficulty in obviating legal proceedings for not supplying current. There were 1,981 in 1898 and 3,980 to-day. The names of 170 applicants who were waiting for connections were on the books. Mr. W. H. Hesketh, Dr. Kennedy, Mr. Metzger, Mr. Allott, the engineer, and Mr. T. de Courcy Meade, city surveyor, gave additional details of the various schemes.

London County Council.—On Tuesday the Council sanctioned the borrowing by the Hammersmith Metropolitan Borough Council of £10,445 for electric light installation (42 years). A report was received from the Highways Committee upon applications for electric lighting provisional orders, session 1902, stating that all the applications, five in number, made this session to the Board of Trade, under the Electric Lighting Acts, for provisional orders relative to areas in the county of London are by borough councils—viz.: (*a*) Bermondsey, (*b*) Camberwell, (*c*) Southwark, (*d*) Stoke Newington, and (*e*) Woolwich. The committee stated: "As regards price for the supply of electrical energy, the maximum specified in the orders (*a*), (*b*), (*d*), and (*e*) is, per quarter year, 13s. 4d. for any amount up to 20 Board of Trade units, and 8d. for each unit over 20; while the price specified in (*c*) is for any amount up to 20 units 10s., and 6d. for each unit over 20. With regard to the orders applied for last year, the Council suggested that the maximum price per unit after the first 20 should be 5d., which, from the information then before the Council, appeared to be the average price charged to consumers. The Board of Trade, however, after holding an enquiry into the matter inserted in such of the London orders as were granted last year 10s. as the maximum price for the first 20 units, and 6d. per unit after the first 20. This, as stated above, is the maximum price stated in the Southwark order (*c*) of this session, and we are of opinion that the Board should be asked to insert the same maximum in the other orders. We have, as regards each of the orders, prepared amendments for submission to the Board of Trade to give effect to the above suggestion, and also amendments of a merely formal character. (*a*) The Bermondsey electric lighting order is in respect of those portions—namely, the parish of Rotherhithe and the district of St. Olave—of the metropolitan borough which are not covered by the order granted in 1899 to the then existing Vestry of Bermondsey. The order contains a new clause to authorise the Borough Council to provide, sell, let for hire, and fix, set up, alter, repair and remove, but not to manufacture, lamp, meters, electric lines, fittings, apparatus and things for lighting and motive power, on terms and conditions to be agreed between the Borough Council and the parties concerned. This appears to us to be to some extent provided for by Clause 76 of the Council's General Powers Bill, which is as follows: 'It shall be lawful for the council of any metropolitan borough being authorised to supply, and supplying, electrical energy, to expend money upon the wiring and fitting, and supplying with wires, fittings, and apparatus the premises of their consumers or prospective consumers, and to enter into any and carry into effect agreements and arrangements with respect thereto, and to make such charges therefor, whether directly or otherwise, as they may think fit'; and the following clause (77) is to authorise the Borough Council to borrow money for the purpose. We see, however, no objection to the provision being made in the order, as the Borough Council appears to so desire. The order requires amendment as regards the maximum price, and this we have prepared. We recommend that the Board of Trade be asked to insert in the Bermondsey electric lighting order the amendment, as regards the maximum price, prepared by the Highways Committee. (*b*) The Camberwell electric lighting order, which is, generally, in the ordinary form for London orders, is to authorise the Borough Council to supply electrical energy within the whole area of the borough. At present portions of the area are supplied respectively by the London Electric Supply Corporation, the County of London and Brush Provincial Electric Lighting Company, and the Crystal Palace District Electric Supply Company. The order contains a clause, not inserted in any order granted hitherto, providing that a person shall not be entitled to demand from the Borough Council a supply of energy to premises having an existing supply, unless such person shall have previously agreed to pay to that body such a minimum annual sum as will give a reasonable return on the capital expenditure and other standing charges incurred to meet the possible maximum demand of that person. We see no objection to this clause, which is evidently proposed by the Borough Council for its own protection. Other clauses are to enable the Borough Council (*a*) to purchase that portion of the undertaking of the London Electric Supply Corporation which is within the borough; (*b*) as in the case of the Bermondsey order (*a*) referred to above, to supply fittings, etc., to consumers; and (*c*) to purchase by agreement electrical energy from the London Electric Supply Corporation or from any company or person, whether empowered to supply within the borough or not; and as regards these provisions, we do not think that the Council need express any opinion. The order also contains a clause to enable the powers granted under the order to be transferred. To this we think that, as in previous similar cases, the Council should take exception, having regard to the fact that the Council has not the same powers of approval or disapproval of works under orders granted to local authorities as it has under those granted to companies direct, and the company to which the powers under a local authority's order may be transferred would, as regards the particular area concerned, be placed in a better position than ordinary electric lighting companies. The Board of Trade has in previous cases struck out the provision for the transfer of the undertaking, and we suggest that the Council should ask the Board to adopt the same course in this instance. The order requires amendments, which we have prepared, as regards some minor matters of detail; and we recommend that the Board of Trade be asked to strike out of the Camberwell electric lighting order the clause authorising the transfer of the powers to be granted by the order, and also to make in such order the amendments prepared by the Highways Committee. (*c*) The Southwark electric lighting order is for the purpose of extending to the other portions—namely, the parish of St. George-the-Martyr, Southwark, and the district of St. Saviour—of the metropolitan borough of Southwark, the provisions of the order granted in 1897 to the then existing Vestry of Newington in respect of that parish. The order incorporates most of the clauses of the Newington order of 1897; but we think it is desirable that the clauses should be set out in full, so that the new order may be complete in itself. The maximum price set out in the schedule to the order is, for any amount up to 20 Board of Trade units, 10s., and for each unit over 20, 6d.; and, with the consent of the consumer, for any amount not exceeding the equivalent of 136 hours' supply at the maximum power demanded by him, 7d. per unit, and for any further amount 3d. per unit. These we think satisfactory. Some amendments are required on minor matters, and these we have prepared. We recommend that the Board of Trade be asked to so amend the Southwark electric lighting order that it may be in the same form as those previously granted to local authorities as regards London areas, and be complete in itself; and also to insert in the order the amendments prepared by the Highways Committee; and that, in the event of the Board deciding to grant the order in its present or any other form, the Council may be afforded another opportunity of submitting observations with regard thereto. (*d*) The Stoke Newington electric lighting order is in respect of the borough of Stoke Newington, or so much thereof as is not within the area of supply under the order granted in 1893 to the then Hackney District Board, of which district Stoke Newington formed part. It incorporates the clauses of the Electric Lighting Clauses Act, 1899. That Act directs that the provisions contained in the scheme shall be incorporated with, and form part of, every provisional order under the Electric Lighting Acts, but (except so far as any of the provisions are incorporated with any order . . . extending to the county of London) the Act shall not apply to the county of London. As the Act of 1899 was not intended primarily to apply to London, the powers usually vested in the Council are omitted. We, therefore, suggest that the Board of Trade be asked to require the clauses to be set out in the order in the usual way, with such amendments as are necessary as regards the maximum price. The order also requires some further small amendments, which we have prepared. We recommend that the Board of Trade be asked to so amend the Stoke Newington electric lighting order that it may be in the same form as those previously granted to local authorities as regards London areas, and be complete in itself, and also to insert in the order the amendments prepared by the Highways Committee; and that in the event of the Board deciding to grant the order in its present or any other form, the Council may be afforded a further opportunity of submitting observations with regard thereto. The Woolwich electric lighting order is in respect of the portion of the parish of Woolwich south of the Thames. Part of the area of the borough of Woolwich is covered by the Plumstead order, granted in 1899 to the then existing Vestry of Plumstead (of which the Borough Council is the successor). The area under the order now applied for is covered by the Woolwich Order, 1891, granted to the Woolwich District Electric Lighting Company. The new order provides for the purchase by the Borough Council of the undertaking of the company, and that the date for the commencement of the order should be fixed by the Board of Trade when it is satisfied that the purchase has been completed, and that as from that date the company's order of 1891 should be revoked. This seems to us to be a satisfactory arrangement. The order incorporates clauses from the Plumstead Order, 1899, and we think that, as in other cases, these clauses should be set out in full, so that the order may be complete in itself. It also contains a clause similar to that in the Camberwell order referred to above, with regard to the arrangements for the supply of energy to premises already supplied from another source. We have prepared amendments as regards minor details, and also as to the maximum price to be charged. We recommend that the Board of Trade be asked to so amend the Woolwich electric lighting order that it may be in the same form as those previously granted to local authorities as regards London areas, and be complete in itself; and also to insert in the order the amendments prepared by the Highways Committee; and that, in the event of the Board deciding to grant the order in its present or any other form, the Council may be afforded a further opportunity of submitting observations with regard to."

Notices under Electric Lighting Acts and Orders were sanctioned as follows: from the Blackheath and Greenwich District Electric Light Company, under the Blackheath and Greenwich District Order, 1897, of intention to lay mains of high and low tension along Woolwich-road and Victoria-road, and to construct a transformer box in Woolwich-

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road, to lay mains of high and low tension and to construct a transformer box in High-road, Lee; from the London Electric Supply Corporation, under its order of 1899, to lay distributing mains along a portion of Borough-road; the Metropolitan Electric Supply Company, under the West London Order, 1889, to lay low-tension mains along portions of Upper George-street and Seymour-place; and the Notting Hill Electric Lighting Company, under the Notting Hill Orders, 1889 and 1895, to lay mains along portions of Bedford-gardens and Campden-hill-road. The receipt of a notice from the Hammersmith Borough Council, under the Hammersmith Order, 1893, of intention to lay mains along Latimer-road, North Pole-road, Brewster-road, Dalgarno-road, Wood-lane, Scrubbs-lane, and Duncan-road, was also reported.

PROVISIONAL PATENTS, 1902.

JAN. 27.

2084. Improvements in joints and joint-boxes for electrical conductors. George Wilkinson, Commercial-street, Halifax.

2094. Improvements in tumbler and other electrical switches. Alfred Watson, 180, Hockley-street, Birmingham.

2159. Improvements in and relating to electric fuses. Charles Edwin Campbell Shawfield and Earl Porter Wetmore, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JAN. 28.

2187. Improvements relating to galvanometers, magnetometers, and like apparatus. Thomas Edward Gambrell and Charles Thomas Gambrell, 17, Giltspur-street, London.

2203. Improvements in ladders for trimming arc lamps. Sydney B. Donkin and H. R. Forbes Mackay, 5, St. Loo-mansions, Chelsea, London.

2228. An improved means of transferring the conducting arms of electric tramcars and other vehicles (using the overhead wire) from one wire to another. Frank Whereatt White, Ivydene, Godstone-road, Kenley, Surrey.

2248. Improvements in electric galvanic belts. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Samuel J. Spalding, United States.) (Complete specification.)

2262. A motive power for the production of electricity, etc., on sailing and other ships. George Agnew Carruthers, 3, Marine-terrace, Weymouth.

2263. Improvements relating to the production of hollow seamless metal articles by electro-deposition. John Arthur Clark, 36, Chancery-lane, London.

2264. Improvements in insulated electrical conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Elihu Thomson and John G. Callan, United States.) (Complete specification.)

2284. Improvements relating to electric lighting. Henry Hayes Cooper, 45, Southampton-buildings, Chancery-lane, London.

2310 Improvements relating to electric telegraphy. Alexander Muirhead, 323, High Holborn, London.

JAN. 29.

2317. Dry seats on electric cars or other vehicles, also for garden seats or seats or chairs exposed to weather. William Walmsley, 92, Philips-park-road, Beswick, Manchester.

2318. Increasing the electrical conductivity of iron and steel. John James Morgan, 28, London-road, Neath, Glam.

2352. Improvements in automatic means of breaking electric circuits. James Ferguson and Kelvin and James White, Limited, 154, St. Vincent-street, Glasgow.

2254. Improvements in and relating to apparatus for automatically controlling electric switches. Arthur Denby Smith, Sunbridge-chambers, Bradford.

2363. Improvements in and relating to portable electric accumulators. Lambertus Alphonsus Lammers, 55, Chancery-lane, London.

2376. Improvements in and relating to electrolysis. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Giovanni Rambaldini, Italy.)

2377. Electric heating fabrics. Joseph Michael Camille Herrgott, 23, Southampton-buildings, Chancery-lane, London.

JAN. 30.

2425. Improvements in and connected with etheric telegraphy. Hammersley Heenan, 70, Market-street, Manchester.

2452. Atmospheric ventilator for electric light mains, tubes, and channels. Arthur Coke, 339, Oxford-street, London.

2463. Improvements in apparatus for use in starting and controlling electric motors. Arthur Henry Adams and John Thomas Mould, 11, Southampton-buildings, Chancery-lane, London.

2477. An improvement in lighting by electric incandescent lamps. Julian Adolphe Halford, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

2492. Improvements in connections for concentric electric cables. James Robert Percival Lunn, 18, Southampton-buildings, Chancery-lane, London.

2496. Improvements in casings for electrical conductors, gas and water pipes, and the like. John Douglas Palmer, 319A, Sherrard-road, Manor Park, Essex.

JAN. 31.

2503. Improvements in wires or cables for use on electric tramways. Henry Etherington Doughty and Herbert Normanton, 40, Brazennose-street, Manchester.

2513. Improvements in electric storage flexible pressure gas batteries. Ernest Bailey and Arthur Crowther, Barstow-square, Wakefield.

2520. Improved means of connecting and disconnecting electric mains or cables in street boxes. Sydney Ernest Britton, 115, St. Vincent-street, Glasgow.

2521. An improved disconnecting box for electric mains with means for rendering same gas and waterproof. Sydney Ernest Britton, 115, St. Vincent-street, Glasgow.

2532. Electro-mechanical signs for advertising. Lionel Marston, 68, Birmingham-road, West Bromwich.

2552. Improvements in electric couplings or terminals. Edmund Hardman, 15, Water-street, Liverpool.

2568. Improvements in electric typewriting machines. Joseph Lemblé, 111, Hatton-garden, London. (Complete specification.)

2584. Improvements in rheostats or electrical resistances. Arthur Bertram Rigby, of the Electrical Transmission Company, and Ernest George Scott, 4, South-street, Finsbury, London.

2587. An improvement in carbons for arc lamps. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

2588. Improvements in electrical incandescent lamps. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany).

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2610. An improved arm or support for holding telephone receivers or transmitters or the like. George Thomas Morgan, 12, Haymarket, London.

2659. Improvements in and connected with resistance switches for electric circuits. George Page, 3, St. Nicholas-buildings, Newcastle-on-Tyne.

2666. Improvements in brush-holders for dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Hermann F. T. Erben, United States.) (Complete specification.)

2673. Improvements in electrically-operated hand-drills. Meno Kammerhoff, 53, Chancery-lane, London.

2674. Improvements in and connected with electric meters of the thermal type. Mads Peter Thomsen, 19, Inverine-road, Old Charlton, Kent.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Feb. 20.

1900.

21228. Electrodes or the wires or conductors connected thereto in electrolytic cells, meters, or other electrolytic apparatus. Bastian Meter Company, Limited, and Bastian.

23647. Electrolytic deposition of metals. Harrison and Day.

1901.

1849. Process for the electrolytic preparation of the bases of the alkaline earths. Brochet and Ransom.

2557. Apparatus for controlling and automatically ringing any number of electric bells. Isaac.

3123. Insulating conduit for the conductors of electric tramways. Seguy.

3710. Regulation and starting of single-phase and polyphase alternate-current motors with magnetic rotating fields. Girault.

3860. Electromagnets. Sheppard, Solomon, and Nernst Electric Light, Limited.

4899. Overhead wires and guard wires for electric traction and other purposes. Burnett.

6587. Watertight electric bells. Eckstein and Coates.

10102. Electrical switches. Evered and Co., Limited, and Holt.

20364. Plural fuse cut-out for electric circuits. Pelsenstein.

21086. Telegraphic receiving instruments. Skirrow.

23542. Electric arc lamps. Davies.

23721. Ageing commutator and other metallic surfaces for regulating friction and other purposes. British Thomson-Houston Company, Limited. (Ingalls.)

23806. Systems of electric motor control and pneumatic apparatus therefor. British Thomson-Houston Company, Limited. (Potter.)

26132. Electric circuit breakers. British Thomson-Houston Company, Limited. (Hewlett and Badeau.)

26227. Electromagnetic switches and methods of controlling or operating same. Lake. (McElroy-Grunow Electric Railway System.)

26342. Electric arc lamps. British Thomson-Houston Company, Limited. (Thomson.)

26343. Electric arc lamps. British Thomson-Houston Company, Limited. (Davis.)

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26349. Electric transmission of power. British Thomson-Houston Company, Limited. (Hewlett.)

26373. Microphones or microphone transmitters for electrical sound transmission. Senkbeil.

26377. Induction electric meters. Blàthy.

26436. Reflector or shade for electric lamps and the like. Rhodes.

26524. Laying of underground electric conductors for lighting and power. Thompson. (Davies.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	Feb. 1	538	514	+ 24	26,358	24,297
Birmingham Tramways	—	—	—	—	—	—
Blackburn Corporation	Jan. 31	577	555	+ 22	2,763	2,421
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	Feb. 1	145	143	+ 2	730	675
Bolton Corporation	,, 2	1,360	1,242	+ 118	7,465	6,654
Bradford Corporation	,, 2	1,168	655	+ 513	5,146	3,588
Bristol Tramways Company	Jan. 31	3,811	3,613	+ 199	—	—
Carlisle Tramways Company	Feb. 1	113	106	+ 7	589	531
Central London Railway	,, 1	6,684	7,112†	- 428	32,879	30,598
City and South London Railway	,, 1	3,021	1,962	+ 1,059	15,077	10,010
Cork E. T. and L. Company	Jan. 30	306	322	- 16	1,561	1,508
Darwen Corporation	,, 31	186	161	+ 25	774	723
Dover Corporation	Feb. 1	164	139	+ 25	813	775
Dublin & Lucan Electric Railway	,, 2	72	65	+ 7	411	334
Dublin U. T., electric cars	Jan. 31	3,167	3,109	+ 58	—	—
Dublin S. District, Electric	,, 31	635	612	+ 23	—	—
Dundee Tramways Company	,, 29	613	444	+ 169	—	—
Glasgow Corporation	Feb. 1	9,889	7,958	+ 1,931	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 1	1,562	1,454	+ 105	—	—
Liverpool Corporation	Jan. 25	8,920	8,099	+ 821	36,200	31,959
Liverpool Overhead Railway	Feb. 2	1,272	1,140	+ 132	6,867	7,398
Newcastle-on-Tyne Corporation	—	—	—	—	—	—
Portsmouth Corporation	,, 1	902	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 2	3,377	—	—	—	—
Southampton Corporation	Jan. 30	720	604	+ 116	—	—

* Fortnightly. † Queen's funeral, 1901.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £615 decrease.
Barcelona Ensanche y Gracia, £5 decrease. Barcelona, £228 increase.
Brisbane, £295 increase (month of Jan., £28 increase).
Buenos Ayres and Belgrano Electric, £419 decrease.
Calcutta, £20 decrease.
Cape Town (month of Dec.), receipts, £16,925; expenditure, £6,792.
La Capital Traction and Electric, Buenos Ayres (month of Dec.), £1,394 increase.
Mexico Electric (month of Dec.), receipts, £18,250; expenditure, £10,750.
Perth Electric, £102 increase.
Port Elizabeth (month of Dec.), receipts, £3,898; expenditure, £1,898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Tramways.—	£	£
Anglo-Argentine, 1-260,007	5 ..	4⅛-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	124-127
Blackpool and Fleetwood Tramroad	10 ..	12½-13½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2¾-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4½-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	7-7½
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	14-15
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12½-13
—— 5 per cent. Perpetual Debenture Stock	100 ..	126-129
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1¾-2
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2⅛-2¼
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¾-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	102-104
New General Traction, Ordinary	5 ..	2½-3½
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10¾
—— 5 per cent. Cum. Pref.	10 ..	11½-12½
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	10s. ..	½
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	50 p.c. ..	50 p.c.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅜-⅞
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅜-⅝
—— Ordinary, 1-125,000	1 ..	⅜-⅝
British Insulated Wire, Ord., 1-70,000	5 ..	10½-11½
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-6½
—— 5 per cent. Mortgage Debentures	100 ..	102-105
British Westinghouse Elec. and Manuf., 5 per cent. Pref.	5 ..	5½-6
Brush Electrical Engineering, Ordinary	2 ..	1⅝-1⅞
—— Nos. 90,001-105,731	2 ..	1⅜-1⅝
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	97-100
Callender's Cable, Debentures	100 ..	111-115
—— Ordinary	5 ..	16½-17½
—— 5 per cent. Pref.	5 ..	5½-6
Crompton and Co.	3 ..	3-3¼
—— 5 per cent. Debentures	— ..	99-104 p.c.
Edison and Swan United, Ordinary	3 ..	1⅞-2⅛
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	78-83
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	84-89
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-2¼ xd
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9⅞-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	17-18
—— 4½ per cent. Preference	5 ..	5½-6
—— 4½ per cent. Debentures	100 ..	112-116
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15½-16½
Telegraph Construction and Maintenance	12 ..	35-38
—— 5 per cent. Bonds	100 ..	102-104
Telegraph Manufacturing, Ordinary	5 ..	10½-11½
—— 5 per cent. Cum. Pref.	5 ..	5½-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	9½-10½
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6½-6¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	103-105
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-⅝
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	97-102
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9½-10½
—— Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	9-9½
—— 7 per cent. Preference	5 ..	9-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7¼-8½
—— Nos. 20,001-30,000	5 ..	7¼-8½
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14¼ xd
—— ,, ,, £10 Ord.	6 ..	10¾ xd
Charing Cross and Strand	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5-5½
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	103-105
Chelsea Electricity Supply	5 ..	5¼-6
—— 40,501-50,936	5 ..	5¼-5⅜
—— 4½ per cent. Debentures	100 ..	108-111
City of London, Ordinary	10 ..	9-10
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	121-126
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	8¼-9⅛
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	106-109
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	5¼-6
—— 6 per cent. Cum. Pref.	5 ..	5¼-6
—— 4½ per cent. First Mort. Deb.	100 ..	103-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-5⅜
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104 xd
Kensington and Knightsbridge and Notting Hill	100 ..	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10½
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	95-100
Metropolitan, Ordinary	10 ..	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	96-99
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7⅛-8
—— £4½ Shares, New	4½ ..	6⅞-7⅛
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1¾-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90 xd
South London, Ordinary	5 ..	2-2½
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15½-16½
—— 7 per cent. Pref.	5 ..	8⅞-9⅛
—— 3½ per cent. Deb.	100 ..	97-100
Westminster, Ordinary	5 ..	12-13
Electric Railways.—		
Central London, Ordinary	100 ..	106-109
—— 4 per cent. Pref.	100 ..	106-109
—— ,, deferred	100 ..	106-109
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-118
City and South London, Consolidated Ordinary	100 ..	64-67
—— Ordinary	10 ..	—
—— Nos. 60,001-70,000	10 ..	—
—— 4 per cent. Debenture Stock	100 ..	112-116
—— 5 per cent. Pref. Stock '91	100 ..	127-132
—— ,, ,, '96	100 ..	122-126
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Telephones.—		
National Telephone, Ordinary	5 ..	3⅛-3⅞
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-5
—— 4 per cent. Deb. Stock, Red.	100 ..	93-96
—— 3½ per cent. Deb. Stock, Red.	100 ..	101-105
Oriental Telephone and Electric Company	1 ..	¾-1

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NOTES.

Manchester Local Section.—Mr. Bertram Blount will read his paper on "Electric Furnaces" before the above section of the Institution on March 4. The paper, it will be remembered, was postponed from Jan. 14.

Society of Arts.—The council of this society announce that they are prepared to award, under the terms of the Benjamin Shaw Trust, a gold medal, or a prize of £20. Under the conditions laid down by the testator, the medal is to be given "for any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means." Intending competitors should send in descriptions of their inventions, not later than May 1 next, to the secretary of the Society of Arts, Adelphi, London, W.C.

Electric Resistance Crucible.—Before a recent meeting of the American Institute of Electrical Engineers, Prof. H. M. Howe described a simple form of electric resistance magnesia crucible for laboratory work. The device consists of a crucible of pure magnesia, surrounded with a spiral of platinum wire, and fixed in a cavity shaped to fit in a large block of magnesia. The cover to the furnace is formed by another block of magnesia. Prof. Howe has had the furnace in use for some months, and no trouble, he asserts, has yet been experienced with it. Temperatures as high as 1,400deg. C. have been attained without injury to the platinum spiral. The apparatus is said to be particularly convenient when it is desired to maintain a high temperature constant for long periods.

Wireless Telegraphy Failure. — Mr. Marconi's system of wireless telegraphy is so often reported as having proved "entirely successful," no matter from what quarter of the globe, that one sometimes doubts whether it is capable of a failure. It seems, however, that the Inter-Island Telegraph Company, which was formed to work the Marconi system in the neighbourhood of Honolulu and San Francisco, has not been particularly fortunate in its efforts. It is said, for instance, that when it came to a question of important commercial messages, the system could not be relied upon, but in such work as the setting of clocks by chronometer the system worked admirably. Its non-success in regard to commercial messages, however, has resulted in a financial failure, and the company which was exploiting the system in that part of the world has been compelled to suspend work.

Sparking in Dielectrics.—Mr. M. H. Bagard has described in a paper recently published in the States a general method of producing sparks in electrolytes in a simple and certain manner. The author reduces the exposed surface of the electrodes to a small amount by using thin wires cased in ebonite up to near their ends. To produce the discharge he uses two Leyden jars, whose internal armatures are joined to an influence machine and to the two branches of an exciter immersed in a liquid. This liquid maintains by its conductivity the equality of the potentials of the two armatures as long as the charge is comparatively slow. But if the exciter is adjusted for a sufficiently high spark potential, as soon as there is a discharge of the internal armatures, the sudden discharge which tends to take place between the external armature cannot take place by simple electrolytic conduction, and a spark breaks across the dielectric.

Theory of Fluorescence.—The current number of the *Journal* of the Chemical Society contains a short abstract of a paper by Mr. Woldemar Voigt on this subject. Fluorescent and phosphorescent phenomena are due to free, incoherent vibrations within the excited substance. The author discusses the electron theory, and from results so far obtained concludes that the molecules of fluorescing substances are capable of existing in two conditions, in which the electrons have different periods of vibration. The change from one state to the other is conditioned by molecular relationships, but an exciting light wave has also the power of aiding or starting the transition. The electrons pass into the new condition with speeds and elongations which are influenced by the motion given to them by the exciting wave in the old condition, and they perform free, incoherent vibrations with a period corresponding with the new condition. The periods of vibration in the two conditions are very different, and one is damped to a much greater extent than the other.

Energy from Tides.—The vast energy of the tides round the British Isles is just now attracting the attention of several municipal councillors. Thus, both at Brighton and Liverpool correspondence in the daily Press is being published on this subject. In Liverpool Councillor M'Guffie advocates the offering of a £7,000 premium for the most practical device for harnessing the tides which flow past the Liverpool docks. He has not yet persuaded the Council to make this offer, and we are sure that the Council will not do so if they take the advice of their able harbour and borough engineers. It is exceedingly difficult to get the non-technical man to believe that although there is a great amount of energy in the tides, the cost up to the present of utilising this energy makes it unavailable for practical purposes. On the score of availability the tides are unfortunately worse off than large waterfalls, and yet we know of several instances in which the utilisation of waterfalls by engineering works brings the annual cost of the energy so obtained to a higher figure than would be the case if the same energy were produced in the same position by means of coal-fed boilers.

Satisfactory Tests in Newcastle.—Mr. A. W. Heaviside and Mr. Le Rossignol, electrical engineers to the Post Office in Newcastle and the Newcastle Corporation respectively, carried out some successful experiments last week in connection with the protection of the public from falling trolley wires in those parts of the city where the electric tramways are running. Guard wires have been erected above the trolley wires in all cases where the telegraph and telephone wires cross, and the tests were made in order to see whether these, in conjunction with the Thomson-Houston magnetic cut-outs on the switchboard at the power-house, are sufficient to assure the protection of the public against the danger referred to. Temporary telephone wires were erected on temporary posts in a particular section of the new tramways, and some of them were cut down. The result is said to have been eminently satisfactory, the current being immediately cut off at the power station. The same success attended the further tests which were made with heavier telegraph wires, and the current from the trolley wires was cut off with such effect that contact with the end of the fallen wires was rendered quite harmless.

Institution "Journal."—The *Journal* of the Institution of Electrical Engineers for February has just been issued. The volume opens with President Langdon's inaugural address, and also contains the inaugural addresses of the chairmen of the various local sections in the United Kingdom, with the exception of Dublin—*i.e.*, of Mr. J. F. C. Snell (Newcastle), Prof. Magnus Maclean (Glasgow), Mr. C. H. Wordingham (Manchester), and of Principal Oliver Lodge (Birmingham). The following

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papers and original communications go to complete a specially interesting issue: "A Permeameter for Testing the Magnetic Qualities of Materials in Bulk," by Mr. C. V. Drysdale; "The Physical Properties of certain Aluminium Alloys, and some Notes on Aluminium Conductors," by Prof. E. Wilson; "Insulation of Conductors of Electricity in India," by Mr. K. A. Scott-Moncrieff (Calcutta Local Section); "Note on a Humming Telephone," by Mr. F. Gill; "Aluminium: Notes on its Properties, Production, and Uses," by Mr. W. Murray Morrison; "Hints on Overhead Construction," by Mr. Oldbury Burne; and "The Limitations of Graphical Methods in Electrical Theory," by Mr. Alexander Russell.

London County Council Labour Clauses.—In placing contracts in connection with the reconstruction for electrical traction of the London County Council's southern tramways, it has devolved on the Highways Committee to consider the question of the clauses relative to wages and hours of labour. As regards contracts for the supply of the stoneware ducts required for the mains and feeder cables, the committee have been faced with the difficulty that the ordinary clauses are not applicable in this instance, owing to the special nature of the work and the conditions obtaining in the trade as regards the payment of workmen. The committee have therefore agreed to insert in the contracts for this work a special clause providing that the workmen's wages shall be paid by the contractors at the rates arranged between the employers and workmen in the pottery trade in that part of the country where the order is placed. In the event of the condition not being carried out by the contractor, the Council reserves the right to cancel the contract for that part of the work not then performed at one week's notice. Our readers may remember that a similar clause was embodied in the contract for the supply of rails for these tramways, which was placed by the London County Council in May of 1900.

Charging for Electricity.—Mr. Wilkens in a recent issue of *Elektrotechnische Zeitschrift* contributes an article in which he puts forward suggestions for the reform of central-station tariffs for charging for electricity. His first idea is that, in addition to the ordinary meter, there should be used another meter which registers the consumption of energy during the time of the maximum load at the station, from about October to February In order to arrive at the average kilowatt during the maximum load, therefore, it is only necessary to divide the kilowatts registered by the hours. It is preferable, however, to combine the two meters by providing the main meter with a second counting device, which is connected and disconnected at certain times by means of clockwork. The author suggests having this device count for two hours every day; which two hours are to be chosen depends, of course, on the load curve of the station. He claims that such a system enables a simple and just tariff to be used. As an example he gives the case of a cigar store, and shows by a table of figures that the average cost per kilowatt-hour during the year is nearly that which would follow from purely theoretical considerations given by him. It comes out as nearly as possible at just under 6d. per kilowatt hour.

Bermondsey Electric Lighting.—With the reorganisation of the local government of Greater London, the areas which come under the new metropolitan borough councils are frequently different from those which were ruled by the old vestries. This is especially the case at Bermondsey, and a considerable area has been added to the district which previously was controlled by the Bermondsey Vestry. The Metropolitan Council have accordingly applied to Parliament for a new electric lighting provisional order to cover the new area, and have inserted in it the maximum price which obtains under the old order for the original area—*i.e.*, 8d. per unit. We see that the Highways Committee of the London County Council are opposing this, contending that 6d. per unit should be the maximum price allowed. We think that the committee in this case are going out of their way to obstruct an energetic Council in the fulfilling of their duties. No one would suggest that the advisers of the Bermondsey Council would advocate a charge of 8d. per unit to the consumers, but it by no means follows that there may not be special instances in which a charge of 7d. per unit to those users of electric light whose loads have a low power factor may not be advisable. It seems to us that in a case like this the interference of the London County Council is both uncalled for and unnecessary.

Telephonic Communication with the Continent. Experiments in long-distance telephony have lately been going on in the North of England with a view to giving the provinces the advantage of direct telephonic communication with the Continent. Last week the Post Office officials were making tests in Leeds, from which place it was found possible to speak with Boulogne, a distance of about 300 miles. It is understood that this is the first occasion on which a telephone message has passed between any provincial town in the North of England and the Continent, with the exception of Liverpool, which was also the scene of similar experiments last week In this case it was found possible to carry on a telephonic communication with Paris, the distance covered being about 500 miles. Further south than Paris, however, the speaker could only be heard in Liverpool under very favourable conditions. It is said that one result of these experiments has been the abandonment of the scheme to attempt telephonic connections between London, Turin, and Milan, the opinion being that these cities are too far apart to be embraced in a telephone circuit. It is to be noted, however, that the distance one can speak with the telephone largely depends on the wires through which the message has to be transmitted, and that the non-success of the authorities to obtain a satisfactory connection with the telephone between Liverpool and towns south of Paris only applies to the particular circuits on which the experiments were made. With heavier copper wires conversations have been successfully held over much longer distances.

Motor Exhibition.—The Crystal Palace and Motor Traders' Co-operative Show opens at that popular place of amusement and instruction to-day. The official *Gazette* of the organisers of the exhibition, which has reached us this week, gives a good condensed forecast of the exhibits. Altogether there are some 60 firms exhibiting, and they include most of the well-known manufacturers of motor-cars and motor cycles in England and on the Continent. We notice that there are this year a larger number of electrically-propelled vehicles being shown than has hitherto been the case at motor shows, which is an encouraging sign. Arrangements have been made so that visitors to the exhibition will be able to see the cars running in the magnificent grounds attached to the Crystal Palace. On the last Saturday of the motor show the Motor Cycling Club will hold a series of speed competitions, both on the track and in the grounds. Three races, each of five miles, will be run on the track, confined to members of the club, the events being for machines up to 1½ h.p., 2 h.p., and over 2 h.p. respectively. The trials in the grounds will be identical as to number and division, but will be open to the world, and these are expected to prove particularly interesting contests, inasmuch as a hill climb will be included, and the course will be arranged to represent as far as possible an average country road. Three

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medals will be given for each event, and entries should be sent to the competition hon. secretary, Mr. A. Lloyd Owen, 40, Oseney-crescent, N.W.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on the 3rd inst., Sir James Crichton-Browne, treasurer and vice-president, in the chair. Among the new members elected were Lord Iveagh and Mr. George Westinghouse. The thanks of the institution were returned to Sir Frederick Bramwell, Bart., for his donation of £100, and to Mr. Frank McClean for his donation of £50 to the fund for the promotion of experimental research at low temperatures. It was announced that the following valuable relics of Michael Faraday, bequeathed to the Royal Institution of Great Britain by the late Mr. Thomas J. F. Deacon, of Newcastle-on-Tyne, had been received: medals of silver and bronze (numbering 20 in all) and including the Fuller Medal of 1828, two Copley Medals of 1832 and 1838, two Newton Medals of the Royal Society, 1833 and 1838, and the Rumford Medal of 1846, and two foreign orders contained in a small mahogany box; a book of portraits and autographs, including original letters from the Prince of Wales and Prince Alfred (written in 1856), Louis Napoleon, Emperor of France, Humphry Davy, Thomas Young, Humboldt, John Dalton, Whewell, Mary Somerville, and many others; a daguerrotype of a consultation of Faraday with Prof. Daniell; a drawing in colours of the laboratory of the Royal Institution, by a niece of Sir John Moore; and a manuscript book entitled "A Class Book for the Reception of Mental Exercises instituted July, 1818," containing contributions by Faraday. The late Mr. Deacon requested that the medals and orders should be preserved with an inscription showing that Margery Ann Reid and Caroline Deacon (*née* Reid), nieces of Faraday's wife, often lived with Faraday and his wife during the most brilliant period of his life, and are mentioned in Dr. Bence Jones's "Life of Faraday."

Electrolytic Oxygen and Hydrogen.—The *Zeitschrift fuer Electrochemie* describes an apparatus which is being manufactured by the Elektricitäts-Gesellschaft (formerly Schuckert and Co.) for the commercial production of oxygen and hydrogen by means of electrolysis. The capital cost of an installation composed of 40 elements and capable of producing 100 cubic metres of oxygen and 200 cubic metres of hydrogen in 24 hours is given at £900, the daily expenses at £3. 1s. 3d. A solution of 15 per cent. of caustic soda in 85 per cent. of water is used, and 2·8 to 3 volts per element is required. The water must be maintained at 70deg. C. If steam is available, some saving in electric energy is made, as part of the power is otherwise lost in heating the water up to 70deg. C. The electric conductors are made of copper; the rest of the apparatus (retorts and reservoirs) is made of cast iron. The two gases coming from the two electrodes are gathered in separate vessels connected by indiarubber tube receptacles, where the last traces of the soda are washed out. Thus oxygen and hydrogen of a purity of from 97 to 98 per cent. is obtained. The apparatus designed by the above-mentioned company has the following over-all dimensions: 2ft. 2¼in. by 1ft. 6in., and 1ft. 3in. high. It contains 40 litres of soda solution, and takes a current of 600 amperes. The production of gas per hour obtained with this apparatus is 220 litres of hydrogen and 110 litres of oxygen at atmospheric pressure, and at 15deg. C. Forty such cells connected together are able to turn out some 200 cubic metres of hydrogen and 100 cubic metres of oxygen in 24 hours. The cost of the apparatus works out at about £900, and, with energy costing 0·575d. per kilowatt-hour, the actual cost of the gas, including working expenses and interest and depreciation at 15 per cent., comes out at about 2·4d. per cubic metre. If the gas has to be compressed into iron tubes for commercial purposes, of course, the cost will assume a slightly higher figure.

Electric Lighting Profits.—As will be seen from a note in our last issue, the Liverpool Town Council have devoted a sum of £7,583 to the relief of the general rates out of the profits of the electric lighting undertaking. The question of the application of the profits came up for discussion at the Town Council meeting on Wednesday of last week, and we are sorry to see that only three advocates could be found for an amendment by which this money would not be paid into the general rate account. These three gentlemen, amongst whom was the chairman of the Electric Lighting Committee, urged the retention of the money in order to decrease more rapidly the item of goodwill which stands on the accounts. When the undertaking was purchased from the electric lighting company a goodwill of £150,000 had to be paid. This has now been reduced to some £21,000. Beyond this reduction there is no provision for depreciation. We believe that the increase of rates which is to take place this year in Liverpool is largely the cause for the small support accorded to the amendment, but we hope that another year this subsidising of the rates by the electric lighting undertaking will be stopped. It is unfair, as we have often pointed out, that the users of electricity should contribute more than their due share to the general rate of a town, as is the case when the profits of the electric lighting undertaking are so applied. The chairman's proposal was that the price of electricity should be reduced, which would in the long run be most advantageous to the town. It is interesting in this connection to see what the profit last year was at Liverpool and how applied. Thus, the gross income was £168,500 and the total expenses £85,681, which left in round figures a sum of £83,000 as gross profit. Out of this, interest and repayment of loan required £37,000; £24,000 was applied to the sinking fund as provided by the Electric Lighting Act; £10,000 was added to a reserve fund; £5,000 to a renewal fund; and the balance of £7,583 to the general rate account.

Municipal Electrical Association.—At a special meeting of the above association called for the 21st inst., in London, the following three important topics are to be discussed: (1) the best means of obtaining an alteration to the existing regulations controlling the repayment of loans borrowed for the purposes of electricity supply undertakings, whereby local authorities are compelled to repay during the construction of works; (2) the desirability or otherwise of deciding the percentage which should be allowed for the depreciation of electricity undertakings; (3) the desirability or otherwise of recommending local authorities to form a reserve fund for the replacement of obsolete plant, and for other purposes specified in the electric lighting orders. The meeting will take place at the Westminster Palace Hotel at three o'clock in the afternoon. It is greatly to the interest of all municipal electric lighting undertakings that uniformity on the above points should be obtained, otherwise it lies within the power of the engineer of one town, in conjunction with his committee, to so reduce the price of electrical energy as to hamper the undertaking in after years when new plant is required, before the expiration of the loan raised for the original plant. Also it is unfair to make comparisons between the results in one town and in another, unless equal percentages are in each case laid aside for depreciation. In our opinion the first item on the agenda paper is perhaps the most important, as it is manifestly absurd that a municipal under-

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taking should be called upon to commence the repayment of the loan before the apparatus for which the loan has been raised has been put to work. It also follows that in all well-designed stations in which due provision is made for the future an expenditure made at any time can become immediately productive. The amounts, thus, which have to be paid off from loans in the earlier stages of such undertakings seriously hamper their development, as it puts a false complexion on the yearly balance sheets. We wish the Municipal Electrical Association a successful meeting, and that a unanimous and fair conclusion on the above subjects may be come to, such as will demand the prompt attention of the Local Government Board.

Telephone Charges.—We are pleased to see that the National Telephone Company have now agreed to an arrangement by which those of their subscribers whose contracts have still a considerable period to run will be enabled, if they so desire, to take advantage of the new rates which will come into force with the opening of the Post Office system in London. The company, however, have only given way after a sharp struggle. The circumstances of the case in point are interesting. "A society subscribing to the Telephone Company" entered into the usual contract with the company for five years at £17 a year from April 1, 1900, but with the announcement of the new rates to come into force in the metropolitan area it suited their purpose to terminate this agreement in favour of the message rate, which only asks a £5 annual subscription with fees at the rate of a penny a call. From correspondence which appeared in the daily Press a short while ago, it then appeared that the company objected to this course, notwithstanding that the society's contract contained a clause, underlined in red ink, to the effect that the "payments shall be subject to such reduction as shall from time to time be made by the company in their tariff rates during the subsistence of this contract, and applicable to the same." The company's contention was stated to be that such reduction applied to those only who had not entered into five years' contracts, or, at any rate, the company would not admit that their subscribers' under five years' contracts had any claim to take advantage of the new terms. It must have been apparent to anyone, however, that such an argument could not be successfully entertained in view of the above clause, and now, it appears, the company have given way. The society in question have received an admission from the company which they consider quite satisfactorily meets the grievance under which they and other subscribers were suffering. The concession which the company have made is that as soon as the new message-rate service can be put in force the society are to be released from their five years' contract at £17 a year, and placed under an annual agreement at £5 subscription, with fees. This arrangement, of course, is of the utmost importance. It not only applies to the individual case in point, but must also hold good with those subscribers having a contract in the same terms as that in question.

Insulation of Conductors in India.—The current number of the Institution *Journal* contains a paper by Mr. K. A. Scott-Moncrieff on "The Insulation of Conductors of Electricity in India," which was read before the Calcutta Local Section at one of their meetings last year. In bringing this all-important subject to the notice of electrical engineers, the author directs special attention to the great need there is for some really efficient system of insulation being adopted which will withstand the very trying conditions of the Indian climate. He first deals with the insulation of aerial lines. The Indian Telegraph Department have designed a system of aerial lines which is in every respect a model one, and the insulators the author has used are, with one exception, of the Indian telegraph pattern. The exception is at Darjeeling, where the 2,300-volt circuit is carried on oil insulators, but oil has not been used in them. In addition to the two main conductors the posts carry an earthed head-wire as a protection from lightning. He has experienced no trouble with the insulation of this circuit. The special feature about the aerial lines in Calcutta is that No. 0 copper wire, weighing practically 1lb. per yard, is used, carried in 150ft. spans on large telegraph-pattern insulators. His conclusion is that the system of insulation for aerial conductors used by the Telegraph Department in India, is suitable for conductors weighing up to at least 1lb. per yard run and for pressures up to at least 2,300 volts. The author next turns his attention to continuously insulated aerial lines. The only insulation he has used for this class of work is vulcanised indiarubber, which he concludes is a suitable covering for aerial lines. An interesting point with regard to the suspension of high-tension lines by means of tags is that raw-hide tags only last about two years in Calcutta, but those made of porcelain have given no trouble. With reference to the insulation of underground conductors, vulcanised indiarubber has been tried for electric lighting purposes in Calcutta, but without success. It was, therefore, necessary to find a system of mains that would not deteriorate when exposed to the specially trying conditions which obtain in Calcutta—*i.e.*, the excessive damp, the heat, the deleterious action of the soil upon all lead pipes, etc., and the want of skilled labour. Finally, Callender's solid system was adopted, in which the cables insulated with vulcanised bitumen are laid upon wooden bridges in a trough, the whole run in with pure bitumen. Then the trouble arose as to what the trough was to be made of. The particular sort of wood wanted, not being available, and earthenware troughing not being obtainable locally, cast-iron troughing had ultimately to be adopted. The use of iron troughing, however, is attended by the great drawback that when a fault develops it rapidly becomes a real short-circuit, so much so that in some cases in India several feet of cable have entirely disappeared through this cause. The author's experience of house-wiring has led to the conclusion that where there is any chance of damp penetrating to the cables, the wiring should not be done in wood casing. As in Calcutta in damp weather the walls of the houses may be described as "excellent conductors," it is abundantly clear that wood casing is not suited to the locality for this purpose, and some efficient system of wiring houses under the climatic conditions of India has yet to be discovered. For dynamos and motors the author has found that the climate of India is by no means a bad one, and faults due to the climatic conditions are not common. It seems to us that protecting the wire in iron conduits is to be commended for houses under the conditions mentioned. Also the experience in the city of London recently makes it clear that the iron troughs for the underground cables are in the end an advantage, as they tend to localise the fault.

London Underground Railways.—A discussion took place in the House of Lords on Monday with reference to the procedure to be adopted this session in dealing with the various Bills which have come before Parliament seeking powers to construct electric railways in London on the "tube" principle. The matter was brought forward by Lord Glenesk, who made an attempt to get the whole of the Bills referred to the Joint Select Committee on London Underground Railways in the same way as they were last session, and he moved a resolution to the effect that the committee should consider and report

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whether any of the lines of route for underground railways in and near London, proposed by the Bills which have been introduced during the last and present session, afford adequate facilities for present and probable future traffic; whether any extensions or alterations of route are required for the purpose of providing cheap and rapid travelling communication throughout London and the outskirts; whether the making of such extensions or alterations should be a condition of the grant of powers to make any proposed railways; and what is the best method of constructing, working, and ventilating such railways, having regard to the safety, health, and convenience of persons travelling by them. We are pleased to find that their lordships did not receive the proposal favourably. The Earl of Morley went to the pith of the matter when he said that the grounds on which Lord Glenesk would refer these schemes to the Joint Committee were almost completely covered by the committee last year, and the only result of referring these Bills would be to delay them for another year. He also pointed out that there were only four new "tube" schemes before Parliament this session. Nine of last year's Bills had survived the period of suspended animation, and were now again before the House for consideration. In addition to these measures 15 were now before the House dealing with tube railways, but nine referred to extensions of works on authorised railways, two were for extensions of time, and only four were new schemes. As the Earl of Morley further remarked, a year's delay in these schemes would be not only serious for the promoters, but it would be inexpedient in the public interest, for the traffic in the London streets was becoming more and more congested, and the construction of lines to the suburbs was most important in connection with the housing of the poor. During the discussion, the question was introduced as to whether, as recommended by the Joint Committee of last year, power should be given to corporations and to the county council, as in the case of light railways, to construct or assist in constructing these tube railways. Without arguing whether or not that was desirable, the Earl of Morley thought it was a very doubtful expedient. In consequence of that recommendation, however, clauses had been introduced into many private Bills this year giving the county council that power. Reference was also made to the committee's recommendation that there should be some central board to control these schemes. With regard to this, although he had great sympathy with the recommendation, his Lordship thought Parliament would be jealous of giving up any powers in the matter which it now possessed. Eventually the motion was withdrawn, so that all these Bills will follow the ordinary course of procedure in relation of the promotion of private measures in Parliament. But in order to simplify matters somewhat, Lord Morley announced that he was endeavouring to devise some means by which they might be grouped together and dealt with by two or more committees, who would be guided to a large extent as to general principles by the report of the Joint Committee of last year.

The Electric Passenger Elevator.—Under this title a very complete paper was presented by Mr. Wm. J. Cooper before the members of the Institution of Junior Engineers at their ordinary meeting last Friday. In his opening remarks the author stated that the principal requirements of an effective electric elevator were safety, reliability, effective control, economy, and compactness, and were divided into two clearly-defined groups, having reference to, first, the winding machinery in operation while the elevator was in use with the safety devices, and, secondly, the car with its safety gear moving up and down the hoistway. The chief features of an ordinary gear were the armature of a motor coupled to a worm, with ball or collar bearings to take the end thrust of the worm; a worm-wheel submerged in an oil bath and fixed in a suitable bracket, entirely protected from the action of dust or grit; and a grooved winding drum or veed wheel fixed to the worm-wheel or mounted on the same shaft. Such machines were almost exclusively operated on the over-balance principle, which had the advantage of economy of power by making the system balance when the average load was in the car, in which case the elevator had no gravity work to perform, and resulted in the most economical type of hoisting apparatus. The electric motor and winding machinery could be erected either at the top or at the bottom of the hoistway as desired. The arrangement of placing the machinery at the top of the hoistway was particularly adapted to the electric elevator, as the current was conveniently conveyed by the cables to the motor and controller. The author next dwelt on the importance of an efficient form of brake. The type now generally adopted was the automatic magnetic solenoid, which could be made to give a pull of 500lb. or 600lb. through ½in. To meet the severe demands of the elevator, motors of a somewhat distinct class had been introduced so as to need little attention. Shunt motors were self-regulating if the potential was constant, and were now almost invariably adopted for this purpose, but with about 10 per cent. of series winding added on the field magnets to enable the motor to develop a powerful torque at the moment of starting. Considerable ingenuity had been expended over the starting and controlling switches, the operation of which might be effected in various ways—either by a hand rope, a handwheel, a lever, or by a push-button arrangement. The latter device was to be recommended for private houses or places where an attendant was not required, the elevator being operated by the passenger. The machine was of the ordinary drum type, the controlling being entirely electric, and operated by simply pushing a button. Various automatic safety devices were used in connection with the working controller or push-button switches. These devices were operated by both car and hoisting machine to cut off the power and apply the brakes at the limits of the car's travel. To guard against the car falling unretarded to the bottom of the hoistway in the event of the hoisting ropes breaking or becoming unshipped, there were several types of safety gears employed attached to the bottom or platform of the car, and arranged to operate by gripping the fixed guide posts or the backings, either by the action of the compressed springs or levers or by the combination of springs and centrifugal governor. The author also referred to accidents arising from the insecurity of entrances to the hoistway, and he recommended the use of a device by which the opening of any door broke the main circuit of the motor, and it was impossible for the motor to be started again until the gate was shut and locked and the circuit remade. On the question of cost, Mr. Cooper stated that the first cost of electric elevators in many instances compared favourably with that of hydraulic or other elevators. He further pointed out that the electric elevator was adapted to standardisation. The length of the travel did not enter into consideration so far as the driving gear was concerned, the motor having simply to run somewhat longer, and the increased length of travel was thereby attained. In conclusion, Mr. Cooper remarked that the power or current used in an electric elevator was in direct proportion to the number of persons or load carried, while with one worked hydraulically it was necessary to fill the cylinder with power water whether the load was light or heavy. A discussion followed the reading of the paper, at the close of which a vote of thanks was passed to the author.

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ELECTRIC DOCK CRANES AND CAPSTANS AT MIDDLESBROUGH.

From the publishing department of Messrs. Siemens Bros. and Co., Limited, York Mansion, York-street, Westminster, S.W., we have received a copy of an admirably illustrated pamphlet descriptive of the electric cranes and capstans recently installed at the North-Eastern Railway Company's docks, Middlesbrough. We venture to abstract the following particulars, which will doubtless prove of considerable interest to our readers. The installation forms an example of the complete equipment of docks with electric cargo appliances, and comprises 17 three-ton jib cranes, three 10-ton jib cranes, besides 24 one-ton capstans.

Three-Ton Jib Cranes.—The following are the principal data relating to each of the three-ton jib cranes: radius of jib, 44ft. 9in.; speed of lift of three tons, 150ft. per minute; speed of lift of 1½ tons, 250ft. per minute; revolving speed at hook, 400ft. per minute; travelling speed, 30ft. per minute. In Fig. 1 are seen some of these three-ton cranes loading rails. It will be noticed that they are of the high gantry type. The height of gantry is 30ft., the construction admitting of the passage of wagons and engines underneath. This arrangement facilitates the working of the traffic on the dock side, while the large radius of the crane enables it to cover five lines of rails, and so minimise delays caused by shunting.

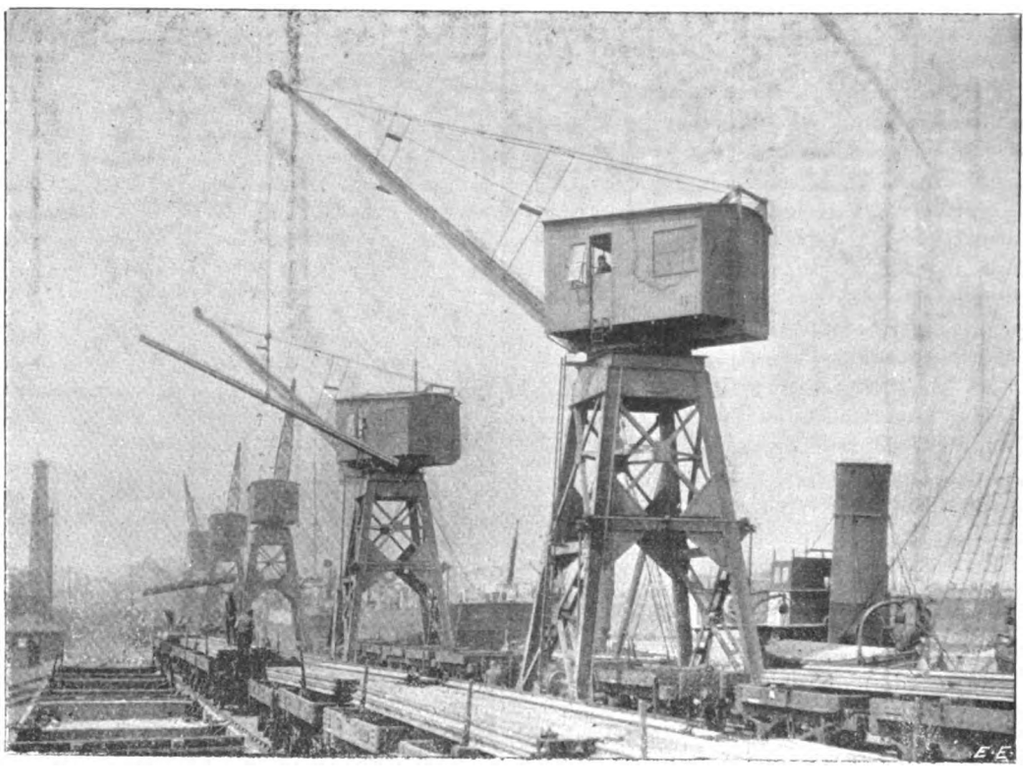

FIG. 1.—3-Ton Cranes Loading Rails.

The bottom framing of the gantry is composed of two channels, tied together by plates and riveted up so as to form an open box-shaped girder. The trod wheels are of cast steel, with double flanges, and keyed on steel spindles running on cast-iron plummer blocks bushed with brass. The travelling gear motion is fitted with both hand and electrical gear. The electrical gear consists of an enclosed series-wound multipolar motor, which is coupled to a steel worm working into a Delta metal worm-wheel. The power is communicated to the trod wheels by means of spur and bevel gearing, the wheels on each side being coupled together by means of a cross shaft, thereby ensuring uniformity of movement and avoiding any twisting strain on the gantry. Upon actual test it has been found that the time taken to release the rail clips and jacks, travel 30ft., and refix the clips and jacks, is about three minutes. This includes the time required for removing and reinserting in the next connection box the plug connection. The switch gear for the travelling motor is placed in a watertight case upon the bottom framing of the gantry. To prevent the possibility of unauthorised persons starting the gear, the switch is provided with a detachable key, which is kept in the crane cabin, and is in charge of the driver. The four uprights of the gantry are comprised of compound steel girders set at an angle which gives the entire gantry the form of a pyramid. The whole structure is rigidly tied together. Holding-down clips for fixing to the rails, and screw-down jacks for increasing the base when the maximum load is being dealt with, are also provided; but it has been found that the cranes are absolutely stable at all loads up to a considerable overload even without these attachments. The top framing is constructed of H-beams riveted up into box shape, and carrying the heavy plate which takes the roller pathway. H-beam cross-stays take the thrust and stiffen the structure. The top plate is turned in a lathe to receive the roller plate, and is bored out to receive the centre pin. The latter is made hollow to allow of the main cables being taken through it into the crane cabin. The roller path and rack are of cast steel. They are not bolted to the top plate, and whilst they are held down by a groove turned out of the latter, they admit of some movement, and ease the crane in case of a sudden stop when revolving. The rollers are 24 in number and of cast steel. The revolving frame is composed of two H-beams tied together by stretchers and having a cast-iron centre piece, through which the centre pillar is taken, and upon which is fitted a grooved steel ring, provided with a series of case-hardened balls. The collector is fitted to this pillar, and consists of two copper rings mounted upon ambroin and separated by rings of the same material. The collecting brushes consist of two gauze straps, each encircling one ring, the tension being regulated by springs. These straps are attached to terminals, which in turn are mounted upon porcelain insulators. The crane cabin is of teak, and the front consists of a wrought-iron framing, glazed to enable the driver to have his work in full view. The floor is covered with oilcloth, and an oil stove is provided for winter use. The cabin contains the lifting and slueing gear and the controlling apparatus. The lifting gear consists of a barrel, wheel, and pinion. The wrought-steel pinion is forged solid upon a shaft which is fitted with a half coupling to meet that upon the motor spindle. Upon this shaft there is a band brake actuated by an electromagnet, which will be described later. The pinion gears into

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a cast-iron spur wheel keyed on the barrel shaft. Both pinion and wheel have machine-cut teeth, and work in a cast-iron gear-case, which forms an oil-bath. The lifting is done on a single flexible wire rope. The barrel is of cast iron, turned and grooved to receive the rope, and is large enough to take the full lift without overlapping. The barrel shaft is carried on cast iron brackets, the bearings being brass bushed, and the whole is mounted upon a cast-iron bed-plate in conjunction with the motor. The lifting motor (Fig. 2) is designed to give 50 b.h.p. at 300 revolutions per minute, and is of the series enclosed multipolar type, with slotted armature and carbon brushes. The field magnets consist of a ring of high-permeability steel, made in halves, and strongly bolted together, carrying four poles of laminated high-permeability steel. The field coils are formed of copper strip, and are easily detachable from the magnet cores. The armature core consists of discs of best annealed mild steel keyed to a spindle. Ample ventilation is provided. The armature coils are all former wound, and easily replaceable. All insulation is subjected to a test at 2,000 volts alternating. The bearings are lubricated on the oil-ring system. The motor is completely enclosed and rendered water and dust proof by means of cast-steel end plates. The revolving gear consists of a motor worm, worm wheel, and spur gear. The worm is forged solid on the shaft, which, in turn, is fitted with a coupling to meet the motor. The worm engages with a Delta metal worm-wheel, and a pinion keyed to the worm-wheel shaft engages with a spur wheel, which is fitted to a short shaft actuating

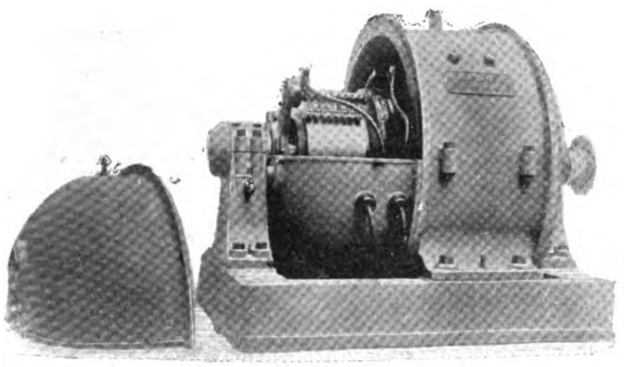

FIG. 2.—Lifting Motor (cover removed).

a pinion. This pinion travels round the rack of the crane, and thus slues the cabin and jib. A brake, actuated by a foot treadle, is fitted to the first-motion spindle, so that the slueing motion is always fully under control. The slueing motor (Fig. 3) is of similar type to the lifting motor.

The jib is composed of two channels with two flat bar bracings, and has a cast-iron bracket fitted at the bottom, through which the jib bottom pin passes, and secures it to the crane framing. The stay rods are secured to the jib tops by a separate pin from that on which the jib top pulley runs. The electric brake magnet referred to above offers some points of interest. It is placed in series with the armature of the lifting motor, and consists of a horse-shoe magnet (with poles arranged as those of a two-pole dynamo) with a solid steel armature of special shape capable of revolving between them. The passing of the current round the field coils tends to move the armature through a right angle. A lever is fixed to the end of the armature, and the brake, which is normally held on to the brake wheel by a weight, is connected thereto by a rod. The movement of the armature lifts the brake and releases the brake wheel. The great advantage of the particular form of magnet described above lies in the strong pull and long range which it affords. The brake is also connected to a lever which stands at the driver's left, so that the brake can be operated by hand instantly when required. The controller (Fig. 4) is of the so-called universal type, and consists of two separate controllers combined in one case and actuated by one handle. One controller actuates the lifting motion and the other the slueing, and both are connected by pinions and quadrants to the lever. The latter is so arranged by means of a universal device that when moved in a vertical plane it actuates the lifting and in a horizontal plane the slueing controller. Thus it will be seen that the hook follows the motion of the driver's hand, lifting when he raises the lever, and so on. One particularly conspicuous point about the controller is the ease with which it is manipulated, owing to the absence of click gear upon the intermediate contacts. Notches are provided only at the two extreme and the off positions, and in consequence the controller may be operated by the driver throughout the day without fatigue and its atten-

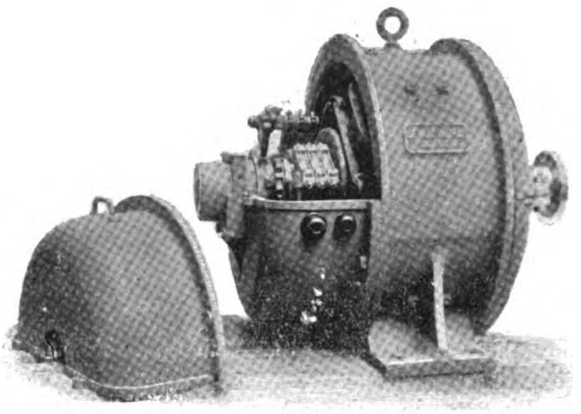

FIG. 3.—Slueing Motor.

dant slackness. The resistances are fixed inside the crane cabin. The switchboard consists of polished slate, framed in teak, and fitted with automatic cut-out, lifting and slueing isolating switches, fuses, and lighting switches. The crane cabin is well lighted by fixed and portable lamps, and a cluster in an enamelled iron reflector is fixed beneath the jib. Terminals are provided upon the switch-board, to which may be connected a registering voltmeter and ammeter.

Ten-Ton Cranes.—The 10-ton cranes are essentially as described above, except that they are, of course, rather heavier; there is a change of gearing both in the lifting and slueing motions.

Capstans.—Twenty-four capstans have been provided for handling trucks. These capstans are electrically driven, and are capable of exerting a steady pull of one ton at a speed of 200ft. per minute, or of hauling a load of 100 tons along a level road. The capstan head is driven by a cast-iron spur wheel, which is engaged with a steel pinion. The latter is keyed on the same shaft as a brass

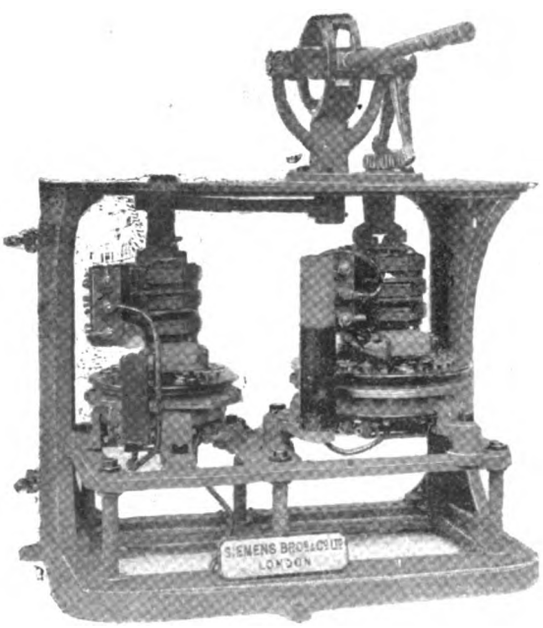

FIG. 4.—Universal Controller.

worm-wheel. The driving worm is forged solid upon its shaft, and is coupled direct to the motor spindle. The worm and wheel work in an oil-bath. The motor runs at 1,000 revolutions per minute, and is completely enclosed. In construction and design it is similar to the crane motors, but it is shunt wound to avoid large variations in speed of

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the capstan head. Upon the motor shaft there is fixed an automatic mechanical brake, the principle of which provides that when the capstan head is driven by the motor the break releases itself automatically, but should the capstan tend to run back through being overhauled by the weight, the brake at once locks itself and sustains the load. Such a brake is absolutely necessary upon an electric capstan, as the latter differs from an hydraulic capstan in one important respect—viz., that in the hydraulic capstan the water in the cylinder holds the load, whereas in an electric capstan there is nothing to sustain the load upon the current being cut off, and if the load is allowed to run back a serious accident may ensue. It is also essential that the brake should be automatic, so as to claim none of the driver's attention from his work. The electrical switch gear (Fig. 5) presents many points of interest. It consists of a controller provided with a magnetic blow-out and overload release gear. The controller is worked by a pedal projecting above the capstan case by about 4in. This pedal is removed when the capstan is out of use. The pedal is connected to a dashpot which prevents the controller being operated too rapidly when the driver is starting the capstan, but at the same time by means of valves in the plunger allows the controller to return rapidly to the off position. The return to the off position is

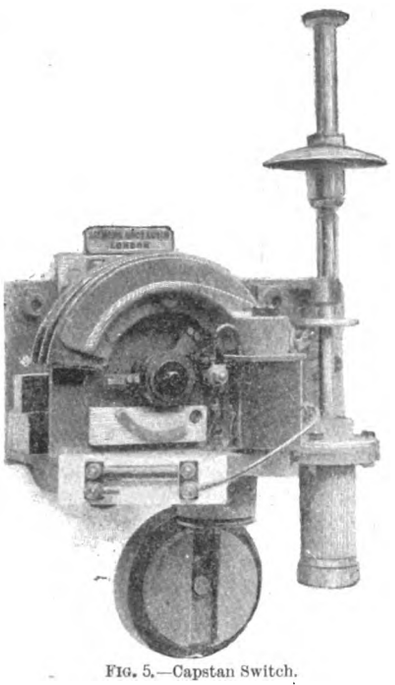

FIG. 5.—Capstan Switch.

effected by means of a weight which is lifted as the pedal is depressed. In the event of the capstan being pulled up by sudden overload, the release gear works instantaneously and breaks the main circuit. Upon the pressure being removed from the pedal, the return of the controller to the off position automatically replaces the release switch and the capstan is ready to start again. The whole of the gear is contained in a watertight cast-iron case sunk in the ground, the top of which consists of chequered plates flush with the quayside.

Cables.—The distribution of current is effected by a network of underground feeder and distribution cables. These cables are fibre insulated and lead sheathed; they are laid in wooden troughs in a mixture of sand and tar, and are at a depth of about 2ft. from the surface. Watertight junction boxes are provided at the junctions of the feeders. The crane connection boxes (Fig. 6) are in two portions, the bottom of which contains the positive and negative distributing cables, and the top the connection apparatus for the cranes. The distributing cables pass through the lower portion, and a connection is taken from each by means of a T-joint to the upper portion. At the same time two cables are taken off to the nearest capstan. The whole of the lower portion is filled with bituminous compound, which effectually excludes all moisture. The upper portion of the box contains two fuses and the crane connection contacts. Both contacts and fuses are mounted on porcelain insulators, and are completely shielded from damp. The top of the box consists of a chequered plate with a circular aperture to receive the connection socket. When the box is not in use a watertight steel cap covers this aperture.

The connection socket consists of a circular gunmetal hood, which accurately fills the aperture in the cover of the box, and is so shaped as to completely shield the joint from wet. The interior of this hood contains two gunmetal tongues which meet the two clip contacts in the interior of the box. A stud and groove insures that the socket shall enter the aperture only in the correct position. The flexible crane cable enters the hood of the socket through a trumpet mouth, and the whole apparatus is shaped so as to obstruct the quayside as little as possible. There are 52 boxes in all, placed 20 yards apart. They have stood the test of the severest weather, and have given no trouble.

Generating Station.—Power is generated by means of four Siemens-Belliss sets of plant, of which three are together equal to running the complete installation. The dynamos are of Messrs. Siemens's two-pole type, and are designed to give each 240 kw. at 400 to 430 volts. They are coupled direct to TEC4 compound engine by Messrs. Belliss and Morcom, and designed to run at 380 revolutions per minute. Steam is provided by four Lancashire boilers (three working and one spare) by Messrs. Danks and Co., fitted with Proctor's stokers. The feed pumps, two in number, are of Messrs. Watson's single-cylinder type. The economisers are by Messrs. Green and Co. A

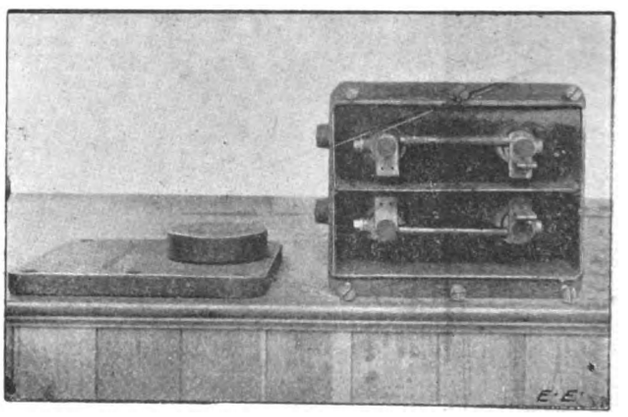

FIG. 6.—Connection Box.

complete set of surface-condensing plant by Messrs. Carrick and Wardale has been installed. The switchboard is of marble, and consists of four machine and one feeder panel. The instruments are of Messrs. Siemens's moving-coil type. The shunt winding of each dynamo is brought to a switch on the board, and these shunt switches are interlocked with their respective main switches, so that it is impossible to break the exciting circuit of any machine until the armature has been cut out of circuit, nor can the armature be thrown in until the shunt circuit is made. The four machines are run in parallel upon the 'bus bars, and the shunt circuits are excited from the bars. An exhaustive series of tests upon the three-ton crane shows that the electrical energy consumed in one complete cycle of evolutions at full load is, roughly, ·17 unit, or 170 watt-hours.

A complete cycle of evolutions comprises the following: lifting three tons through 30ft., slueing through 120deg., lowering three tons 30ft., hoisting light hook 30ft., slueing back through 120deg., lowering light hook 30ft. With a three-ton lift 45 complete cycles per hour were found to be quite easily obtained, and with a practised driver even a higher rate of speed is possible.

The contractors for the above-described installation were Messrs. Cowans, Sheldon, and Co., Limited, Carlisle, and Messrs. Siemens Bros. and Co., Limited, Woolwich, the latter firm being responsible for the whole of the electrical equipment. Since the completion of these cranes at Middlesbrough, the nucleus of a similar installation, consisting of five cranes and a number of capstans, has been supplied to the North-Eastern Railway Company's dock at Hartlepool. In conclusion, we have to thank Messrs.

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Siemens Bros. for the loan of the photographs from which the accompanying illustrations have been prepared.

SOME NOTES ON THE INFLUENCE OF THE SUB-STATION EQUIPMENT AND TRANSMISSION LINE ON THE COST OF ELECTRICITY SUPPLY.*

BY ANDREW STEWART, ASSOCIATE.

(*Continued from page 161.*)

It has been assumed in the following tables that at the end of the 10-mile line already discussed we shall place a sub-station of 1,250 kw. capacity, consisting of two sets of 500 kw. and one of 250 kw. Further, the maximum load on this station should be 750 kw.; this would allow of one 500-kw. set being in reserve, leaving the smaller one to deal with the day load, which is probably an economical arrangement for a load factor of 30 to 40 per cent. A high load factor it is admitted, but not greater than the sanguine promoters of the Power Bills would have us expect when these schemes are properly under way, nor greater than is obtained in tramway work. Such a sub-station might be equipped with synchronous or induction apparatus, or three or six phase rotatory converters. The station may even contain a combination of the first and second types; such combinations seem favoured in some quarters by reason of their flexibility. Smaller machines might be asynchronous, giving easy starting from the alternate-current side, and the larger synchronous apparatus with its accompanying high power factor (not necessarily unity). The capital cost would be somewhat as follows:

500-kw. Sets.

	Motor-generators. Asynchronous.	Motor-generators. Synchronous.	Rotatory converters. Three-phase.	Rotatory converters. Six-phase.
Total	£2,750	£2,750	£2,375	£2,125
Per kilowatt	£5. 10s.	£5. 10s.	£4. 15s.	£4. 5s.

Only the converters include static transformers.

250-kw. Sets.

Total	£1,750	£1,750	£1,312. 10s.	£1,250
Per kilowatt	£7	£7	£5. 5s.	£5

The total capital outlay on such a station will therefore be: asynchronous or synchronous, £7,250; rotatory converters—three-phase £6,062, six-phase £5,505.

The efficiency is as follows:

500-kw. Sets.

	Asynchronous. Per cent.	Synchronous. Per cent.	Rotatory converter, including statics. Per cent.
Full load	86	86·5	92
Three-quarter load	84·3	85	90·5
Half-load	81·5	81·5	88
250-kw. Sets.			
Full load	84	84·3	90
Three-quarter load	82·5	82·5	89
Half-load	78·5	78·5	86

Taking the maximum load at about 750 kw,, and a load factor of about 38 per cent., we have 2,490,000 units required at the low-tension 'bus bars. This output would be obtained with the smaller set, running with a mean load of, say, 200 kw. over the 24 hours, and the large set with 500 kw., about four hours per day. The smaller set would thus convert 1,760,000 units per annum and the larger about 730,000 units. The hypothetical nature of these figures should, of course, be borne in mind. With the smaller set running, as already noted, at about 80 per cent. of its load, its efficiency would be about 83 per cent. and the line at this very light load about 99 per cent., giving 82½ per cent., therefore to get 1,760,000 units on the low-tension side approximately 2,140,000 units must be supplied at the high-tension end. The load on the large machine being at all times added to the smaller one, the line load will, while the larger machine is running be the sum of these two, and the line efficiency about 95 per cent., the efficiency of the machine being 84·3 per cent., a total of 80 per cent., which means 910,000 units at the high-tension end. The units at high-tension generating station 'bus bars will then be 3,050,000, and at low-tension sub-station 'bus bars 2,490,000, an over-all efficiency of 81·2 per cent. It should be noted that a proportion of the units supplied to the small machine will not be delivered to it at 99 per cent. line efficiency, but at 95 per cent. This, however, has been neglected, as while complicating the problem does not give results of corresponding value. The process by which my results have been reached is in the above case fully explained, and in all other examples the results only will be quoted.

TABLE I.—Synchronous Motor-Generator—15,000 Line Volts, Two Three-Core Cables, one spare.

Capital Costs.

Sub-station plant	£7,250
Buildings	900
Copper in line	1,000
Insulation	13,000
Laying and reinstatement	5,873
	£28,023

= £22·5 per kilowatt installed. = £37·5 per kilowatt of maximum demand, taking 750 kw. as maximum demand.

Total Capital Cost per Kilowatt Demanded.

Generating station	£20·8
Line and sub-station	37·5
Total	£58·3

Annual Costs—Standing Charges per Kilowatt.

Interest on capital at 5 per cent. (£58·3)	£1	15	0
Depreciation, 7 per cent. on £20·8, generating station	1	8	7
Depreciation, 7 per cent. on £10·8, sub-station plant and buildings	0	14	7
Depreciation, 5 per cent. on feeders, 1 per cent. on ducts ...	1	0	3
	4	18	5

Running Costs.

Labour (one engineer and one labourer per shift) = £456 per annum, = £·61 per kilowatt maximum demand	0	12	3
Proportion of distribution engineer's salary and staff charges, say £100 per annum per sub-station = £·13 per kilowatt maximum demand	0	2	9
Total annual cost per kilowatt	£5	13	5

Of these charges £3. 12s., or 58 per cent., is on account of mains and sub-station. Over-all efficiency = 81·2 per cent. A further 1 per cent. (nearly) is lost in dielectric hysteresis,* reducing this figure to 80·2 per cent. A unit costing ·3d. at high-tension station 'bus bars will cost ·373d. at low-tension 'bus bars, and a consumer using a maximum demand of 100 kw., with a mean of 70 kw. over 24 hours, will use about 613,200 units per annum, which at ·373d. costs £950. We thus have

Energy costs	£950
Fixed charges	565
	£1,515

Average price per unit, ·59d.

Consumer using 100 kw. maximum demand and mean of 70 kw. over 10 hours per day: 255,000 units per annum at ·373d.	£400
Fixed charges	565
	£965

Average price per unit, ·9d.

Typical short-hour consumer using 100 kw. maximum demand, and using that 100 kw. one hour per day: 36,500 units at ·373d.	£57
Fixed charges	565
	£622

Average price of 4·1d. per unit.

TABLE II.—Induction Motor-Generator.—Power Factor, ·9.—15,000 Line Volts.

Capital Cost.

Sub-station plant	£7,250
Buildings	900
Copper in line	1,210
Insulation	14,000
Laying and reinstatement	5,873
	£29,233

= £23·9 per kilowatt installed. = £39 per kilowatt maximum demand.

Total Capital Cost per Kilowatt Maximum Demand.

Generating station	£20·8
Line and sub-station	39·
Total	£59·8

Annual Costs.

Interest on capital at 5 per cent. on £59·8	£1	16	0
Depreciation, 7 per cent. on generating station, £20·8	1	8	7
Depreciation, 7 per cent. on sub-station, plant, and buildings, £10·8	0	14	7
Depreciation, 5 per cent. on feeders, 1 per cent. on ducts and manholes	1	2	0
	5	1	2
Labour at sub-station = £·61 per kilowatt maximum demand, proportion of distribution engineer's staff charges.....	0	15	0
Total fixed charges.....	£5	16	2

Of this amount £3. 15s. 7d., or 65 per cent., is on mains and sub-station account. Over-all efficiency of system, 80½ per cent. Allow an additional 1 per cent. for dielectric hysteresis, 79½ per cent.—*i.e.*, a unit costing ·3d. at high-tension 'bus bars of generating station will cost ·387d. at low-tension 'bus bars.

* The charging current of this line (capacity 1·25 microfarads) would be at no load about 5·8 amperes = 152 apparent kilowatts. The power factor has been taken at ·023, giving a loss of slightly over 30,000 units per annum. This loss has been considered in the paper as a function of the line loss; it really is a fixed loss, independent of the number of units transmitted. and should be reckoned at the works cost per unit, in this case about £38 per annum per cable in use, this figure being placed amongst *annual* charges. The cost of the dielectric losses may seem small, but it must be noted that there may be six to eight such cables radiating to various sub-stations all in use continuously. With smaller cables, the losses are not reduced in proportion, as the ratio of sectional area to surface does not diminish in proportion.

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, Jan. 27.

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Consumer as before: 613,200 units at ·378d.	=	£962
Fixed charges, £8. 3s. 6d. × 100 kw.	=	580
		£1,542

$$\text{Average of } \frac{£1,542}{613,200} = \text{·685d. per unit.}$$

Consumer using 100 kw. maximum demand and 70 kw. 10 hours per day: 3,650 × 70 = 255,500 × ·378d.	=	£403
Fixed charges		580
		£983

$$\frac{£983}{255,500} = \text{·92d. per unit.}$$

Short-hour consumer, 100 kw. maximum demand, and used it one hour per day: 36,500 × ·378d.	=	£57 10	0
Fixed charges		580 0	0
		£637 10	0

$$\frac{£637.\ 10s.}{36,500} = 4\text{·}2d.$$

TABLE III.—Rotatory Converter Sub-Station Equipment—15,000 Volts.

Sub-station plant, including statics	£6,062
Buildings	750
Copper	1,000
Insulation	13,000
Laying and reinstatement	5,873
	£26,685

Cost per kilowatt maximum demand (750 kw.), £35·5.

Total Capital Cost per Kilowatt Maximum Demand.

Generating station	£20·8
Sub-station and mains	35·5
	£56·3

Annual Costs.

Interest at 3 per cent. on £56·3	£1 13	9
Depreciation at 7 per cent. on £20·8	1 8	7
,, 7 ,, £9·2	0 12	8
,, 5 ,, feeders and 1 per cent. on ducts, etc.	1 0	4
	4 15	4
Labour at sub-station and distribution, department charges as before	0 15	0
	£5 10	4

Of this amount £3. 10s., or 59 per cent., is on mains and sub-station account. Over-all efficiency = 88 per cent. (89 – 1 per cent. for dielectric loss). A unit at generating station costing ·3d. will cost ·343d. at low-tension terminals in sub-station.

Consumer as before: 613,200 units at ·343d.	£876
Fixed charges, £7. 16s. 11d. × 100	550
	£1,426

$$\frac{£1,426}{613,200} = \text{·558d. per unit.}$$

Consumer 100 kw., maximum demand 70 kw., 10 hours per day: 3,650 × 70 = 255,500 × ·343d.	£366
Fixed charges	550
	£916

Average price, ·852d.

Short-hour consumer, 36,500 × ·343d.	=	£52	5 0
Fixed charges	=	550	0 0
		£602	5 0

Average price, 3·95d. per unit.

TABLE IV.—Synchronous Motor-Generator—Three Cables, 15,000 Line Volts (one cable spare).*

Sub-station equipment	£7,250
Buildings	900
Copper	750
Insulation	16,500
Laying and reinstatement	6,460
	£31,860

Cost per kilowatt installed, £25·4: ditto maximum demand, £42·3.

Total Capital Cost per Kilowatt Maximum Demand.

Generating station	£20·8
Sub-station and mains	42·3
	£63·1

Annual Charges.

Interest at 3 per cent. on £63·1	£1 17	10
Depreciation at 7 per cent. on £20·8	1 8	7
,, 7 ,, £10·8	0 14	7
,, 5 ,, feeders and 1 per cent. on ducts, etc.	1 4	3
	5 5	3
Labour at sub-station and distribution charges	0 15	0
	£6 0	3

* A draw-in system in cast-iron pipes has in all cases been assumed.

Of this sum, £4, or 66 per cent., is on mains and sub-station account. Over-all efficiency of mains and machinery remains as Table I., except that the line efficiency is somewhat higher, due to a slightly larger copper section having been taken, a cable exactly half the section of the size in Table I. not being a maker's size. The slight gain due to this has been neglected. On the other hand, the losses due to dielectric hysteresis have been more than doubled, as the condenser action of a cable is, *inter alia*, proportional to the area of conductor exposed to the insulation. This has been more than doubled. Hence, if we put 2½ per cent. to this we shall be safe. This amount would not be exceeded, as, although the loss may mean more than double that in Table I., it is unlikely that both cables would be used in parallel through the whole 24 hours. Over-all efficiency, therefore, will be 79 per cent., making a unit at ·3d. in generating station cost ·382d. at low-tension terminals.

Consumer using 70 kw. for 24 hours, 100 kw. maximum demand: 613,200 at ·382d.	£972
Standing charges, 100 kw. × £9. 14s.	600
	£1,572

Average cost of ·61d. per unit.

Consumer using 70 kw. for 10 hours, with 100 kw. maximum demand: 255,500 units	£408
Fixed charges	600
	£1,008

Average price, ·94d. per unit.

100 kw. Maximum Demand used One Hour per Day.

Energy cost, 36,500 units at ·382d.	£58
Fixed charges	600
	£658

Average price, 4·32d. per unit.

TABLE V.—Six-Phase Rotatory Converter—15,000 Volts fed through Bare Overhead Wires; Six Line Wires.

Capital Costs.

Sub-station plant	£5,505
Buildings	750
Cost of 10 miles overhead line with six No. 10 copper wires (two separate circuits), including erection	3,438
	£9,693

Cost per kilowatt installed, £7·72; ditto maximum demand, £12·8.

Generating station	£20·8
Sub-station and mains	12·8
Total	£33·6

Annual Costs per Kilowatt of Maximum Demand.

Interest at 3 per cent. on total capital per kilowatt	£1	0	0
Depreciation, 7 per cent. on generating station, £20·8	1	8	7
Depreciation, 7 per cent. on sub-station and buildings, £8·35	0	11	9
Depreciation, 3 per cent. on line = £45·8	0	2	8
	3	3	0
Labour at sub-station and distribution charges	0	15	0
	£3	18	10

Of this sum £1. 2s., or about 27 per cent., is spent on mains and sub-station. Over-all efficiency, 89 per cent.

Consumer taking 613,200 units per annum at ·338d.	£865
Fixed charges, 3·9 × 100	390
	£1,255

Average price per unit, ·49d.

Consumer taking 70 kw., mean load 10 hours per day: 255,500 units at ·338d.	£360
Fixed charges	390
	£750

Average price of ·7d. per unit.

Short-hour consumer: 36,500 units at ·338d.	£51	8	0
Fixed charges	390	0	0
Total	£441	8	0

Average price, 2·9d. per unit.

Summarising Tables I. to V., we have price of one unit delivered at low-tension 'bus bars for various classes of consumers, synchronous motor-generator, 15,000 line volts, and two three-core feeder cables.*

Table I.—(1) Consumer whose mean load is 70 per cent. of his maximum demand, and takes his mean load over 24 hours, can have his supply delivered to the low-tension 'bus bars for an average price of ·59d. per unit; (2) consumer who takes same demand and mean as above, but for 10 hours per day, ·9d. per unit; (3) ditto, but takes his maximum demand for one hour per day, 4·1d. per unit.

Table II.: *Induction Motor-Generator.*—Consumer Class 1, ·685d. per unit; Class 2, ·92d. per unit; Class 3, 4·2d. per unit.

* Instead of two cables, each having a capacity of 1,000 kw., three of 500 kw. carrying capacity may be used, as in Table IV., giving one cable spare, and although this would be an economical plan where copper predominated over insulation, costing approximately £750, as against £1,000 by the other method, yet insulation costs £16,500, against £13.000 by the lines having two cables. An interesting result showing that the largest cables are generally the most economical.

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Table III.: *Rotatory Converter.*—Consumer Class 1, ·558d. per unit; Class 2, ·852d. per unit; Class 3, 3·95d. per unit.

Table IV.: *Synchronous Motor-Generator, Three Line Cables.*—Consumer Class 1, ·61d. per unit; Class 2, ·94d. per unit; Class 3, 4·32d. per unit.

Table V.: *Six-Phase Rotatory Converter, Six Line Wires* (*Bare Copper*).—Consumer Class 1, ·49d. per unit; Class 2, ·7d. per unit; Class 3, 2 9d. per unit.

These figures give some idea of the commercial possibilities of distribution with various equipments in the sub-station and different lines. The predominant influence of the line is apparent in every case, and shows that the problem of economical power distribution is to a large extent a question of cables. The advantages to be derived from the use of a bare copper overhead line are so great, even when a pretty expensive line construction is adopted, that nothing but the very strongest reasons against their adoption should prevent the Board of Trade from permitting their use under more liberal conditions than at present. It is remarkable that the maximum price per unit which any supply authority may charge is fixed, while, on the other hand, restrictions are placed on the business from a commercial and engineering standpoint which make the cost of delivering a unit at a place distant from the generating station so great as to make the supply of short-hour consumers unprofitable. No legislative authority is justified in making the long-hour consumer pay for the short-hour consumer, nor is it justified, even to the very slightest degree, in imposing conditions upon a business which renders trading commercially unsound; yet it is apparent that such would be the case if a low-tension network were tacked on the sub-station under conditions in Table IV. The capital charges, distribution, and other costs would make it difficult to deliver a unit to any short-hour consumer at very much less than 6d., even, as is assumed, that the energy is generated at a station where every possible opportunity is taken to secure economical generation; and, as will have been noted, the transmission efficiency is taken at very favourable figures.

A feature of some interest is the small difference between a rotatory converter and synchronous motor-generator equipment (Tables I. and III.). These come very close to each other in point of cost per unit delivered at the low-tension terminals. The total cost to the long-hour consumer differs by only £89, and the total capital investment by an equally small amount. Of course, the aggregate saving on the cost of the line and sub-station may appear fairly large, but each kilowatt of maximum demand only benefits to the extent of $\frac{1}{7\frac{1}{2}}$th of the total saving. Nevertheless, it is of importance to the supply authority, as the saving of £89 per annum on the long-hour consumer is over 15 per cent. additional revenue on the capital invested by the company in order to supply that consumer, or giving the consumer the benefit of the saving, it means that he saves annually a sum equal to the investment of an additional £900 in his business. Taking everything into consideration, it is apparent that only the very strongest engineering reasons can justify the adoption of motor-generators in preference to rotatory converters. Such disadvantages as the latter may have are not at all serious, and do not, in the writer's opinion, justify their exclusion from a distribution system under ordinary conditions.*

It will be observed that the diversity of consumers' demands on the sub-station has been left altogether out of account in the foregoing paper. While recognising the advantages of a load where the maximum demand of all consumers does not occur simultaneously, or nearly so, the writer is of opinion that too much may be made of this point. A manufacturing district is seldom a residential district, and a moment's reflection will show that the maximum demand of such a district will occur, in winter, between 4.30 and 5.30 p.m. While, of course, that hour does not represent the period of maximum intensity of production in most manufacturing establishments, it, nevertheless, represents the maximum load, as, in addition to power, there is a large lighting load, due to works, drawing, and commercial offices. The writer has had many opportunities of observing this point, and he has yet to learn of exceptions. One large station supplying, through several sub-stations, residential and industrial districts would naturally derive some considerable advantage from such a diverse demand, as has already been noted, but, as will be seen from the figures given, it cannot seriously modify the price per unit, as in most cases the high-tension feeders and sub-station, to which must also be added a low-tension network, will exercise a great if not predominant influence upon the commercial results.

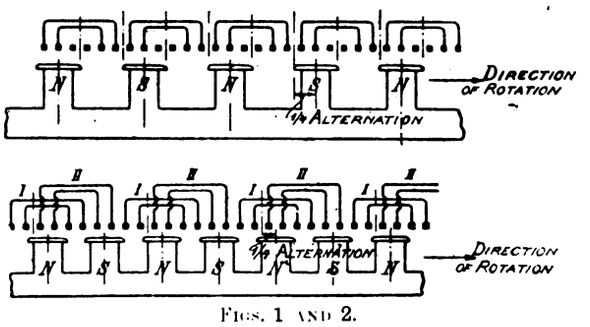
(To be continued.)

A NEW METHOD OF DETERMINING THE ANGLE OF PHASE DISPLACEMENT IN ALTERNATORS WITH ROTATING POLE RINGS.†

BY O. QUEISSER.

It is a well-known fact that the rotating pole ring of an alternator illuminated by the light of an arc, whose current is taken from the alternator in question, appears stationary, whilst the pole ring of a second machine, started up for the purpose of being put into parallel with the first, appears to rotate with a speed which is directly proportional to the instantaneous difference in the number of revolutions of the two machines. When the second machine has attained the same speed as the first, its pole ring also appears to be at rest. If this appearance is examined more closely, it will be found that the radial axes of the magnet poles of the apparently stationary pole ring always occupy the same positions relatively to the armature, and that the poles of the second machine, as soon as it has got into synchronism, also appear to occupy the same position relative to the armature. It can be proved that this position of rest relatively to the axes of the armature coils is directly connected with the amount of phase displacement between the current of the arc lamp and the voltage producing it. In order to make this proof clear, it will be necessary to explain the matter a little more in detail. The human eye is unable to distinguish the different intensities of light which in ordinary alternating supply follow one another periodically at the rate of 80 or 100 alternations (40 or 50 periods) per second sinusoidally. On this account the alternating arc lamp under ordinary conditions appears as a source of light of constant intensity. The conditions are different when the rotating pole ring of an alternator having a high peripheral speed (in large machines this is from 50ft. to 100ft. per second) is viewed by the light of an alternating arc. During the motion of one pole of the pole ring through a distance equal to the pole spacing, it will at one particular instant be illuminated by the maximum light intensity. This maximum illumination of the pole, in comparison with the weaker light impulses, makes a lasting impression on the retina of the human eye. As, after the expiration of another $\frac{1}{80}$ to $\frac{1}{100}$ second, the next pole on the pole ring will appear at the exact same point and under maximum illumination again, the new impulse is added to the previous one on the retina. This process is repeated at every alternation, with the result that the rotating pole ring appears stationary. Now, since the maximum light intensity occurs at a point in phase close to the point of maximum current through the arc, the pole will appear to be stationary in a position corresponding to this point of maximum current.

Following this explanation we will next indicate, by means of two examples, at what actual point the ring would appear stationary. Experience has shown that alternate-current arc circuits have power factors of $\cos\phi = \cdot 8$ to $\cdot 7$. Taking the last figure, for example, this would indicate, with approximately sine wave currents, an angle of phase displacement of about 45deg. Since, in such a circuit containing self-induction, the current vector lags behind the voltage vector, the current maximum will also lag about a quarter of an alternation behind the voltage maximum. If, therefore, the E.M.F. curve and the corresponding instantaneous position of the pole ring are followed, starting from the point of zero E.MF., and passing towards that of maximum E.M.F., it will be necessary to proceed another quarter of an alternation in the same direction in order to reach the point occupied by the pole ring at the instant of maximum current in the arc. This position is the point at which the pole ring appears to be stationary.



FIGS. 1 AND 2.

The position of pole ring corresponding to maximum voltage is readily discovered by reference to the arrangement of the armature winding. Figs. 1 and 2, which hardly need further explanation, show the positions of apparent rest for the case of a single-phase and two-phase alternator respectively. The current for the arc is assumed to be taken from the terminals of the machine, and to have

* The motor-generators are all to one specification, and were built for the line pressure on the stator, which accounts for their price being higher than figures generally quoted. The three-phase rotatory is based on a machine having the same temperature rise as the motor generators, while the six-phase rotatory is approximate.

† Translated from the *Elektrotechnische Zeitschrift*.

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a 45deg. lag behind the terminal voltage. The maximum light intensity is also assumed to be in phase with the maximum current. It will be found that the above theory is, at least as far as the eye can judge, borne out in practice.

The method can be employed as a ready way of directly determining the angle of lag at any instant from the apparent position of rest of the pole ring, provided that the arc by which the machine is illuminated at the time of observation is produced by the main current of the machine. It may be supposed, for instance, that two carbon contacts are introduced into the main lead of the alternator, and are usually kept in contact. When a power-factor measurement is to be made, these contacts would be drawn a few millimetres apart. If placed close to the alternator in the central station, the resulting arc will illuminate the machine and enable the power factor to be read off directly by means of a calibrated scale. This method would be more especially applicable to high-tension machines, as the resulting drop of 30 volts or so across the arc would only be a very small percentage of the terminal voltage. If it considered preferable, on account of insulation troubles and danger, to avoid the use of the high-tension main current, it is only necessary to provide a small transformer whose primary carries the main current, and whose secondary is subdivided so that the necessary 30 volts can be obtained at any time and with any value of the primary current by connecting more or less of the secondary to the arc. It should be pointed out that the question of phase displacement between maximum illumination and maximum current, about which, so far as I know, no exact experimental results have yet been obtained, has no influence on the result, as it is already allowed for in the calibration of the scale.

In order to ensure fair accuracy in the readings, it will be necessary to make the appearance as clear as possible by suitable means—*e.g.*, marking the middle line of the pole cores by a white line, etc.

The question as to how far the method is applicable in practice must be determined by future experience.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

455. I notice in some makes of drum armatures the supporting wedges or horns are omitted. Trusting only to the binding bonds to prevent the conductors shifting, is this style good enough? What is the electrical and mechanical strain on the conductors? Give calculating formula.—H. W.

456. I have a boiler which is constantly priming. Can any reader tell me the best means of determining the quantity of water in the steam?—R. T.

ANSWERS.

Question No. 449.—What is the cause of the deposit of sodium in glazed earthenware casing? Has the glaze on the earthenware anything to do with it, and is it usual to find a greater deposit in the negative hole than in the positive? Describe fully the chemical action which takes place?

Best Answer to No. 449 (*awarded* 10s.).—In 1895 some explosions occurred in underground electric conduits in London, and these called forth investigation and report. The system was direct current, and the deposit was found at and near to the negative wires. Prof. Thorpe's analysis of the deposit found in the St. Pancras conduits on March 2 was: caustic soda, 7·69 per cent.; caustic potash, 4·88 per cent.; sodium carbonate, 34·40 per cent.; potassium carbonate, 52·77 per cent.; together with traces of silica, alumina, and lime. Three samples taken from Southampton on March 9, 1895, were practically pure carbonate of soda, with a very small admixture of carbonate of potash. Not one of these contained any free alkali. The sample taken from an earthenware insulator was amorphous, and contained traces of carbonate of lime. The other two samples taken from a glass insulator were crystalline. The soil, mortar, and concrete in which the mains were laid in St. Pancras were also chemically tested and found to contain compounds of sodium and potassium. Water in contact with each of these dissolved the alkaline salts, and was also distinctly alkaline.

These analyses and the investigation were under the auspices of a committee of members of the Royal Society and the Institution of Electrical Engineers appointed to confer with the electrical adviser to the Board of Trade. A very interesting abstract of the proceedings of this committee is given in the *Electrical Engineer* for April 12, 1895. Evidence was given that 60 or 70 per cent. of the insulators were affected by the incrustation, and that in some cases when scraped off it formed again within 24 hours; that insulators supported on wooden supports near the street boxes were generally affected; that very few cases of incrustation had been found on insulators supported on iron brackets within the culverts; that the wooden supports had been let into the brick sides of the culverts; and that these wood supports were invariably thoroughly saturated with saline moisture. It was also observed that when water was thrown on the deposit it gave forth the yellow sodium flame in several instances. In some cases the glaze on the insulator was spoilt. The incrustation was a bad conductor of electricity, and glass insulators were found better than earthenware.

These are the chief points to be gathered from this interesting report, and they enable us to see clearly the chemical action which goes on. Firstly, we must notice that there is a supply of potash and soda salts in the earth about the conduit, and that moisture is also present. Reference to a chemical book will tell us that potash is the oxide of potassium and soda the oxide of sodium. Potash is very hygroscopic—*i.e.*, it attracts moisture forcibly—and so is soda. In either of these states they are very caustic, but they are also strong bases, and so can unite with any acid they meet with, and then they are called salts of potash and soda. Carbonic acid is a gas, and is always present in the air, especially underground. Under these circumstances we cannot expect to find either potassium or sodium in the metallic state anywhere in nature, but we do find salts of these two metals in great abundance. In an underground culvert we expect to find everything, including insulators, more or less damp and dirty. The damp and dirt make a covering film, and we know from experience that this covering grows both in extent and in thickness. It is also capable of dissolving any soluble matter presented to it, and, moreover, it is a fairly good conductor of electricity, so that on insulators it makes a way of escape for electricity, and the line is said to have a leak. Of course, this leak is really a passage of electricity along the film of dirt and moisture from one insulator to another. Potassium and sodium salts are dissolved in the film, and where wood is used to support the insulators, also in the substance of the wood. Consequently we now have all that is necessary for electrolytic action, and the film of moisture having dissolved potassium and sodium salts represents the electrolyte. The passage of the electric current carries the metals—*i.e.*, potassium and sodium—to the negative side of the system, and draws the acids to the positive side. But, as stated above, these metals take moisture and oxygen from almost everything they touch, and also absorb carbonic acid with great rapidity. It is therefore a matter of which is the most rapid action. If the electrolytic because the leakage is great, and there is abundance of potassium and sodium salts to electrolyse, then we may get a deposit of potassium and sodium, but these will quickly be coated with a covering of oxide or carbonate, and this, of course, would protect the metals deposited underneath it, but as these grow in quantity, the covering would be constantly cracking, and therefore under

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no circumstances could the potassium or sodium exist there long in the metallic state. If, on the other hand, the electric leak was small, and there were plenty of carbonic acid and moisture present, then the potassium and sodium would absorb the carbonic acid as fast as the electrolytic action set them free, and so only carbonates of potash or soda would be observed. Of course, the electrolysis would be going on just the same, but the chemical absorption being the most rapid, would hide the visible effect of it. It will now be apparent why the negative wire remains clean and the positive wire gets corroded and turns green—*i.e.*, because the acids are drawn by electrolysis to the positive wire, and they attack it to form copper salts, which are generally green.

This is a full description of the chemical and electrolytic actions causing the deposit. They are quite independent of the glaze, although possibly a bad glaze might be injured by contact with such strong chemicals, or by heat formed by the chemical absorption, but in any case, the glaze being insoluble, could not take any part in starting the action. The greater deposit would certainly be found in the negative hole, but as the deposit is soluble in water, it might be spread about a good deal under favourable circumstances, especially when the electric current was switched off. Doubtless moisture finds its way into the casing mentioned in the question, and with it the potash and soda salts for electrolysis.—F. G. A.

Answer to No. 449 (*awarded* 5*s.*).—This effect is primarily due to the electrolytic decomposition of alkaline salts, chiefly derived from the soil, and conveyed by moisture along the earthenware ducts to the negative conductor. At all times, and more especially in damp weather, the earthenware ducts become covered with a thin film of moisture, which acts as a conductor or medium for forming leakage, and if the casing in this case is used for a three-wire system of supply, such leakage will not only be from pole to pole—*i.e.*, positive to negative—but also to earth. The resistance of such a path is comparatively high, and so a short-circuit between the outers (positive and negative) is not usually established. But there is a sufficiently large current from positive to negative, then from negative to earth, and thence back to the positive, to electrolyse the ducts, and more particularly the glazing material on them. This material is electrolysed into numerous white incrustations, and as the negative conductor becomes the cathode electrode, the salts are carried along by the current and deposited on the conductor just where the casing touches or nearly touches the negative main. These salts are naturally conductors of somewhat high resistance, but they retain moisture, which increases their powers of conductance. Thus the leakage goes on—the more the moisture, the worse it becomes

The question also asks, "Has the glaze on the earthenware anything to do with it." A known peculiarity with glazed earthenware is that with a slight variation of temperature it becomes coated with a thin film of moisture, and so provides a path for a leakage current which has the above described effect. It will thus be seen that glazed earthenware has the disadvantage of tending to promote such leakage currents. An analysis made on specimens of this white incrustation shows that its composition consists of potassium carbonate, sodium carbonate, caustic soda, and caustic potash. In addition there were traces of alumina, silica, and lime.—A. H. M.

Answer to No. 449 (*awarded* 5*s.*).—There is little doubt but that the sodium deposits found in conduits are connected with the salt used in glazing. This, of course, the makers deny, stating that the amount of salt used is too small to have any such effect; and it is likely that there are other agents at work, such as water impregnated with mineral salts from the surrounding earth or from roadway traffic refuse. It is generally with rubber cables that such deposits are found, and the deposit is almost entirely in the neighbourhood of the negative conductor. This points to electric osmosis, and its result is to destroy the rubber and to then obtain a partly cuprous deposit In some cases the setting up of such chemical action has been traced to the grease used when drawing in long lengths of cable, which has not been of a sufficiently neutral character. The most fruitful growths are found when rubber cables are used at the conduit joints when made with cement, cement being particularly destructive to rubber. Where deposits occur with lead-covered cables, they may sometimes be traced to leakage currents on the lead which find their way to earth by the best conducting routes, and thereby indicate where the salt in the glaze is most abundant.—B. C. H. J.

Question No. 450.—What characteristics would a compound-wound motor manifest (1) on starting, (2) working under varying load, with the shunt and series coils connected in opposition?

Best Answer to No. 450 (*awarded* 10*s.*).—The object of winding a motor with a series winding in opposition to the shunt is to give a constant speed at all loads, and as the series winding is calculated to give this result, we will consider the second part of the question first; we shall then have sufficient data to deal with the first part. Fig. 1

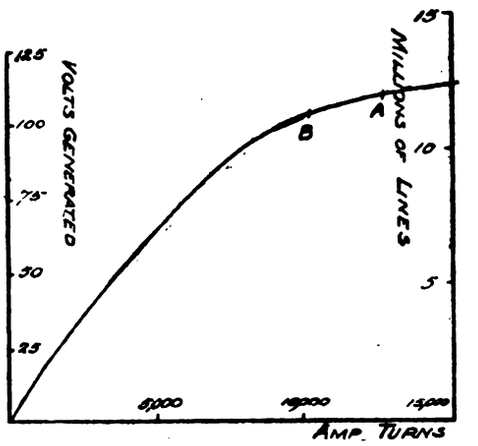

FIG. 1.

shows the saturation curve of a motor taking 400 amperes at 110 volts running at 450 revolutions. The resistance of armature and brushes is ·0125 ohm hot, giving a drop of five volts at full load. The point A shows the working part of the curve at no load. In order that the motor may run at the same speed at full load, it must then generate only 105 volts at 450 revolutions. The working point will then be B, the reduction in ampere-turns being 2,500. Part of this reduction is brought about by armature reaction and part by the series turns opposing the main field. There is no need to consider them separately, as each is proportional to the current, provided that the brushes are fixed, as is usual. If we now consider what occurs at half load we find that the net ampere-turns are then 11,750, giving a voltage of 108 instead of 107½, owing to the convexity of the saturation curve. This means that the motor speed falls slightly at half load. The answer to (2), then, is that the differential compound winding, if correctly designed, gives the same speed at no load and full load with a slightly lower speed at intermediate loads. It is easily seen that on overload the speed will rise.

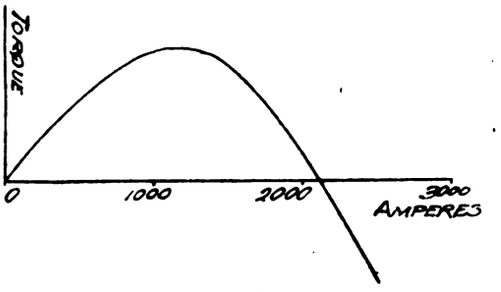

FIG. 2.

We can now consider the first part of the question. The torque is proportional to the product of N, the number of lines, and C, the current in the armature. We have seen that a current of 400 amperes must reduce the ampere-turns from 13,000 to 10,500, and we can read from the curve the value of N for any number of ampere-turns. The following table gives the comparative torque for any value of the current.

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Current.	Ampere-turns (net).	N.	C × N.
200	11,750	11·9 mill.	239
400	10,500	11·5 ,,	460
600	9,250	10·9 ,,	655
800	8,000	10·1 ,,	808
1,000	6,750	9·12 ,,	912
1,200	5,500	7·7 ,,	922
1,500	3,625	5·4 ,,	810
2,080	0	0·0 ,,	0

This shows that the torque rises to a maximum and then falls off again, and finally, with a very large current, it tends to run in the reverse direction. This is clearly shown in Fig. 2. It is clear that a differentially-wound motor will take a large current at starting, and if heavily loaded will refuse to start. Such motors are seldom used, but if constant speed is essential, the series winding should be short-circuited until the motor is up to speed. This answers part (1).—W.

Answer to No. 450 (*awarded* 5*s.*).—Motors having a shunt and a series winding connected in opposition—commonly called differential motors—are occasionally employed where very constant speed under varying loads is required. Such motors can neither exert so great a starting torque nor stand so great an overload as plain shunt motors, for any increase in current actually weakens the field, and after a certain excess of current has been reached the torque (proportional to armature current × field strength) decreases instead of increasing. If, either when switching on or when running at an overload, this particular current is exceeded, the motor will fail to start in the one case and will stop in the other, and unless promptly switched off again will probably burn out. The shape of the characteristic curve, connecting speed and horse-power, of a differential motor depends greatly on the relative numbers of shunt and series ampere-turns on the field. Even in the case of a plain shunt motor the characteristic curves differ considerably. Thus, very small slotted-armature shunt motors and small or moderate sized shunt motors, with smooth cores, drop more or less in speed as the load increases (Curve A, Fig. 1). Large shunt motors with

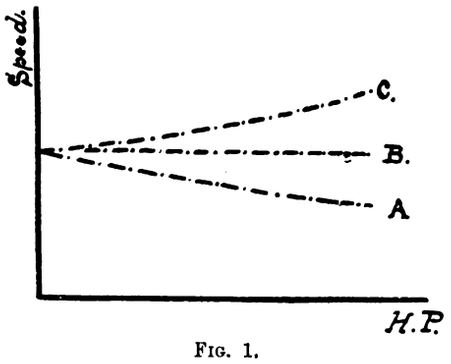

Fig. 1.

smooth-core armatures, and moderate-sized ones with slotted cores, have practically level characteristics (Curve B, Fig. 1), whilst the larger slotted-armature motors (20 h.p. and upwards) have actually rising characteristics (Curve C, Fig. 1). These variations are due to the opposite effects of the C R lost volts in the armature winding and the armature reaction, both of which increase with the load, the former tending to reduce the speed and the latter to raise it. In the case of large slotted machines, which usually have a large armature reaction and few lost volts, the former entirely outweighs the latter, and the speed rises at full load.

No useful object would be served by fitting a shunt motor having a level or rising characteristic, as shown at B or at C (Fig. 1), with an opposing series winding, as the former is already running at constant speed, and the latter requires a series winding *helping* the shunt in order to run at constant speed. It is therefore only on motors with shunt characteristics like A (Fig. 1) that the opposing series winding would be applied, and even then the amount of this series winding would usually be very small. Thus, whilst an ordinary constant-voltage compound dynamo will usually require one-fifth to one-third as many series as shunt ampere-turns, and a compound motor (series and shunt windings in same direction) such as is commonly employed for lifts, hoists, single-motor cranes, etc., will usually have about the same proportion, a differential motor will seldom have a greater proportion than $\frac{1}{10}$. By putting on rather more series winding the speed can be made to rise as the load increases, as in Curve C (Fig. 1), but in such a case the motor is liable to give trouble in starting unless the starting switch is put on very slowly, and unless the torque required at starting never exceeds the full load torque. Such a motor would also have far less margin than a shunt motor as regards the amount of overload which it would stand before stopping.—Q.

Answer to No. 450 (*awarded* 5*s.*).—It is assumed that the connections of the starting resistance are as in Diagram 1.

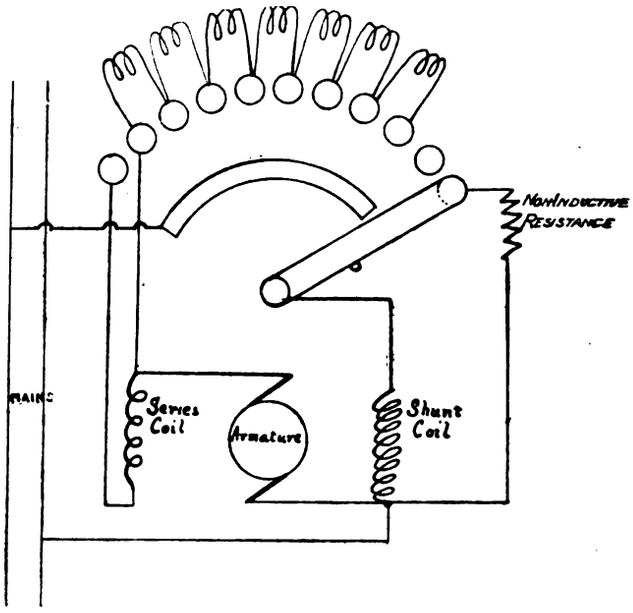

Fig. 1.

The series coil is only put in after the machine has obtained its full speed as a shunt motor. If this is not the case, with a badly proportioned starter large currents may be obtained both in the armature and the series field coils, thereby causing the machine to run backwards against the brushes.

1. *Characteristics on Starting.*—If the starter is as in the diagram, the characteristics on starting are those of an ordinary shunt motor. If it is not as in the diagram, and the starter is well proportioned, the machine will get up speed at a slower rate than a shunt motor of the same size. This is on account of the series turns in opposition to the shunt turns, thereby causing a relatively smaller induction. The result of this is that torque being directly dependent upon induction ($t = 1{\cdot}41\ M\ i$), the motor has less torque impressed upon it, and, therefore, it accelerates at a slower rate than it would do as a shunt machine. This would be

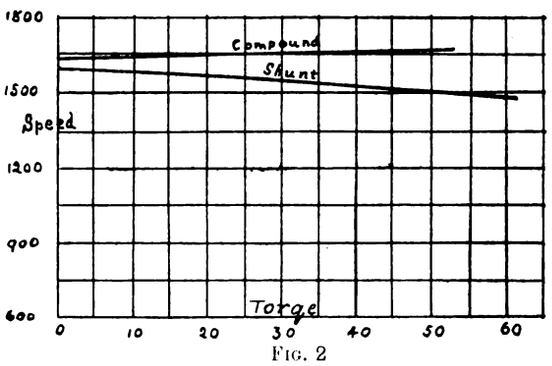

Fig. 2

a pronounced effect if the motor had to start under full load, as the ampere-turns of the series coil would here be a maximum.

2. *Working under Varying Load.*—If the series coil is well proportioned, the speed will be constant under all loads. This is on account of the fact that no decrease of speed is necessary to reduce the back E.M.F. at larger currents, as

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the series coil will reduce the field, and, therefore, the back E.M.F. a sufficient amount. In some compound motors the speed may increase with output. This is the case where a strong series coil obtains. Two curves are given (Diagram 2), showing the relation between torque and speed of a small motor (1) running as a shunt motor, (2) running as a compound motor with the series opposing the shunt.

The speed in Case 2 increases on account of the fact that the machine was originally intended as a dynamo and over-compounded for lighting at a distance. A compound motor is not as powerful as a shunt motor of the size, on account of the fact that the induction at the higher loads is not as great as in the case of a shunt motor. A compound motor, if too much overloaded, will lose its magnetism and stop. The cut-outs will also go.—T. T.

Answer to No. 450 (*awarded* 5*s.*).—The equation for the torque of a motor is

$$\tau = \frac{Z\,C\,N}{K},$$

where τ = torque, Z = turns of wire on armature, C = armature current, N = magnetic flux, and K is a coefficient depending upon the unit τ is required to be in.

From this it is apparent that the torque is directly proportional to the turns of wire, armature current, and magnetic flux. Now, the turns of wire in all ordinary motors being fixed, the torque will vary with C and N, and when both are at a maximum the torque will also be at its maximum. Thus a series motor exerts its greatest torque at starting. This also occurs with a cumulative-wound compound motor—that is, with the shunt and series coils magnetising in the same direction. It is obvious that the starting torque of a differentially-wound compound motor will not be so good; as a matter of fact, it is inferior in this respect to a well-designed shunt motor. There is a further objection to a

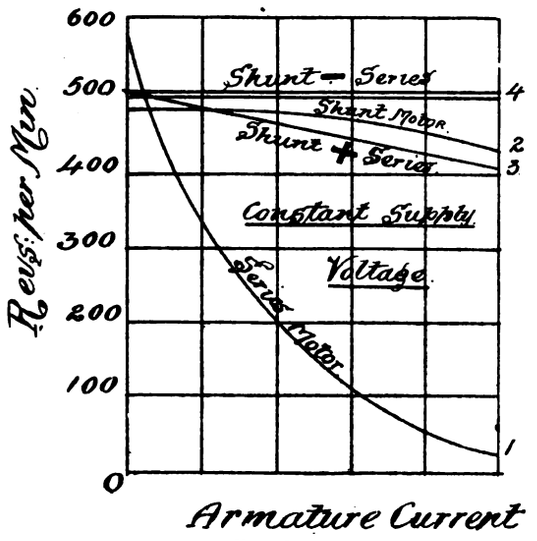

FIG. 1.

differentially-wound compound motor in the fact that it is liable to start in the wrong direction owing to the reversed series winding speed. With a constant pressure on the shunt the speed of a motor varies directly as the back E.M.F., and inversely as the armature current, therefore the speed tends to fall as the armature current rises, or if the speed is to remain constant the magnetic flux must be decreased. This can be accomplished either by inserting resistance in the field circuit or by putting series coils on the motor in opposition to the shunt coils. Thus a differentially compound-wound motor gives a practically constant speed. This will be evident from Curve 4 (Fig. 1), which gives characteristics (Curves 1, 2, 3, and 4) of series, shunt, cumulative, and differential compound motors respectively. From these curves it is evident that where perfect speed regulation is required, this is best attained by using a differential compound motor. But for ordinary practical purposes the shunt motor gives quite satisfactory speed regulation. Sometimes a differential compound motor with an arrangement for short-circuiting the series winding at starting is adopted; this obviates the liability of starting in the wrong direction referred to above. Compound-wound motors have not found any great favour in general use, excepting where a constant speed is required or where a combination of the good starting torque of the series motor with the speed regulation of the shunt is most suitable. In the first case a differential compound motor meets the requirements, and in the second a cumulative compound motor combines the two characteristics to a certain extent.—T. H.

TUNBRIDGE WELLS TELEPHONE ENQUIRY.

At the Town Hall, Tunbridge Wells, on Tuesday, a Local Government Board enquiry was held in respect of the application by the Town Council for powers to raise a further sum of £15,000 for the purpose of extending the system of municipal telephones which were established there six months ago. The proceedings created a great deal of interest in the town, and the large hall was crowded. The application was supported by all the local authorities through whose districts the Corporation's wires run, as well as the largest ratepayers in the borough, and the only opposition was on the part of a few gentlemen who have been antagonistic to the undertaking for some time past.

Mr. W. C. Cripps, the town clerk, in the course of his observations said so early as June, 1896, the question of telephonic communication in Tunbridge Wells came before the Town Council, and on the 3rd of that month the Council passed a resolution viewing with favour an application which was at that time being made to the Postmaster-General by the Tunbridge Wells Telephone Subscribers' Committee for a license to carry out a telephone exchange. At that particular period the only system in the borough was the National Telephone Company. In January, 1897, the Town Council again passed a resolution calling the attention of the Postmaster-General to the inadequacy and inefficiency of the local telephone service, and urging upon the Duke of Norfolk the necessity of granting a license to the local company. When, in June, 1898, the Government were contemplating the introduction of a Bill enabling facilities to be granted to town councils for establishing their own telephonic systems, the Council passed yet another resolution that it would be to the general public benefit if an Act of Parliament were passed for that purpose. When that Bill became law, the Town Council of Tunbridge Wells at once took steps to obtain a license from the Postmaster-General, and they succeeded in obtaining one. That license enabled the Corporation to establish a system in the borough of Tunbridge Wells and in the area of three other urban districts and rural districts. Application was made to the Local Government Board for a loan of £10,000 in March, 1901, and just six months ago the exchange was opened. In December the Town Council found it necessary to increase the capital, and they passed a resolution in favour of applying for another £15,000. It was a significant fact that when the first loan of £10,000 was considered by the Council the voting was 14 for and 12 against, but in December last, when this further loan was contemplated, it was agreed to unanimously by the 22 councillors present. From September, 1889, to March, 1891, the company then in existence in Tunbridge Wells was the South of England Telephone Company. In 1891, after three years' working, the company had obtained 62 subscribers in Tunbridge Wells, 2 at Tonbridge, and 3 at Southborough. The National Telephone Company absorbed them, and from 1893 to 1896 they increased the number of subscribers in Tunbridge Wells from 62 to 90, Tonbridge 2 to 17, and Southborough 3 to 5, making a total of 112 subscribers. Then came the local agitation, and they extended their lines to 349. The Corporation opened their system on July 27, 1901, and obtained 240 subscribers at once. From that time until February, 1902, the competition, in the words of the report of the Select Committee, had been "effective," and the effect had been this: the National Telephone Company now had 624 lines and the Corporation 533. In these figures he had excluded what were called internal extensions so far as the Corporation were concerned, but he believed the National Telephone Company had included them in their figure. From 1896 the number of subscribers had increased from 112 to 1,200—on both systems, of course. With regard to the rates charged by the two systems, in January, 1896, at the commencement of this agitation, the National Telephone Company were charging £10 for the whole of the district and £8 for Tunbridge Wells alone. At the present time he should be very much surprised if there was a single person paying £10 or £8. A month before the Corporation exchange was opened, the National Telephone Company, whilst retaining these rates, brought out a new one of £4 for 5,000 messages, a maximum he did not believe one person in a hundred in Tunbridge Wells would ever exceed. Beyond 5,000 calls they charged 6d. per 100—a charge which would not pay for the entering and collecting. They also adopted the party-line system, by which from 15 to 20 people used one line and were put to a great deal of misery in consequence, as might readily be imagined. The National Telephone Company now admitted that Tunbridge Wells had the best telephone service of any town in the kingdom, an admission in which the Corporation joined. When the Corporation applied for the £10,000 loan, it was estimated that they could put up a system for 300 subscribers, but at the present moment they had no less than 533 revenue-bearing lines, and 283 persons were waiting to be connected up, making a total of 816. Between Dec. 9, 1901, and Jan. 12, 1902, they had increased the overhead metallic circuits from 444 to 539, and the underground metallic circuits from 723 to 741, and other items had gone up in proportion. The average number of calls had increased from 700 to 904 and they did not multiply these

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by 2, as the National Telephone Company did. The number of subscribers who had the "flat" or £5. 17s. 6d. rate had risen from 170 to 206. He thought such a progress during the past six weeks for an undertaking so young was somewhat remarkable. The ratable value represented by subscribers was over £50,000 in the borough alone. He had endeavoured to show them why it was necessary that they should increase the capital of the undertaking, and he might tell them that the work already accomplished and in hand represented £19,320, so that they needed £5,680 to make the £25,000. It might be suggested that they had done wrong in carrying out the work without first obtaining the money. Well, they had been the victims of circumstances, or, rather, they had been fortunate. The moment the exchange was opened the applications commenced to flow in, and from the 300 they originally estimated for they had gone to 533, and there were 283 more to come on as soon as they could be connected. It was only by pushing the thing in an ordinary business-like way that they had been able to accomplish this. With regard to the opposition which was being raised that morning, he should like to point out that this was the first time any objection had been raised, and he thought that the results of the first six months' working was quite sufficient answer to the objections which were now being put forward. Calculating upon the results of the first six months, it was estimated that at the end of the first year there would be a surplus of £1,086, after allowing for maintenance, inspection, reduction of loans, and other charges. Having regard to what he had told them that morning, and the facts which would be spoken to by the consulting engineer and the borough accountant, he thought there was every reason why the Board should grant this loan, and thus enable the successful undertaking to become even a greater success.

Mr. A. R. Bennett, the consulting engineer to the Corporation, in the course of his evidence, stated in his original estimate he provided for 319 lines, which worked out at £17. 10s. per line. Since then he had issued a supplementary estimate in which the cost worked out at £21. 10s. Originally he estimated for 4½ miles of cable, but there had been nine miles put in. In putting in the cables beneath the paths they encountered various difficulties, and they had had to go into the roadway, which had added to the expense. In putting up the overhead wires they had had to make several detours, which had all added to the cost. They were now proposing to link up some more of the rural districts in the area, and it was for the purpose of undertaking these extensions that the present application was being made. It was very necessary that these extensions should be carried out without much delay, as the National Telephone Company were doing their utmost to get in front of the Corporation.

Replying to questions by Mr. Thorn Drury, barrister, who opposed the application, Mr. Bennett said his appointments in these cases were dependent upon the schemes being carried out. He denied with a good deal of warmth the suggestion that he went about the country recommending municipalities to undertake telephonic schemes. He was now advising the Eastbourne Corporation, but they approached him in the first instance. The scheme now working at Tunbridge Wells was a first-class one and up to date. The Manchester Mutual was also a first-class scheme. It did not work out at a cost of £35 per line, although he was aware that Mr. Forbes, of the National Telephone Company, had said many times that it did. Mr. Forbes, however, was a man who had made some very great mistakes.

Mr. Drury: Is he a reliable and credible man?

Mr. Bennett: I cannot give general testimonials like that.

The **Inspector** asked Mr. Drury what it was he wished to convey by his cross-examination?

Mr. Drury said he was endeavouring to show that the scheme which had been carried out at Tunbridge Wells was not a sound one. He was then proceeding to further question Mr. Bennett with regard to the Glasgow enquiry and certain statements he made there, when

The **Inspector** said he thought that they had had enough of that. They wanted to get to business.

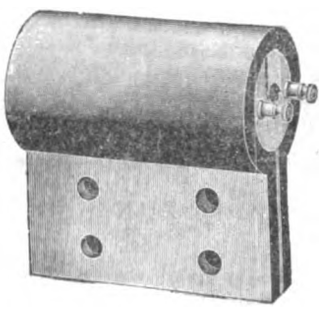
Replying to further questions, **Mr. Bennett** admitted that telephony made very rapid strides, but he did not anticipate that in a few years' time the whole of the system at Tunbridge Wells would need to be renewed. The system was constructed of the best possible materials, but he must admit that he had had to go abroad for some of the materials. They had had to get some instruments from abroad owing to the unsatisfactory character of some of the instruments supplied by an English firm. The fault of these instruments was that they were not put together properly. He was very sorry for this, because he was a great champion of home industry. He had been consulting engineer to the Dover Corporation, and in that case he advised the Corporation not to proceed, and they adopted his recommendation. He did not know anything about Sir William Preece in that matter. In the Tunbridge Wells undertaking he had been astonished at the rate of progress, for in less than six months they had obtained nearly three times as many subscribers than they originally anticipated. With regard to the cables which had been put in, they were of the armoured pattern, and were likely to have a long life. A great deal depended upon the locality as to the necessity of putting the cables in pipes. If there was likely to be a large number of subscribers in a small area, then it was desirable to have the cable in pipes, because it was so much easier to draw in a new cable when it was necessary to extend the service. In Tunbridge Wells he considered that the cables laid into the earth was the best plan, and he was quite prepared to stand by it. In his estimate he had allowed 2 per cent. for repairs and inspection. He considered that was quite sufficient. He did not anticipate gales or blizzards doing much damage, as they did not frequently occur. He was now advising the Portsmouth Corporation, but he had not told them that it was necessary to have a £5. 7s. 6d. rate. He said that it would be desirable for certain reasons. The Portsmouth undertaking was about three times the size of that at Tunbridge Wells. He was more than satisfied with the progress Tunbridge Wells had made.

The enquiry was then adjourned until March 6.

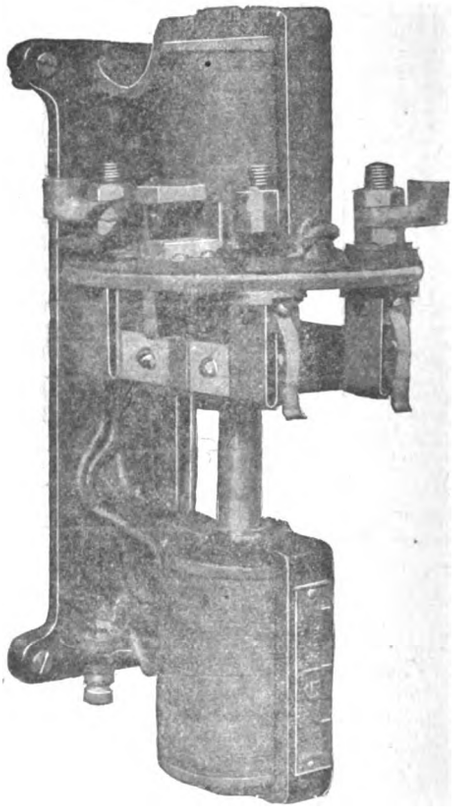
TRADE NOTICES AND NOVELTIES.

Blackwell Specialities.

We have received from Messrs. Robert W. Blackwell and Co., Limited, 59, City-road, London, E.C., a copy of their catalogue No. 43, which contains information relating to Whitney electrical measuring instruments, motors and dynamos, controlling rheostats automatic switches, enclosed fuses, "Packard" incandescent lamps, etc. The first of the accompanying illustrations taken from this catalogue represents a series transformer for alternating-current instruments. These transformers perform for alternating-current instruments



the same function that shunts do for direct-current ones. They are bolted directly to the 'bus bars, and light wires of any requisite length run from them to the meters. The transformers of this type listed range in capacity from 500 to 10,000 amperes. The second illustration herewith shows an automatic distance switch. This, it will be seen, consists of two solenoids held firmly in an iron frame, the switch contacts being mounted and rigidly fixed to the movable iron core. The latter is free to move either up or down, and is electrically operated by passing current through the upper or lower coils. These coils are placed in circuit with a two-way push-button switch, which may either be connected to an exterior circuit or worked from the main switch. One button operates the upper coil, the other the lower coil, thus switching "on" or "off" as desired.



Immediately the operation is completed this exterior circuit is broken on a carbon break, it being impossible to maintain the current through either coil, and so burn up or damage them in any way. The iron frame which forms the mounting acts as a return path for the lines of force, increasing the "pull" on the iron core. During the period of opening or closing of the switch this "pull" continually increases until it reaches a maximum at the end of the stroke. This is an extremely important and very essential feature, as any sluggishness would cause excessive arcing and pitting at the contacts, when necessarily the blades of the switch would not make clean contact in the contact clips. At the side of these contact clips are catchers are provided, serving to further preserve them. The illustration shows a 100-ampere three-wire switch suitable for three-wire systems, but the switch is standardised in either single, double, or triple pole, for any capacity, voltage, or system, and for either direct or alternating current circuits. Ordinarily, about 150 to 200 watts are required to operate it, but this is a momentary current only. Attention is also called to two new depar

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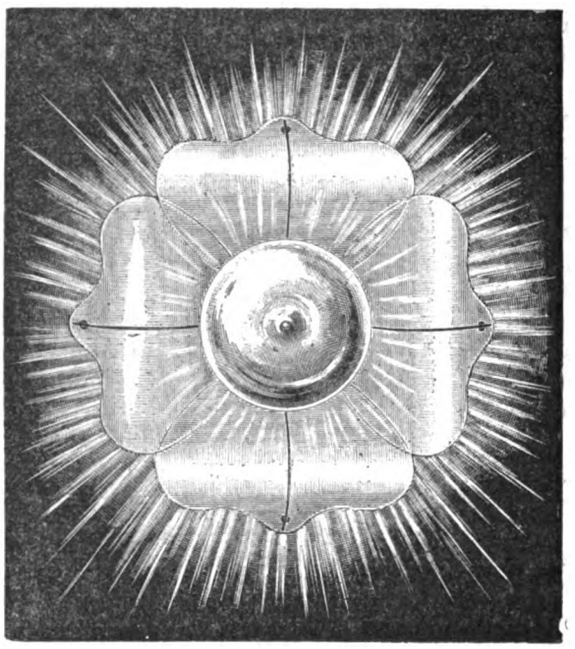
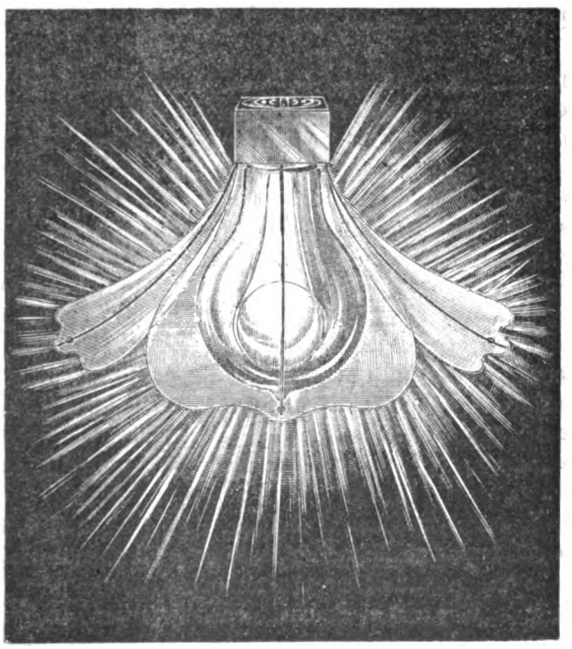
tures in the manufacture of shunts for switchboard instruments. The first is that all give exactly the same drop (50 millivolts) across the contact studs with full rated load, thus rendering them interchangeable. The second is that they are made of a metal having a temperature coefficient midway in value between that of copper and zero, thereby ensuring a much greater average accuracy under commercial variations in temperature than German-silver or copper shunts. Moreover, four times the radiating surface usually allowed per watt dissipated is used, so that the shunt can carry full load continuously without heating appreciably.

The "Micaylorite" Reflector.

The accompanying illustrations will convey to the reader's mind some idea of a simple but effective little reflector just introduced by Messrs. Taylor and Co., mica merchants, 19, Hatton-garden, London, E.C. A very few words will suffice to describe the construction of this reflector, which will be known to the trade as the "Micaylorite."



It consists of four petal-like vanes of clear mica, bent outwardly as shown, and held in place by means of a square collar of brass, which latter serves also to grip the lamp-holder when the reflector is in position. Hence the attachment of the reflector entails no derangement of the lamp fittings, but simply the withdrawal of the lamp and its reinsertion after the collar of the reflector has been slipped over the holder. We have seen a number of these reflectors in use, and can testify as to the flower-like and charming effect produced. This has its explanation in that the lamp



filament is vividly reflected in each of the mica vanes, the result being remarkably pleasing, but no attempt has been made to reproduce the effect in the illustration herewith. In virtue of the semi-transparency of mica a useful amount of side-light is also obtained, while no appreciable shadow is cast. Being made of material which is practically indestructible, the reflector lends itself especially for outdoor work, and as a means of enhancing the brilliancy of sky-sign illuminations will no doubt find favour, while the non-conducting attributes of mica should recommend its employment where it is desired to place lamps in close proximity to inflammable materials. Having regard to the forthcoming national festivities in June next, the introduction of this simple contrivance is timely, and its obvious value for decorative purposes should therefore alone ensure its success in the near future.

Cable Calculator.

We have received from Messrs. Isidor Frankenburg, Limited, Greengate Rubber Works, Salford, a "cable calculator," by means of which it is very easy to calculate accurately the cost of any length of any size or class of wire and cable whose listed price is between £15 and £650 per mile. The method of using the calculator does not require much teaching. It is only necessary to place the price per mile—which is found on one or other of the sides of the inner slide—opposite the required length (as given at the upper, or lower, edges of the opening in the outside cover); and the gross price for such length will be found between the short black lines at either of the two upper or lower windows, according as the length needed is on the upper or lower edge of the opening. This calculator should be very useful for calculating estimates and tenders.

FORTHCOMING EVENTS.

FRIDAY, FEB. 14.

Physical Society of London.—At 5 p.m., annual general meeting. Address by Prof. S. P. Thompson (president), to be followed by an ordinary meeting, at which Mr. T. H. Littlewood will exhibit an Atwood's machine.

SATURDAY, FEB. 15.

Royal Institution.—At 3 p.m., Lord Rayleigh on "Some Electrical Developments."

MONDAY, FEB. 17.

London School of Economics.—At 6.15 p.m., 10, Adelphi-terrace, Mr. L. Macassey on "Electric Traction on Railways" (Lecture II.).

Institution of Electrical Engineers (Newcastle Section).—Ordinary meeting. Paper: "Equipment of a Modern Telephone Exchange," by Mr. F. A. S. Wormull.

TUESDAY, FEB. 18.

Royal Institution.—At 3 p.m., Dr. Allan MacFayden on "The Cell: Its Means of Offence and Defence" (Lecture VI.).

Institution of Electrical Engineers (Glasgow Section).—First annual dinner. (Manchester Section): At 7.30 p.m., ordinary meeting. Paper: "The Construction of English and Foreign High-Tension Central-Station Switch Gear," by Mr. R. W. Clothier."

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper: "Electrical Traction on Railways," by Messrs. W. M. Mordey and B. M. Jenkin.

WEDNESDAY, FEB. 19.

Royal Meteorological Society.—At 7.30 p.m., ordinary meeting. Papers: "Report on the Phenological Observations for 1901," by Mr. Ed. Mawby, and "La Lune mange les Nuages—a Note on the Thermal Relations of Floating Clouds," by Mr. W. N. Shaw.

Institution of Electrical Engineers (Students' Section). — At 7.30 p.m., ordinary meeting. Paper: "Electrical Equipment of Printers' Machinery," by Mr. E. W. Short.

Society of Arts. — At 8 p.m., ordinary meeting. Paper: "The Use of Balloons in War," by Mr. E. S. Bruce.

Institution of Civil Engineers.—At 2.30 p.m., Students' visit to the works of Messrs. J. I. Thornycroft and Co., Chiswick.

THURSDAY, FEB. 20.

Municipal Electrical Association. — At 3 p.m., Westminster Palace Hotel, special general meeting.

Institution of Electrical Engineers (Dublin Section). — At 7.30 p.m., ordinary meeting. Paper: "Notes on Irish Water Power and its Electrical Development," by Mr. W. Tatlow.

Carpenters' Hall.—At 8 p.m., Prof. J. A. Fleming on "Trans-Oceanic Telegraphy by Ether Waves."

FRIDAY, FEB. 21.

Royal Institution.—At 9 p.m., Mr. W. Duddell on "Musical and Talking Electric Arcs."

Institution of Mechanical Engineers.—At 8 p.m., annual general meeting, followed by special meeting. Paper to be further discussed: "Modern Machine Methods," by Mr. H. F. L. Orcutt. If time permit the following papers will be read: "Fencing of Steam and Gas Engines," by Mr. Henry D. Marshall; "Fencing or Guarding Machinery used in Textile Factories," by Mr. Samuel R. Platt; "Protection of Lift-Shafts, and Safety Devices in connection with Lift-Doors and Controlling Gear," by Mr. Henry C. Walker; "Guarding Machine Tools," by Mr. W. H. Johnson.

SATURDAY, FEB. 22.

North-East Coast Institution of Engineers.—General meeting at Newcastle.

Royal Institution.—At 3 p.m., Lord Rayleigh on "Some Electrical Developments" (Lecture II.).

Manchester Association of Engineers.—Ordinary meeting. Paper: "Intensified Gas Lighting," by Mr. J. Nasmith.

Institution of Electrical Engineers.—At 12.15 p.m., students visit to the Bankside station of the City of London Electric Lighting Company.

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TO CORRESPONDENTS.

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THE GROWTH OF COMMUNITIES.

The present tendency of grouping together rival firms in any industry has many advantages and disadvantages. Its main advantage is that wholesale economies can often be effected which force weaker undertakings of the same class to the wall. In this way the "survival of the fittest" is now exemplified by the rapid dying off of weaklings unfitted to withstand modern competition. When, however, the combination of interests aims at the artificial increase of prices or of demand the same result is not obtained, as unstable conditions are set up temporarily. This has been the case with the electrical industry on the Continent, as is shown by the present crisis in Germany. The same reasoning may be applied to the growth of towns. Where local conditions are favourable to the establishment of a large industrial community, the common prosperity is assisted by the increase in the population of the same. It by no means follows, however, that this increase of population, if continued, is bound to be advantageous to all classes of the community. This problem was treated by Mr. W. L. Madgen in a paper before the Society of Arts on Wednesday last, entitled "Industrial Redistribution and its Connection with the Overcrowding Question." In this he showed that already there has been a considerable migration of industries out of London, and that there were still large manufacturing firms in the London area who are labouring at a disadvantage compared with their rivals in the country. Thus in the early days of electrical engineering all the more important manufacturing works were in London. These have now practically all moved into the Midlands, and even Messrs. Siemens Bros. and Co. have found it more advantageous to erect new works at Stafford rather than to extend the large factories which they have used for years at Woolwich. But it must be borne in mind that no general conclusions should be drawn as applied to all classes of industry, as the Woolwich district still holds the field for the manufacturing of submarine cables, in which a large quantity of unskilled labour is required. The great disadvantage of unduly large towns is that the costs of living go up as the housing facilities decrease. The result leads to insanitary areas being overcrowded, and so far in London there has been little progress made towards the solution of this problem. The attempts at the solution of the same by the London County Council show how difficult the problem is, as when insanitary areas are cleared the new and sanitary buildings erected do not accommodate the displaced population. Also, the financial side of the housing schemes of this authority will not bear criticism, as it amounts to the provision of rate-assisted dwellings for a particular class. The erection of artisans' dwellings in the suburbs, combined with cheap transport facilities for the artisans, is only a palliative, as even the low fares are prohibitive to the labourer class. Mr. Madgen's solution of the trouble is that there should be a larger migration of industries to the provinces. For this he demands the following inducements: (1) the provision of cheap power for driving machinery; (2) increased traffic facilities by means of light railways; (3) the improvement of the canal system by the use of mechanical haulage, etc.; (4) the intelligent design of industrial building estates. He then echoes the cry so often heard of late, that many of our municipalities are opposed to the establishment of power distribution schemes, and also of the light railway schemes so required. This is so to a qualified extent, but the opposition arises, as a rule, to these undertakings being in the hands of certain companies. Mr. Madgen thinks that if these companies are obstructed, the whole country will go to ruin. We do not share this opinion. When the large manufac-

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turing interests demand these facilities they get them. Any obstruction of municipalities will not stop progress, but will drive the factories out into areas beyond the control of such bodies. In fact, the opposition tends to prevent the overcrowding of large towns rather than to increase it.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

CHAUVIN AND ARNOUX INSTRUMENTS.

SIR,—A paragraph appears in your issue of the 7th inst. to the effect that Messrs Giepel and Lange, of Westminster, have been appointed sole agents in the United Kingdom and English Colonies for the sale of the electrical testing and measuring instruments made by Messrs. Chauvin and Arnoux, of Paris. This statement is incorrect, as my clients, Messrs. H. M. Salmony and Co., Limited, of New Compton-street, are sole agents for Messrs. Chauvin of these instruments. Messrs. Chauvin have purported to transfer the agency from my client to Messrs. Geipel and Co., but I am advised that no circumstances have arisen entitling them to make such transfer, and my clients have instructed me to assert their legal rights. The paragraph as it appears in your issue is calculated to do my clients considerable damage, and unless it is at once contradicted my clients will hold you responsible for the publication of the paragraph in question.—Yours, etc.,

F. C. LINGARD.

[N.B.—We insert the above letter from the solicitor of Messrs. H. M. Salmony and Co. as requested, and it must be read as contradicting our note of last week.—ED., *E. E.*]

"WHEN DOCTORS DISAGREE."

SIR,—Under the above heading in your issue dated the 7th inst., you mention the discussion which arose after the reading of Mr. Earle's paper on "The Supply of Electricity in Bulk." Firstly, you credit me with being one of Mr. Earle's supporters, and you place Mr. Sturgeon in the opposite camp. Should not these names be transposed? Secondly, you say "Mr. Clirehugh instanced the rate charged by the Trafford Park Power Company to the Lancashire Dynamo Company as being ¾d. per unit, which would come out at £1. 6s. per horse-power per annum." Are these figures correct? If ¾d. is the price per unit, and the works are running 56 hours per week and 52 weeks per annum, would not the result be as follows:

$\frac{\cdot 75 \times \cdot 75 \times 56 \times 52}{240}$; £6. 8s. or £6. 16s. per h.p. per annum.

The ¾d. per unit I can understand, but it is hardly fair to give publicity to a statement that the Trafford Park Power Company is supplying power at £1. 6s. per horse-power per annum without some qualification, especially as that company is just now asking the public to subscribe funds to develop its undertaking into a large power works.

I hope this and similar companies will be successful, but such statements as the one above are certainly misleading.—Yours, etc.,

J. E. PANTON.

Bolton, Feb. 10, 1902.

[N.B.—Dr. Panton's figures are substantially correct, and we think that Mr. Clirehugh should qualify his remarks respecting the works demanding 230 h.p., and paying £306 per annum.—ED. *E. E.*]

REVIEWS.

Graduated Exercises in Elementary Practical Physics. By CLEMENT J. LEAPER. London: Biggs and Co.

It is with something like a feeling of envy, mingled with satisfaction, that some of the old workers, whose love for science enabled them to overcome with much labour and brain-sweat the elementary difficulties with which its path is strewn, will view the manifold advantages and aids to study offered to a younger generation. To have access to the instruments and apparatus—for the most part simple and inexpensive—pictured in the above work of some 260 pages, together with its author's clear and concise guidance in performing the experiments—also for the most part simple and satisfactory—given in the form of graduated exercises, is a privilege which can scarcely be over-appreciated by those who are anxious to obtain the "key to nature" offered by physical science. Never in the old days, in our experience, was the value of the ratio π impressed upon the young student by the natural and rational method of making him measure the circumference and the diameter of a disc or cylinder, as on p. 2 of the present work. He was simply told to note the integer 3 followed by a string of decimals, and to remember them; which, except in phenomenal cases, he never did. Fortunately, there was a well-known story about Prof. De Morgan, of King's College, and a mathematical cabman, whose mnemonic device was often brought into requisition. "You take the first three odd numbers two by two," said the cabman, "and then divide them into two lots of three figures, and put the first lot underneath the second, $\frac{355}{113}$, and that equals *pi*." So it does, nearly; and would do so more nearly if its value in the fifth place of decimals were 9 instead of 8.

The work is divided into three parts, and, by the way, would be all the better for a table of contents, showing at a glance the problems treated in each division. Part I., comprising 94 pages, relates to mensuration and mechanics; Part II. (71 pages) is devoted to problems on heat, light, and sound; and Part III. (96 pages) gives a number of experiments and explanations relating to magnetism and electricity. The following (p. 10) is a useful hint which we do not remember to have seen elsewhere: "Care must be taken that the inside of the 100 cubic centimetre measure is first wetted (before filling with a known volume in fluid ounces), as such measures are graduated so that they measure the volume of liquid which they *have delivered*, and which is less than the volume which they *contain*, when filled to the same level, by the amount of liquid needed to wet the measure."

In some works of a similar character to that under notice, no demonstrations are given of the laws of falling bodies. In the present work these are perhaps sufficiently illustrated for the purpose in view by means of a simplified form of Atwood's machine. No direct demonstration, however, is given of the equivalence of the respective expressions for work, potential energy, and kinetic energy. But on pp. 15, 18, and 32 the student is guarded against any error so glaring as that which was pertinaciously adhered to for a long period by a fellow-student of our own in the days of long ago. This young gentleman, disregarding the advice of his more prudent colleagues to accept the equations in mechanical dynamics as articles of faith, somehow got it into his head that *work* is measured, not by F L, but by F T. Not only that, but he undertook to maintain his propositions against all comers, and algebra, in large doses, had apparently no curative effect. His argument, so to call it, was that five men can do in a given time five times the work of one man in the same time, and that one man in a fivefold period of time can do the work of the aforesaid five men. And this because five men can exert five times the *force* of one man, and one-fifth of their force exerted for a fivefold period would do the same amount of work. Proselytes even were found so long as, in the so-called argument and experimental tests, mass was varied approximately as the number of men, and *vice versâ*—*i.e.*, so long as V was maintained within small limits. At length the theory suddenly collapsed when it was shown that one man, exerting his normal amount of force on the mass that had been moved by five men, *did no appreciable work*, whatever might be the value of T; and that five men, in attempting to exert a fivefold force upon the mass, now moving with considerable velocity, that had been acted upon by one man, had to "give up," by reason of complete exhaustion, declaring with truth that they had been doing more than *five times the amount of work* they had bargained for.

The experimental illustrations of the measurement of

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the relative densities of liquids and of the densities of solids by the method of Archimedes will be readily understood by the learner, and are likely to lead to the adoption of this method in practical work. Incidentally, the question as to why the hydrometer of Beaumé should be in such general use, more especially abroad, is answered by pointing out that its range is greater than that of more simple and cheaper hydrometers.

Our space will not allow of any reference in detail to the experiments in relation to heat, light, and sound in Part II. of the work, the description of which involves a large amount of careful labour on the part of the author. We are, however, called upon to notice at some length Part III., which is devoted to experimental work in magnetism and electricity. The construction and use are first described of various magnetometers based upon the method of deflections—indicated either by means of a graduated circle or the reflection of a ray of light from a mirror—upon the method of vibrations, or upon that of torsion. The dip circle, or inclinometer, and the law of the solenoid, are next referred to; and we then come to the very important section on electromagnetic—or, as we should prefer to call it, magneto-electric—induction. We should have been pleased to see this section very considerably extended. So far as it goes, the information afforded (pp. 186-8) is very concisely put and valuable. But it is incomplete; and the illustrations given, as well as the omission of certain fundamental facts, tend to increase rather than to remove the manifold difficulties which the student has had to encounter in obtaining a clear comprehension of the subject.* What is valuable is the statement to enable the learner to memorise the directions of the momentary current induced in a conductor forming portion of a circuit when this conductor cuts the lines of force in the terrestrial magnetic field. This is as follows: "Consider only that portion of the circuit which is in motion relatively to the lines of force; make the lines round that portion have the same direction as they would have if the lines actually encircled that portion of the circuit, and make the current round the circuit agree with the direction of such lines." But nowhere in the present work is the learner instructed *how* to make the current agree with the direction of the lines. It may be said that the learner is supposed to know that when the lines of magnetic force surrounding a conductor are so viewed that their positive direction is that of the hands of a watch, then the direction of the current is away from the observer, and *vice versâ*, and, moreover, that this knowledge may be derived from an intelligent inspection of the diagrams given. But it is precisely such assumptions that render the path of the learner so difficult. Then, as to the experimental illustrations given, the motion of a conductor cutting the lines of force near a pole, or between the poles, of a steel magnet or a solenoid is not the same thing as the motion of a conductor cutting the lines of force in a terrestrial magnetic field. Indeed, we think it most important, in regard to the application of theory to practice, the student should understand that, in the passage of a conductor across the pole of a bar magnet, or between the poles of a horseshoe magnet, four induction currents, all tending to resist the motion, are in reality produced—viz., an inverse current (repelling) as the conductor approaches the pole, a direct current (attracting the hypothetical current around the pole), a second inverse current (repelling the hypothetical current) prior to the completion of the passage across the pole, and, lastly, a direct current (attracting) which resists the passage of the conductor away from the pole; whereas in the terrestrial field two currents only can be induced by motion in a given direction—viz., one when the motion commences, and the other when the motion is arrested

The present writer would not be surprised to find that the notions derived by students from text-books as to the direction of the terrestrial lines of magnetic force are, in the present as in the past, of a somewhat indeterminate and unsettled character. When they have mastered the facts that the positive direction of the lines of force within a magnet is *in* at the S pole and *out* at the N pole, that the latter pole is the one which tends to point nearly to geographical north, and the hypothetical current around which, when it faces the observer, is in the direction opposite to that of the hands of a watch, and that the geographical north pole is, magnetically speaking, a S pole, they are naturally inclined to be quite confident that the direction of the terrestrial lines of force must be from geographical north to geographical south—*i.e.*, *in* at the magnetic S and *out* at the magnetic N pole. So, indeed, they are, *within* the terrestrial magnet; but what the student often does not realise, and what, as a rule, he is *never told*, is that in the terrestrial atmosphere we have to deal with the lines of force in what may be termed the external portion of the earth's magnetic circuit, and in this portion the direction of the lines of force is *reversed*. Thus, in the earth's atmosphere the lines of magnetic force pass as curves in the direction from geographical south to geographical north—*i.e.*, from magnetic N to magnetic S. In many cases it would be a most kindly and charitable action to supply the learner with this simple information.

Mr. Leaper does not attempt to substitute either "north-seeking" or "austral" for the term "north" applied to the marked pole of a magnet. It may be regretted that the latter substitution was not many years ago adopted in this country, but we think it is quite certain that no alteration of the accepted terminology would now obtain any general acceptance. The method of determining the *restivity* of a material is clearly exemplified, but the old method of expressing the *specific resistance* of conductors in terms of that of pure annealed copper as unity is so convenient in practice, that it cannot be altogether superseded by the more novel system. The articles on the "Efficiency of an Electric Motor," the "Efficiency of a Dynamo-Electric Machine," the "Determination of Permeability," are of practical value, and their titles may be taken as indicating the scope of that portion of the work devoted to experimental work in electricity.

* In one popular text-book, at least, the directions of the hypothetical currents round the north and the south poles of a magnet were *reversed*. This, no doubt, was due to the fact that the engraver simply copied on the wood block the diagram giving these directions correctly; and the mistake was rectified in subsequent editions of the work; but, nevertheless, the reversal of these hypothetical currents, when the wood block was used in printing, was for years a source of mystification nd mental worry to a great number of learners.

MANAGEMENT OF DYNAMO-ELECTRIC MACHINES.

BY P. E. MOOCK.

This subject having been assigned to me, and rather insisted upon, I will proceed to give you nothing very elaborate, but a few simple facts as gleaned by actual experience I would say, also, this article is not intended so much for the wise as for the novice.

Speaking of the management of dynamos, it always reminds me of the young man who, being put in charge of a dynamo, worried a great deal, imagined there was something wrong or going to happen, finally wrote to his engineer friend for information and advice. His friend answered his letter, and, among other things, said if his dynamo was free from grease and dirt, and the wires all properly connected, he would have no more trouble with it than with a buzz saw. This advice, though a dozen or more years old, has always served me a good purpose, as it helped to set forth the real simple construction of the dynamo.

We will take the direct-current, low-voltage station generator, such as is used on the three-wire system for lighting. In my experience four-fifths of all care and attention necessary for the proper running of these machines—yes, I might say all machines—must be applied to the commutator. Let us stop for a moment and consider the simplicity of a dynamo. At least, in a mechanical way, there is nothing but a cylinder or drum supported by two bearings, with a pulley on one end by which it can be driven. This cylinder, as we will call it, and for this reason, as well as electrically, it must be kept in the centre of rotation. This is very important, as if the cylinder ran too close to the side caused by the pull of the belt, so as to cause the winding carried by it to touch at more than one place, it would be likely to arc and be the

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means of a very serious burn-out. Thus it is necessary to see that the bearings are not unduly worn, or if they should accidentally become so they should immediately be replaced with a new one, or the old one taken out and repaired. To my knowledge several armatures have been burned out from this cause

Returning to the commutator, it is absolutely necessary that it be kept nice and clean and smooth at all times, and if necessary to keep it so, use sand-paper every time the current is off. But be sure and apply it with a concave block cut to a true circle of the commutator. Do not apply sand-paper while brushes are resting on commutator, except it be a desperate case. You probably have noticed that the commutator of all dynamos wears away faster at either edge of the segment than in the centre, caused by sparking, not because of making and breaking the circuit, for the brush contact is wide enough to bridge across, but for the reason that copper wears away faster than mica, and as the mica projects above the copper (just a trifle, of course), each time the mica passes under the brush it is slightly raised, thereby impairing the contact and causing sparking. This at first is very slight, but if neglected soon becomes worse and makes the commutator very rough and uneven, as each spark takes away a small particle of copper corresponding to the size of the spark, thus lowering the copper, and as the mica is not affected by sparking it remains high. Thus the process goes on until it ends in a lathe, only to be gone over again in the same manner. The remedy for this is the hollow block, vigorously applied, which cuts down the mica and only smooths up the copper.

The brushes are next of importance to the commutator, and should at all times be watched by the attendant. They should be placed so as to bear on a horizontal line lengthwise on the commutator, and never allowed to fray out or spread over too large an area of the commutator, for if contact surface becomes too wide, a part of current generated passes around cells through brushes, thus unduly heating the armature. A good rule for woven-wire copper brushes such as are used on old-style machines, is to trim on both sides, and as they wear away turn them upside down. On nearly all modern machines carbon brushes are used, and if brush area is large enough to carry current without heating there will be little or no trouble. However, it is very essential when first starting to see that they are properly set at non-sparking point, the commutator cleaned frequently, and that they bear properly on the commmutator. This is best done by binding a piece of coarse sand-paper around the commutator, letting the brushes down on same with ordinary spring tension, and then slowly turning the armature. Carbon brushes should at no time carry more than 30 amperes to the square inch of contact area, while about 18 to the square inch would be much better, and even then they should have a good contact solid to the brush-holder.

A good motto to hang in the dynamo-room would be "To keep an eye on the commutator brushes."

The direct-current dynamo is composed of three classes, first, shunt-wound; second, series-wound; and third, compound-wound, which, as the word implies, is simply a combination of the first two. The series is used mostly for arc lighting; the shunt and compound for incandescent and power.

A word on coupling of these machines may be of interest. The shunt machine is most simple of operation, to be connected in either series or parallel, the parallel being daily practised in nearly all central and generating stations, the only precaution necessary being as each new dynamo is switched in service the voltage be brought to or nearly the same as the ones already in service. Series-wound dynamos will run satisfactorily together without special precautions when connected in series, the positive terminal of one dynamo being connected to the negative terminal of the other, and the two outer terminals to the two main conductors through ammeter, fuse, and switch.

As before stated, compound dynamos are a combination of the shunt and series, and as no special difficulties are experienced in running these latter in series, it is obvious that under similar circumstances they can be coupled together with equal facility, it being only necessary to connect the series coils in series with each other. Compound machines will also run very satisfactorily in parallel by having all their positive terminals connected by an equalising wire of exactly the same resistance between each machine.

During last summer I was called upon to connect a 115-volt lighting machine, shunt wound, on a 520-volt street railway circuit, compound wound. This at first looked very hard to do successfully, but after setting to work and making proper connection, it was found very simple. Three machines were used, two 125 volts each and one 250, the three connected in series, with the extreme positive and negative connected to trolley and ground respectively, which put the shunt machines in parallel with compound wound at street railway end. The stations were at least a mile apart, and it was found that a nearly constant load was maintained with the shunt machines, the variation being taken by the compound machines. Later in the summer three separate generating sets were connected together, consisting of the two first-named and another set eight miles distant, composed of two multipolar 100-kw. Westinghouse, which gave the very best results, there being no trouble experienced whatever.—*Power.*

APPOINTMENTS VACANT.

General Traffic Manager, Wolverhampton Corporation Tramways, £250 per annum, Feb. 15.

Switchboard Attendant, Carlisle electric light and power station, 25s. per week, Feb. 17. Full particulars in our advertisement columns.

Assistant Electrical Engineer, York Corporation, £150 per annum, Feb. 15. Full particulars in our advertisement columns.

Borough Electrical Engineer, Croydon Corporation, £400 per annum, rising by annual increments of £25 to £600, Feb. 27. Full particulars in our advertisement columns.

Foreman, firm of rubber manufacturers about to manufacture rubber-covered electric wires and cables. Full particulars in our advertisement columns.

Wireman and Improver. Full particulars in our advertisement columns.

Estimating Clerk, large electrical engineering firm in Manchester district; one accustomed to switchboard estimating work preferred. Full particulars in our advertisement columns.

Assistant Draughtsman, Newton Electric Works, Limited, Taunton. Full particulars in our advertisement columns.

Shop Foreman, Manchester district. Full particulars in our advertisement columns.

Borough Electrical Engineer, Croydon, £500, rising by annual increments of £50 to a maximum of £800 per annum.

Architectural Draughtsman for a period of three months, at a salary of £3 per week; a **Junior Draughtsman** for three months, at £2 a week; and a **Junior Clerk**, at £1 a week, Finchley Urban District Council.

Mains Superintendent, £150 per annum, **Switchboard Attendant,** 30s. per week, Harrogate.

NEW COMPANIES REGISTERED.

T. Emlyn Jones, Limited.—Capital £15,000. Objects: to adopt an agreement with T. E. Jones for the acquisition of the business carried on by him at Glebe-street, Penarth, and to carry on the business of general and furnishing ironmongers, as plumbers, gas-fitters, bellhangers, electricians, and electrical engineers.

The National Rail and Tramway Appliances Company.—Capital £1,000. Objects: to adopt an agreement with P. McCullough to acquire certain inventions relating to appliances and fittings for railways, tramways, motors, and vehicles, or to the production, storage, and use of electricity or other motive power.

Cornwall Electric Power Syndicate, Limited.—Capital, £5,006. Objects: to carry on in the county of Cornwall or (and) elsewhere the business of an electric and gas supply company in all its branches, and in particular to construct, lay down, establish, and maintain generating stations, works, plants, apparatus, and machinery; as wire manufacturers, manufacturers of accumulators, pipes, and lamps for the production of electricity and gas for all purposes; to acquire and turn to account any patents, patent rights, and inventions of every description. The registered office is 30 and 31, St. Swithin's-lane, E.C.

Institution of Junior Engineers.—The members of this Institution will visit the new baths and wash-houses of the borough of Fulham, Melmoth-place, at 3 p.m. on Saturday, Feb. 22.

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LEGAL INTELLIGENCE.

CHLORIDE ELECTRICAL STORAGE SYNDICATE.

In the Court of Appeal, before the Master of the Rolls and Lords Justices Romer and Mathew, the appeal was heard of the defendants in the case of Gibbs *v.* the Chloride Electrical Storage Syndicate, Limited, from the judgment of Mr. Justice Bigham in favour of the plaintiffs. The action was brought by Messrs. Gibbs against the syndicate to recover £487, balance of the price of sulphuric acid sold to defendants. Defendants counter-claimed for damages on the ground that some of the sulphuric acid supplied by plaintiffs was of greater strength than that contracted for, and also that certain carboys contained hydrochloric acid. In consequence, it was alleged damage was done to certain storage batteries for which the defendants had orders in 1899. Plaintiffs declared that there was no hydrochloric acid contained in the acid supplied, and, further, that if there were, it did not do the damage alleged. Mr. Justice Bigham, in the King's Bench Division, held that the damage done to the batteries was not due to the acid supplied by plaintiffs, whatever other cause it might be attributable to. He thought, however, that plaintiffs had not delivered to the defendants as they had contracted to do, and that the defendants had not been unreasonable in setting up the counter-claim. He therefore entered judgment for the plaintiffs on the claim and also on the counter-claim, but deprived the plaintiffs of their costs on the counter-claim.

The Court of Appeal now upheld this decision, and dismissed the appeal.

ELECTRIC LIGHT IN A WESTMINSTER HOTEL.

The Court of Appeal, composed of Lords Justices Vaughan Williams, Stirling, and Cozens-Hardy, on the 6th inst., heard the appeal of the defendants in the case of Husey *v.* the London Electric Supply Corporation from an order of Mr. Justice Kekewich restraining the company from cutting off the supply of electrical energy to St. Ermin's Hotel, Westminster. As the proceedings before Mr. Justice Kekewich were reported in our issue of the 31st ult., it will be unnecessary to repeat the facts of the litigation, except to say that the plaintiff is the receiver in possession of the hotel, and that the company attempted to deprive him of the benefit of a supply of energy for lighting purposes from their mains in consequence of an outstanding account for electric current supplied prior to Jan. 17 last—*i.e.*, before the appointment of the receiver.

At the conclusion of the arguments of counsel, **Lord Justice Vaughan Williams** said it seemed to him that it was not right to grant the injunction restraining the company from cutting off the electric current. His opinion was that the receiver was not entitled to any supply of electricity unless and until he had made a contract with the company for that supply, and as he had not made that contract he was not entitled to restrain the company from cutting off the supply.

The other Lords Justices concurred, and the appeal accordingly was allowed, the injunction granted by Mr. Justice Kekewich being discharged.

AUTOMOBILE MANUFACTURING COMPANY.

Mr. Justice Bryne, in the Chancery Division of the High Court on the 7th inst., gave judgment in the petition of the Clipper Pneumatic Tyre Company, Limited, for a compulsory winding-up of the Automobile Manufacturing Company, Limited. He said there was no doubt that the company were in that condition of solvency which did not enable them to meet their judgment debts. An order would have been a matter of course but for the contention on behalf of the debenture-holders that the amount due to them was such as to exhaust all the available assets of the company. To that the creditors replied that these debentures were bad, as being a fraudulent preference. He could not say that this contention was one that might not have a fair chance of success, and he was of opinion that there were circumstances connected with the company which required investigation. Considering all the circumstances of the case, he was not satisfied that a winding up order would be injurious, or, if injurious, so injurious as to induce him to say that the plaintiffs had lost the rights which they otherwise would have had. He, therefore, made an order for the compulsory winding-up of the company, with the usual order as to costs.

WEST LONDON COLLISION CASE.

In the Brompton County Court, on the 7th inst., George Cull, a 'bus conductor, sued the London United Tramways Company for £50 damages in respect of personal injuries said to have resulted from the negligent driving of an electric car by one of the defendant company's servants.

The evidence in support of the plaintiff's case went to show that on Oct. 23 last the plaintiff was the conductor of a 'bus which was running along the Uxbridge-road, when the driver pulled out a little towards the centre of the road in order to avoid a butcher's cart. Before the 'bus could clear the tramway lines again an electric car "bashed" into its rear with great force. The horses of the 'bus were knocked down, and the plaintiff was injured. For the defence, evidence was given to the effect that the car at the time was not going at more than six miles an hour, and that the driver rang his gong several times to let the 'bus driver know that it was close behind. In spite of this, however, the 'bus, it was alleged, suddenly turned out on to the lines, and so brought about the collision.

Eventually the jury found a verdict for the plaintiff for £25 damages, and judgment was entered accordingly, with costs.

Arising out of the same collision, the driver of the 'bus subsequently obtained a verdict against the tramways company for £30 damages and costs.

HEAVY DAMAGES FOR COLLISION.

Mr. Daniel E. Ruffee, a veterinary surgeon, brought an action last week against the Norwich Electric Tramway Company to recover damages for personal injuries alleged to have been received through the negligence of defendants. The facts were that on April 27, whilst plaintiff was driving a seven-year-old horse along the Newmarket-road, he met an electric tramcar, and his horse was frightened by it, and swung round, bringing the hind part of the cart on to the tram. The cart was broken, and plaintiff was thrown out and severely injured. It was contended on his behalf that the driver of the tram refused to pull up when signalled to, and that he also frightened the horse more by repeatedly sounding his gong.

On the other hand, the driver denied that he sounded the gong, or that plaintiff put up his hand for the car to stop. He alleged that the accident was due to the horse shying.

In the result the jury found for the plaintiff for £104 personal expenses, and £750 damages, and judgment was entered accordingly.

ELECTRIC SIGNS.

At the Westminster Police Court on the 30th ult., Mr. Arthur Bucknill, the occupier of 1, Sloane-street, and Mr. E. H. Benson, advertising agent, of 1, Tudor-street, E.C., were each summoned under the County Council by-laws for permitting and causing a flashlight to be exhibited which was dangerous to traffic.

Inspector Croston said what was complained of was an illuminated advertisement produced by 214 electric lamps changing alternately in colour from white to red. The contrivance was different from many with which the public had been familiarised, because the lights faded away and grew again to maximum intensity, with an interval of about four seconds of absolute darkness. Notwithstanding the gradual changes he maintained that the light was dangerous, and horses were startled by it.

Mr. Pritchard, for the defence, contended that this was not a flashlight within the meaning of the by-law; it did not alter suddenly. It was the first and only contrivance of the kind, and it had been devised to meet the police objections to flashlight advertisements.

Mr. Shiel, the magistrate, held that the contrivance was a flashlight coming within the words of the by-law—"altering suddenly in intensity"—and he thought it was dangerous to traffic. This was a test case, so he should only impose a fine of 20s. and 23s. costs.

An application to state a special case for the opinion of the High Court was refused.

COMPANIES' MEETINGS AND REPORTS.

ELECTRIC LIGHTING AND TRACTION COMPANY AUSTRALIA, LIMITED.

Directors: Joseph Bevan Braithwaite, jun., M.I.E.E., chairman; J. F. Albright, M.I.E.E.; M. F. Armstrong; R. Percy Sellon, M.I.E.E., managing director. Engineer and manager: F. W. Clements, M.I.E.E. Secretary: W. E. Lane, A.M.I.E.E.

Report of the directors to be presented to the shareholders at the second ordinary general meeting of the Company to be held at Winchester House, Old Broad-street, E.C., at 12 noon, on Feb. 17.:

After placing the sum of £3,500 to reserve for depreciation, repairs, and renewals, and writing off from the cost of the recent capital issue the sum of £1,489. 9s. 5d., being the proportion of the Melbourne past profits earned prior to the incorporation of the Company, the profit and loss account shows an available net profit of £7,771. 9s. 4d., and the directors recommend that this sum be applied as follows: to reduction of loss incurred in starting the Adelaide undertaking, £500; to dividend on preference shares at the full rate of 6 per cent. per annum for year ended Aug. 31, 1901, £6,317. 5s. 3d.; to balance carried forward, £954. 4s. 1d. During the year further capital expenditure in Australia on land, buildings, and plant has been incurred as follows: on the Melbourne undertaking, £41,296. 4s. 7d.; on the Geelong undertaking, £17,552. 4s. 9d.; on the Adelaide undertaking, £40,894. 6s. 2d.; total—£99,742. 15s. 6d. In order to provide for the above expenditure, the capital of the Company was increased in July, 1901, by the issue of the remaining £50,000 preference shares, and by the creation and issue at par of £75,000 5 per cent. debenture stock, redeemable at par in 21 years. Pending the issue of the remainder of the authorised capital, the directors have arranged with the Company's bankers to advance the necessary funds for the further development of the Company's undertakings. A resolution will be submitted to the shareholders at the general meeting confirming this action. Formal completion of the purchase of the two Melbourne undertakings was effected on Jan. 11, 1901, since which date they have been under the sole control of this Company. The anticipated administrative economies are being realised, and the business generally is developing satisfactorily. Although these economies are not yet complete, it will be seen from the profit and loss account that the net profit from Melbourne for the 7½ months' working from Jan. 11 to Aug. 31, 1901, amounts to £9,802. 16s. 9d., notwithstanding an increase of some 30 per cent. in the price of coal. The Melbourne undertaking is now being carried on under a new Order in Council granted to this Company for a period of 25 years from Nov. 13, 1900, without prior right of

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purchase by the local authorities, and covering all the most important suburbs of Melbourne. The Company's engineers report that a large demand for electricity for lighting, heating, and especially for power purposes, has sprung up in these hitherto untouched districts, and that the expenditure on additional plant and mains which has been, and is being incurred, is fully justified. A permanent supply of electricity from the Company's new works at Geelong was commenced in May, 1901, and has been taken up rapidly, there now being the equivalent of about 4,500 8-c.p. lamps connected to the mains. The result of the first four months' working shows that a small loss of £14. 15s. 2d. has been incurred, but the expenses are now being covered by revenue, and it is anticipated that a profit will be shown in the accounts for the current year. The new station for lighting Adelaide has been completed, and was opened in November, 1901. The equivalent of about 5,000 8-c.p. lamps are already connected, and applications for supply are coming in satisfactorily. The loss of £1.560. 8s. 7d. incurred during the past year is principally due to the use of temporary generating plant, rendered necessary by the previous company's agreement with the Town Council. The starting of the new station has, however, enabled the temporary plant to be discontinued, with corresponding reduction in the working expenses. The small station of Port Adelaide again shows a loss on the year's working. The directors intend to close it down at the earliest opportunity, and supply the district by high-tension current from Adelaide. Under these conditions they believe that the Port Adelaide undertaking is capable of earning a profit. The Stock Exchange granted an official quotation on March 4, 1901, to the Company's first issue of preference shares, numbered 1 to 20,000. Mr. A. U. Alcock has resigned his seat on the Board. The directors do not propose to fill the vacancy for the present. The retiring director is Mr. J. F. Albright, who, being eligible, offers himself for re-election. The auditors, Messrs. Cooper Bros. and Co., also retire, and offer themselves for re-election.

Dr. PROFIT AND LOSS ACCOUNT.

	£	s.	d.
Directors' fees—head office expenses, etc.	2,071	0	2
Debenture interest accrued	357	0	5
Interest on loans from bankers	2,366	2	3
Loss on the Geelong undertaking	14	15	2
Loss on the Port Adelaide undertaking	196	4	9
Amount carried to reserve for depreciation, etc.	3,500	0	0
Amount carried to general balance-sheet in reduction of cost of share issue	1,489	9	5
Balance carried to general balance-sheet	7,771	9	4
	£17,766	1	6

Cr.

	£	s.	d.
Balance of profit and loss account, less dividends on preference shares	1,950	8	8
Interest and discounts, etc.	1,198	10	8
Transfer fees	1	2	6
Profit on the Melbourne undertaking	9,802	16	9
Past profits on the Melbourne undertaking	4,813	2	11
	£17,766	1	6

CITY OF LONDON ELECTRIC LIGHTING.

The directors, in their report for the six months ended Dec. 31 last, announce that they have decided to recommend the payment of the following dividends, after provision for reserve: on the preference shares a final dividend of 6s. per share for the six months ended Dec. 31 last, making, with the dividend paid on account in July, 1901, a total distribution of 12s. per share, or at the full rate of 6 per cent. per annum. On the ordinary shares a dividend of 10s. per share, being at the rate of 5 per cent. for the year ended Dec. 31 last, carrying forward a balance of about £13,000.

NORTHAMPTON ELECTRIC LIGHT AND POWER.

The thirteenth annual report of the directors states that since the presentation of the last annual report the steps then being taken with a view to more economical working and greater efficiency have been diligently followed up, and important improvements in management and administration have been brought about. The saving in fuel, oil, etc., has been most marked, and in all respects the Company is now working under new conditions. The year opened very badly, in spite of which the net result is of a gratifying character. The second half of the year shows a profit, after ample provision for all contingencies, which would have admitted of a very substantial dividend on the ordinary shares. The change-over to the higher voltage was successfully effected in April last. The boilers and accessories suffered much in the past from the hardness of the water, but an effectual remedy has been found in a softening apparatus, supplied by Messrs. Mather and Platt at a moderate expense. The lamps fixed have increased by 2,962 and motors (reckoned in their equivalent of lamps) by 700, making 29,121 in all (at 8 c.p.). The growing use of current for motive power is very satisfactory, being conducive to a larger day load, always a great desideratum. From the beginning of the new year the price of current for motors and heating purposes is reduced to a uniform rate of 2d., whereby the advantages of electricity are made available for all classes of the community using machinery or requiring electric stoves. The meter rents have also been considerably reduced. The consumers now number 502. The directors have abstained from any large extension of mains during the year, the additions amounting to 436 yards, making a total of 7 miles and 1,026 yards. Enquiry has been made by the Corporation of Northampton whether the directors would be willing to enter into negotiations for the sale of the Company's undertaking. Any further steps will be notified to the shareholders in due course. After setting apart £800 for depreciation, and £43 in reduction of preliminary expenses, there remains applicable to dividends a sum of £1,526. 11s. 10d. It is proposed to pay a year's dividend on the 6 per cent. preference shares, £226 10s.; on the 5 per cent. preference shares, £466. 1s.; also 3½ per cent. on the ordinary shares, £798. 3s. 7d.; and to carry forward £35. 17s. 3d. Mr. R. Cleaver and Mr. H. Manfield retire from the Board in rotation, and will be proposed for re-election.

GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital account—amount received	72,732	0	0
Sundry tradesmen and others due on construction of plant, machinery, etc.	6,189	3	4
Net revenue account	1,526	11	10
Depreciation fund account	3,036	10	0
	£83,484	5	2

Assets.	£	s.	d.
Capital account—amount expended for works	80,543	14	7
Stores on hand	89	17	7
Preliminary expenses	302	1	6
Sundry debtors for current	2,402	10	8
Other debtors	146	0	6
Cash in hand	0	0	4
	£83,484	5	2

REVENUE ACCOUNT.

				£	s.	d.
Generation of Electricity.						
Coal	£955	7	10			
Oil, waste, etc.	88	15	4			
Proportion of salaries	269	18	4			
Wages at generating station	621	11	1			
Repairs and maintenance	297	7	11			
				2,233	0	6
Distribution of Electricity.						
Proportion of salaries and wages	39	19	0			
Repairs and maintenance of mains	24	18	1			
				64	17	1
Rents, rates, and taxes				357	0	6
Management Expenses.						
Directors' remuneration	100	0	0			
Salaries of secretary, accountant, etc.	100	0	0			
Stationery and printing	59	3	10			
General establishment charges	18	7	5			
Auditor	21	6	8			
				298	17	11
Law expenses				0	13	0
Depreciation				800	0	0
Insurances, etc.				81	12	3
Total expenditure				3,836	1	3
Balance carried to net revenue				2,670	3	3
				£6,506	4	6

	£	s.	d.
Sale of current	5,873	6	5
Rental of meters	303	1	11
Sale of lamps	0	16	2
Rents receivable	325	17	6
Transfer fees	3	2	6
	£6,506	4	6

MARCONI'S WIRELESS TELEGRAPH.

The report of the directors of this Company for the year ended Sept. 30 last, to be submitted at the meeting on the 20th inst., states that Mr. Marconi continues, in a highly satisfactory manner, to develop his system of wireless telegraphy beyond the most sanguine expectations of the Board, whilst at the same time the commercial application of the system by this Company and by its subsidiary undertakings is making rapid progress in all directions. The Company now possesses a complete international organisation, having for its purpose the uniform adoption of the Marconi system in other countries on the same lines as it is established here. The chief event of the year so far as the progress of the invention itself is concerned occurred in December last, when Mr. Marconi, present at St. Johns in Newfoundland, received there wireless telegraphic signals from the Company's station in Cornwall—a distance of over 2,170 miles across the ocean. This result was obtained in spite of adverse circumstances, the masts which had been erected for the permanent station having suffered severely from the winter gales. Steps have now been taken to build permanent stations both on the American and English shores, and the Board anticipate with considerable confidence that this Company will shortly establish regular wireless telegraphy across the Atlantic, available to the public at rates and conditions which need not seriously interfere with the welfare of the cable companies. These companies, on the other hand, should benefit by new traffic which the wireless telegraphy will bring to them from many hitherto undeveloped sources. The other main feature of the year has been the progress of the business of the Marconi International Marine Communication Company, Limited, in which the Company is at present interested to the extent of £100,000, being one-half of the issued capital. This Company was incorporated for the purpose of establishing international sea communication between ship and ship and ship and shore of all nations, and with the help of a Continental group of financiers and others

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organised in Brussels, the establishment of Marconi's system for commercial shipping purposes is progressing satisfactorily in all directions. A formal agreement has also been concluded with Lloyd's, whereby that corporation has adopted Marconi's system exclusively in connection with their signal stations. The necessary instruments are now being installed at 10 of their stations, and these will also be worked for the passenger and commercial traffic of the Marconi International Marine Communication Company. The chief steamship companies are also giving orders for installations on their vessels. In other directions the Company is also busily engaged. Many installations of wireless telegraphy have been carried out which are giving profitable returns to the Company, either by royalty or by an interest in the receipts. Contracts have been entered into with various Governments, and negotiations are in progress for a number of other engagements of a beneficial character, which, however, it would not be in the interests of the shareholders to disclose at the present moment. The Company, as far as is practicable, is itself working the apparatus for receipts as part of a general telegraph system, both alone and in connection with the existing ordinary telegraph systems. It is, so far, selling the apparatus only to Governments for naval and military purposes and for lighthouse work, or to private persons for their private use. The Company's factory at Chelmsford has been greatly improved, and the rapid extension of business has led to the establishment of a technical school for the special training required for the Company's staff of operators. In view of the extreme value to the Company of Mr. Marconi's services, the directors considered it right to take out an insurance policy on his life for £150,000 for three years. As to finance, it may be stated that since the date of the last balance-sheet 40,000 shares were offered for subscription to the shareholders at £2 per share in order to provide the Company with the necessary funds for the extending business.

SMITHFIELD MARKETS ELECTRIC SUPPLY.

The report of the directors for 1901, to be submitted to the shareholders on the 14th inst., states that the revenue account shows an increase in the receipts of £3,058. 13s., exclusive of the amount received from the cold-air store which has been transferred to net revenue account, and a gross profit on working of £4,307. 5s. 11d. as compared with £2,952. 9s. 3d. in 1900. The net profit for the year after providing for interest, depreciation, and other charges is £1,824. 14s. 10d., an increase of £939. 11s. 1d. To this must be added the amount brought from last year's accounts, £675. 1s. 1d., making a total credit balance of £2,499. 15s. 11d. Of this balance, however, a considerable part has been appropriated for the extension of the business, as no working capital was available, and the directors regret, therefore, that they are not in a position to recommend the payment of a dividend for the past year. There has been a substantial increase in the number of new installations and lamps connected, while the cost of production has been still further reduced as the result of the increased output and the improvements which have been introduced in the generating station. The plant and machinery have worked satisfactorily throughout the year, and are in good condition.

METROPOLITAN DISTRICT RAILWAY.

The report of the directors of this Company for the half-year ended Dec. 31 last recommends the payment for the half-year of a dividend on the 4 per cent. guaranteed stock at the rate of 15s. per cent. per annum, leaving £185 to be carried forward. The Company has during the half-year had to meet not only the competition of the Central London Railway, opened on July 30, 1900, but also that of the electric tramways which commenced running to Acton and Kew in April, 1901, and were extended to Hounslow on the one hand and Southall on the other in July, 1901. By a revision of fares the Company has arrested the loss of traffic at some of their stations, and they hope by further revision at an early date to recover their traffic at other stations. The loss in gross passenger traffic in the year 1901, as compared with 1899, reaches the serious figure of £53,000. Referring to the question of electric traction, the report states that at the request of the Metropolitan District Electric Traction Company, the necessary notices to treat have been served upon the owners of the land required for the power-house, and possession of some of the land has been secured. Arrangements are now being concluded with the London and South-Western Railway Company for the electrical equipment of that company's lines from Putney to Wimbledon, and from Turnham Green to Richmond, over which the District Company have running powers. Ealing and Harrow Railway—Arrangements are being made to instal forthwith upon this branch an electrical system of traction which will be worked from a temporary power station. The Company expects to have an electrical service of trains working from Harrow to Mill Hill Park and thence to South Acton in September next. The Metropolitan Railway Company have let the contract for the construction of the Harrow and Uxbridge Railway, and those works are now proceeding. The important extension of the District Railway from Whitechapel to Bow, which is being constructed jointly by the Company and the London, Tilbury, and Southend Railway Company, is expected to be ready for opening in May. Brompton and Piccadilly-circus Railway—Arrangements are being made with this Company, pursuant to the statutory powers, for the construction of the deep-level line of the District Company from Earl's Court to South Kensington authorised by the Metropolitan District Railway Act, 1897. The Brompton-Piccadilly Company have let their contracts for the construction of their railway, and are now acquiring the necessary land. The following Bills affecting the Company's interests have been introduced into Parliament, and will be submitted for approval at the Company's Wharncliffe meeting: (1) the Metropolitan District Railway Bill; (2) the Whitechapel and Bow Railway Bill; (3) the Metropolitan Railway Bill; (4) the Charing Cross, Euston, and Hampstead Railway (No. 3) Bill; (5) the Great Northern and Strand Railway Bill. Numerous other projects will be submitted to Parliament, some of them for railways, which will seriously affect the Company. All necessary steps are being, and will continue to be, taken to protect the interests of the Company. The Board reports that since the last half-yearly meeting Mr. J. S. Forbes has resigned the position of chairman, which he has held for the long period of 29 years. The Board desires to place on record its appreciation of the services which Mr. Forbes has so long faithfully rendered to the Company. Mr. Forbes has consented to serve the Company as advisory director for a period of four years.

DUBLIN AND LUCAN ELECTRIC RAILWAY.

The directors, in their report for the half-year ended Dec. 31 last, state that the expenditure has been reduced, that the traffic receipts show a considerable increase; the general position of the Company's affairs, too, is considerably improved. After providing for debenture interest, there is a balance available of £1,036. Out of this it is recommended that a dividend at the rate of 5 per cent. per annum on the preference shares be paid, which will absorb £475, and that £200, as well as the half-yearly instalment of £100 due to the electrical contractors, be paid towards the balance due for electrical equipment, leaving £261 to be carried forward. The steady increase in passenger traffic is largely owing to the punctuality and popularity of the train service. During the last three months of the half-year goods traffic has been undertaken on a small scale and contributes £40 to the revenue. Some increase in receipts under this heading will probably be seen in future. The revenue from all sources shows an increase of £360 for the half-year. The expenditure shows a decrease of £460, which is partly due to the reduced price of coal and partly to the reduction of other expenditure.

WIGAN AND DISTRICT TRAMWAYS.

The report of the directors for 1901 recommends the payment of a dividend at the rate of 10 per cent. per annum for the six months ended Dec. 31, an interim dividend at the rate of 7 per cent. having already been paid for the half-year ended July 31 last. The application for a light railway order authorising the construction of a light railway to Ashton-in-Makerfield has now been confirmed by the Board of Trade. The opposition to the Bill of the South Lancashire Tramways Company to Parliament (which company also applied for powers to lay a tramway along this route) has added very considerably to the cost of obtaining the order. The directors have entered into a provisional agreement for the sale of the Company's undertaking to the Corporation of Wigan, and it is intended to call the shareholders together at an early date to ascertain their views thereon. The provisional agreement with the British Electric Traction Company, Limited, to which reference was made in the last report, expired on the 31st ult.

BLACKPOOL AND FLEETWOOD TRAMROAD.

In their report for the half-year ended Dec. 31 last the directors state that, including the sum brought forward, the balance of profit, after providing for debenture interest, is £10,555, and the directors recommend a dividend at the rate of 9 per cent. per annum, which will absorb £6,750, writing off £1,500 to depreciation reserve, and £400 from the cost of application to Parliament for further powers, leaving a balance of £1,905 to be carried to the current half year. The number of passengers carried during the half-year was 1,254,103, and the car mileage run 357·132 miles. The receipts from all sources amounted to £21,340.

NATIONAL TELEPHONE.

The report of the directors of this Company for the half-year ended Dec. 31 last recommends dividends as follows: at the rate of 6 per cent. per annum on the first and second preference shares; at the rate of 5 per cent. per annum on the third preference shares; at the rate of 6 per cent. per annum on the preferred stock; and at the rate of 4½ per cent. per annum on the deferred stock, being equivalent to 5 per cent. per annum on the ordinary shares now divided into preferred and deferred stocks; carrying £100,000 to reserve and about £7,000 forward.

TOTTENHAM AND HAMPSTEAD RAILWAY.

The directors' report for the half-year ended Dec. 31 last states that after providing for £2,702, being the amount of debenture interest accrued during the past half-year on the debenture power transferred to the Midland Company under the Act of 1874, a balance remains upon the half-year's working of £16,144, to which must be added the £67 brought forward, making a balance of £16,211 available for dividend. The directors recommend a dividend at the rate of 5 per cent. per annum on the No. 1 preference shares, 5 per cent. per annum on the No. 2 preference shares, and of 4 per cent. per annum on the No. 3 preference shares, leaving a balance of £12,240. It is recommended that out of this balance a dividend be paid on the ordinary shares at the rate of 8¾ per cent. per annum, which will absorb £11,951, and leave £289 to be carried forward.

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CARLISLE ELECTRIC TRAMWAYS.

The report of the directors of this Company states that the revenue account shows a surplus of £2,458. 16s. 6d., and the balance of profit and loss account, after providing for debenture stock interest, debenture stock trustees' remuneration, and writing off a second instalment of one-third of the preliminary expenses, was £915. 16s. 2d., which the directors recommend should be dealt with as follows: to carry to the fund to meet depreciation, £570. 17s. 6d.; to carry forward, £344. 8s. 8d. The car miles run in the period have been 323,044, and the number of passengers carried, 2,010,873. The sum of £500 carried to reserve in respect to the period to Dec. 31, 1900, has been employed with other funds in the purchase of three new cars, which were urgently required; and it is intended to devote the further sum of £500 proposed to be set aside this year to the same purpose. In arriving at the amount recommended to be carried to the reserve fund, depreciation of the new cars is specially provided for. The revenue account for the year shows that the receipts and expenditure were as follows: Receipts—traffic receipts, £8,383; advertising receipts, £263; sundry, £28; bank interest, £19—total, £8,695. Expenditure—electrical energy purchased, £2,003; running expenses, £3,267; maintenance and repairs, £146; administration and general expenses, £816—total, £6,236, giving a surplus of £2,458. Profit and loss account: Receipts—balance brought forward, Dec. 31, 1900, £1,669; revenue account for surplus on the working for the year ended Dec. 31, 1901, £2,458—total, £4,128. Expenditure—to reserve fund, to meet depreciation, £500; dividend for half-year ended Dec. 31, 1900, at the rate of 3 per cent. per annum, £900; honorarium voted directors, £100; debenture stock interest, £1,600; debenture stock trustees' remuneration, £50; preliminary expenses account for amount written off, £62—total, £1,712; balance carried forward, £915.

WATERLOO AND CITY RAILWAY.

The half-yearly general meeting of the proprietors of this Company was held at Waterloo Station on the 6th inst., Sir Wyndham Portal presiding.

The **Chairman,** in moving the adoption of the report, stated that for the first time in the history of the Company the directors were able to pay a dividend of 3 per cent. without any assistance from the London and South-Western Company, who worked the undertaking. The expenditure on capital account had been £599,201, and the directors hoped to be able to close this account altogether during the present year. After referring to other items in the accounts, he mentioned that he had had some correspondence and one or two interviews respecting the contingent liability mentioned by the auditors in their certificate. It referred, as must be known to all the proprietors, to the deficiency in net revenue, which had to be made up by the working company in any half-year when such revenue was not sufficient to pay 3 per cent. on the ordinary and borrowed capital. Except on the present occasion, there had been a deficiency every half-year since the opening of the line, and on June 30 last the deficiency amounted to £12,011. The same agreement which provided for any deficiency being made up by the working company also provided that the latter should be entitled to recoup themselves out of any excess over 3 per cent. The South-Western Company were, therefore, entitled to retain the surplus mentioned of £103, and therefore the deficiency now stood at £11,907, which, however, did not bear interest. The deficiency had to be disposed of, according to the agreement, before any excess over 3 per cent. could be divided between the owning and the working companies. For the past half-year the working expenses were at the rate of 45·50 per cent., compared with 50·63 per cent. for the June half of 1899, 55 per cent. for December, 1899, and June, 1900, 53·75 per cent. for December, 1900, and 54·78 per cent. for June, 1901. The number of passengers carried, and the amounts received from them, had gone on steadily increasing, and the railway was becoming more and more popular. There were several underground railway schemes which were to be considered by Parliament this session. Some of them it would be necessary for the directors to watch and to seek protection from in this Company's interests. He hoped that, as time went on, the number of their passengers would greatly increase. The chief difficulty which had to be contended against was that the trains were full in the morning and nearly empty during the day, and, whatever facilities might be given, the trains in the morning would not only be full, but over-full. The attention of the working company was being directed to this matter, and they were doing all that they could to make things go as smoothly as possible.

Lieut.-Colonel the Hon. H. W. Campbell seconded the motion.

A **Shareholder** expressed the view that before the line could be a complete success it must have a West-end terminus at a conspicuous point—for instance, Westminster Bridge—from which people started for the City.

After some further remarks the motion was adopted unanimously.

ANGLO-AMERICAN TELEGRAPH.

Mr. F. A. Bevan presided over the ordinary meeting of this Company held at Winchester House.

In moving the adoption of the report (which has already appeared in this journal) the **Chairman** thought it was a matter of congratulation that, in spite of competition, and the fact that during the past year they had lost the whole of the outward German traffic, they were able to pay dividends to the full amount on the preference stock and to give a small one to the deferred holders. The result of the half-year was that, after placing the usual £24,000 to reserve, the directors were able to recommend a dividend on the ordinary stock of £3. 1s., as against £3. 2s. 6d. There was, he said, a considerable decrease in the Atlantic traffic receipts, owing to the land lines between London and Valencia being broken during the great storm, the result being that they certainly lost £2,000 worth of traffic. On the other hand, they had derived rather more income from their local traffic, particularly in Newfoundland. For that they were considerably indebted to Mr. Marconi, who in the summer had to employ their lines to a large extent, and, so far as that gentleman had gone, the Company was indebted to him for an extensive use of its lines. Competition, however, was on the increase, and the new Pacific cable would be laid in a few months. During the year the Company had dealt with 9¾ millions of words, which number had only been exceeded in two previous years. Referring to the Marconi telegraphic system, he said that anyone could see that in these days of scientific discovery, any system which was invented would have very considerable difficulty in beating the work of the Anglo-American Telegraph Company, as they were able to send a brief message to New York and obtain a reply in one minute. Unless the Marconi system was able to telegraph at the same speed, it would not be able to compete commercially with the cable companies. As for social messages, they bore a very small proportion to commercial messages, which chiefly occupied their cable. Again, unless this system were able to compete with the cable companies in point of accuracy and secrecy, it appeared to him that it could not compete successfully. He then quoted the expert opinions given by Sir J. Wolfe Barry in his recent speech to the Eastern Telegraph shareholders, and pointed out that, according to these, only two or three commercial words could be sent per minute by the wireless system, whereas they could send 50. In conclusion, he expressed the hope that the shareholders would not feel alarmed about their shares, as he believed that for some time at least they would continue to carry the bulk of commercial messages.

Sir G. Fitzgerald seconded the motion, which was adopted.

St. JAMES'S AND PALL MALL ELECTRIC LIGHT.

The general meeting of the shareholders was held at the offices, Carnaby-street, Golden-square, on Tuesday, Mr. Eustace J. A. Balfour presiding.

The **Chairman,** in moving the adoption of the report (which appeared in our last issue), drew attention to the excellent position which the Company had attained. The past year, however, was far from favourable to the Company's business. The price of coal was abnormally high, the extra cost under this head having been £4,000, while the increase in rates laid on them a further burden of £3,175. These two items, in spite of economy in other directions, accounted for the increase in the cost of generating of about ½d. per unit. The directors, therefore, did not at present see their way to reduce the charge for lighting; but they had felt justified in offering the Company's customers a substantial reduction in the price of electricity used for power purposes. There could be no doubt that this portion of the business was capable of substantial development. Considerable orders for the supply of electricity for motors had already been received, and there was every reason to suppose that the demand for such purposes would become general throughout the Metropolis. The plant at the Company's two stations would be sufficient to meet this increase of business until next winter, when the supply from the Central Electric Supply Company would be available, and thenceforward all further requirements would be drawn from that company. In conjunction with the Westminster Electric Supply Corporation, this Company undertook the construction and equipment of the works of the Central Supply Company, and to that end each company had provided one-half of the ordinary capital, and had jointly guaranteed the payment of the principal and interest on an issue of £250,000 4 per cent. debenture stock of the Central Supply Company. He then referred to the Bill promoted by the London County Council for enabling the Council in certain circumstances to enter into competition with existing companies in the supply of electrical energy. The Board were unanimous in their opposition to this Bill, which they regarded as unjust to companies who were already fulfilling their duty to their consumers.

Mr. Walter Leaf seconded the motion, which, after a short discussion, was agreed to.

LIVERPOOL OVERHEAD RAILWAY.

Sir Wm. Forwood presided over the half-yearly meeting of this Company at Liverpool on Tuesday.

The report, together with the statement of accounts, appeared in our last issue.

The **Chairman,** in moving the adoption of the same, regretted that the report was not of a more satisfactory character, but the shareholders must not be discouraged. They had a well-equipped and well-maintained line, which was economically worked, with a large population living from end to end of the service. Referring to the fact that, as compared with the corresponding period last year, there was a decrease of 356,659 passengers, representing a loss of £3,500, he stated that among the causes for this were the completing of the Corporation electric trams, the slackness of trade at the docks, the diversion of the timber trade from the Canada Dock, and the conversion of Sandon graving docks into wet docks. The train mileage for the half-year amounted to 403,546 miles, a decrease of 2,968 miles, and the percentage of expenditure to revenue was 72·65, against 69·33. Recently the weekly returns of traffi had been more favourable, and there were signs that trade was improving. This and an accelerated service, with, perhaps, 1d. stages, would help them to recover their position. To equip the trains and line to run the through service in 20 minutes instead of 32 minutes as at present would cost nearly £28,000, and was a matter for serious consideration. Alluding to the recent fire on the railway, he said that from the opening of the railway, nine years ago, to the present time, the first care of the directors had been to work the line with safety, and the fact that they had carried 73,000,000 passengers without any serious accident was a proof of this. The directors had

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the satisfaction of feeling that the recent accident, which they all deeply deplored, was not due to the want of oversight. It was satisfactory to be assured that no passenger would have been injured if they had left the station in the usual way, and not remained to watch the fire. He then formally put the motion to the meeting.

Mr. R. Hobson seconded, and the motion was adopted.

NORTH METROPOLITAN TRAMWAYS.

In submitting the half-yearly report to the meeting of the shareholders in this Company at the Cannon-street Hotel on Wednesday, **Mr. George Richardson** referred mainly to the proposed electrical equipment of the lines. Remarking that the net profit for the half-year was only £9,295, allowing of a dividend at the rate of 3 per cent. per annum, he much regretted this small result, and observed that the remedy was to be found in electricity. The London County Council had given the Company notice that the lines were to be electrified under the agreement between them. The County Council, however, had not yet furnished them with any plans, but their idea was to adopt the conduit system, which was very expensive. According to the Council's original estimate the cost was to be about £15,000 a mile, but it now turned out that it was to be considerably more—even up to £30,000. However, the County Council were to find the money, and the Company had to pay the interest thereon at the rate of 6 per cent. If the County Council gave powers to adopt the overhead system it would be much easier to carry out and cost far less, probably one half, and he did not think that anything that was beautiful in the North of London would be interfered with. At all events, the overhead system could be carried out in about half the time and for half the cost of the conduit system ; and there was no reason why the County Council should not do the same in the North of London as was being done in the West of London. He did not think that the United Tramways Company's installation was at all offensive to the public eye. He did not agree with Mr. Benn and others that the enormous savings which had been mentioned would be effected, because those gentlemen were extremely sanguine men, but, at the same time, if they were sanguine the fact showed the value of the Company's lease. The County Council were rather anxious to obtain this lease, but unless they would give a price that would be at all commensurate with the profits which they had shadowed forth, the directors would not bring the matter before the proprietors. He moved that the report be adopted.

Mr. John Goddard seconded the resolution, which was carried.

A resolution was also passed approving of the Bill in Parliament authorising the use of mechanical and electrical power on the Company's tramways in the county of Middlesex. The **Chairman** explained that these proposals had nothing to do with the London County Council.

UXBRIDGE AND DISTRICT ELECTRIC SUPPLY.

Mr. J. F. Stilwell presided over the annual general meeting of this Company in the absence of the chairman through illness.

The report stated that good progress had been made with the erection of the generating station, and that the laying of the mains throughout the compulsory area was nearly completed. Steps were now being taken to lay extensions of the mains to serve Hillingdon Court and Swakeleys, Ickenham, Denham Court and the Lea, Denham, as well as Bishopshalt, Moorcroft, Evelyns, and other houses at Hillingdon, all on terms which the directors were advised would be remunerative. Arrangements were now in progress for the hire wiring at a low rental of small houses, or houses where short tenancies are in existence. The directors had been able to let off portions of the freehold site acquired, but not at present utilised, for the generating station at rents which produced a satisfactory return on the purchase price of the entire site. The directors (except the managing director) had agreed to forego any fees until the commencement of the general public supply, and the secretary was also performing his duties on the same footing.

On the motion of **Mr. Potter**, seconded by **Mr. A. R. Phipps**, the report was unanimously adopted.

The meeting concluded with the customary vote of thanks.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Tulcea (Roumania).—The Municipality invite tenders for lighting the town. Tenders by Feb. 25.

Spezia (Italy).—The Arsenal Authorities invite tenders for bronze wire, tubes, etc. Tenders by Feb. 24.

Bacau (Roumania).—The Mayor invites tenders for electric lighting of the town by March 15. The estimate is £5,646.

Ghent.—The Municipality require tenders for the electric lighting of the town. Tenders must be posted before March 1, 1902.

Bucharest.—The Administration of Government Monopolies invite tenders for metals for the year 1902-3. Tenders by Feb. 27.

Cuellar (Spain).—The Municipality require tenders for an electric lighting installation and working of the same for 20 years, by Feb. 27.

Bucharest.—The Administration of Government Monopolies invite tenders for supply of electric carbons for the year 1902-3. Tenders by March 3.

Brussels.—Tenders are invited for material and apparatus for electric lighting by the Government Railways. Tenders by Feb. 28. Specification No. 802.

Irun (Spain).—Tenders for the electric lighting of the town, which were called for Feb. 9, will be received by the Municipal Authorities until Feb. 23.

Rockhampton (Queensland).—The contract for the municipal tramways, full particulars of which appeared in a former issue, will remain open until March 31.

Burgess Hill.—The Urban District Council invite tenders for the construction of electricity supply works in the district. Tenders by March 12. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply, delivery, and erection complete of materials for switchboard extensions. Tenders by Feb. 21. Details in our advertisement columns.

Doncaster.—The Corporation invite tenders for the supply, delivery, and fixing of a fuel economiser at the Corporation Electricity Works. Tenders by Feb. 28. Details in our advertisement columns.

King's Lynn.—The Corporation invite tenders for the supply and erection of one Lancashire boiler, together with steam and feed pipes. Tenders by Feb. 21. Details in our advertisement columns.

Aldershot.—The Urban District Council invite tenders for the supply of electricity meters and for maximum demand indicators. Tenders by Feb. 24. Details in our advertisement columns.

Pontypridd.—The Urban District Council invite tenders for Section M, comprising the overhead equipment and bonding for their tramways. Tenders by March 7. Details in our advertisement columns.

Aberdeen.—The Tramways Department invite tenders for the supply of 12 double-deck single-truck cars, complete with motors, controllers, etc. Tenders by March 6. Details in our advertisement columns.

Madrid.—The Post and Telegraph Department invite tenders for supply of 3,000 telegraph poles of horse-chestnut wood. The estimate is 7 and 8 pesetas per pole of 7m. and 8m. length respectively. Tenders by Feb. 22.

Bournemouth.—The Town Council invite tender for a motor-generator by Feb. 21. Specification, etc., can be obtained from Mr. F. W. Lacey, borough and tramway engineer, Municipal Offices, Bournemouth.

Rochdale.—The Corporation invite tenders for the supply, delivery, and erection at Rochdale, Lancashire, of one complete traction switchboard and accessories. Tenders by Feb. 25. Details in our advertisement columns.

Madrid.—The Public Works Department invite tenders for extensions to the San Sebastian tramways and working the same for not more than 60 years. Particulars may be obtained from the Department. Tenders by April 5.

Paris.—The Post and Telegraph Department, Rue de Grenelle, 13, invite tenders for 10 tons galvanised iron wire of 1mm. diameter ; 160 tons galvanised iron wire 3-4mm. ; 340 tons galvanised iron wire 4-5mm. Tenders by Feb. 28.

London and South-Western Railway Company.—The Directors invite tenders for the supply and fixing of plant and fittings for the electric lighting of Salisbury Station. Tenders by March 4. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply of a 12in. lathe, radial drilling machine, shaping machine, and other workshop tools for their Hylton-road station. Tenders by Feb. 28. Details in our advertisement columns.

Edinburgh.—The Council invite tenders for the electric lighting installation, etc., of the third portion of the Colinton Mains Fever Hospital, the number of lighting points being about 600. Tenders by March 3. Details in our advertisement columns.

Christiania.—The Government Railways Department, Jernbanetorvet, 8 9, invite tenders for 3,000m. of 1·5mm. rubber-insulated copper wire, 4,000 7-stranded rubber-insulated cables, 100 kilo. zinced copper wire, and 150 3-stranded copper wire. Tenders by Feb. 19.

Manchester.—The Tramways Committee invite tenders for the supply of permanent-way materials, tools, and plant. Specifications, etc., may be obtained from Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders by Feb. 22.

Fulham.—The Guardians invite tenders for the supply, delivery, and erection on their premises of two 50-kw. steam dynamos and boosters, four dry-back marine boilers, storage battery, and wiring for about 2,000 lights. Tenders by Feb. 25. Details in our advertisement columns.

Battersea.—The Council invite tenders for the supply of the following materials required by the Electricity Department from March 31 next: coal, oil and engine-room stores, arc lamp carbons, and electric meters. Tenders by Feb. 18. Details in our advertisement columns.

Halifax.—The Tramways Committee invite tenders for the supply of various stores and materials during 12 months ending March 21, 1903. Specifications, etc., may be obtained on application to Mr. W. M. Rogerson, borough electrical engineer, Foundry-street, Halifax. Tenders by March 1.

Madrid.—The Department of Agriculture invite tenders for the construction of an electric tramway from Linares to the mines of San Roque and Torilla, in the Province of Jaen. Tenders by Feb. 24. This is the extension of the tender advertised for Nov. 17, but the conditions have been modified.

Croydon.—The Town Council invite tenders for the supply of 10 double-deck double-truck cars, equipped complete with motors, etc., for overhead trolley system. Specifications, etc., can be obtained on application to Mr. E. Mawdesley, town clerk, Town Hall, Croydon. Tenders by Feb. 17.

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Manchester.—The Electricity Committee invite tenders for electric overhead travelling crane for generating station, and hand-driven overhead travelling cranes for sub-stations, by Feb. 19. Specifications, etc., can be obtained from Mr. F. E. Hughes, secretary, Electricity Department, Town Hall.

Aberdeen.—The Tramways Committee invite tenders for the electrical equipment of their Rosemount circular route, comprising overhead equipment and bonding (poles and bonds supplied by Corporation), and supply and laying of cables. Tenders by March 6. Details in our advertisement columns.

Stalybridge.—The Tramways Committee of the Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board invite tenders for the supply of rails, anchor plates, and fishplates, points, crossings, filling pieces, tie-bars, bolts, nuts, and rivets, and trolley wire (43 tons). Tenders by March 3. Details in our advertisement columns.

London, S.W.—The London County Council invite tenders for two lots of 50 double-decked double-bogie electric tramcars, equipped with a plough for working on a conduit system, and to be capable of seating about 68 persons. Specification and other particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by March 4.

Valetta (Malta).—Tenders will be received at the office of the Receiver-General and Director of Contracts, Valetta, until 11 a.m. on 21st inst., for the supply of 75,000 arc lamp carbons. Particulars, specifications, etc., may be obtained on application to the Superintendent of Public Works in Malta, or to the Crown Agents for the Colonies, Downing-street, London.

Walsall.—The Corporation invite tenders for the following works in connection with the construction of the permanent way and overhead equipment of about six miles of single track and 1¾ miles of double track of tramways on the overhead trolley wire system. Specification, etc., may be obtained from the office of Mr. Richard Henry Middleton, borough surveyor, Walsall, and of Mr. Alexander Wyllie, borough electrical engineer, Electricity Works, Wolverhampton-street, Walsall. Tenders by Feb. 21.

East Ham.—The Urban District Council invite tenders for the supply and erection of one 500-kw. continuous-current multipolar generator, direct-coupled to an 800-i.h.p. horizontal cross compound slow-speed engine, and extension to switchboard, and two water-tube boilers, condenser, feed-pump, steam and exhaust piping, and cooling tower. Specifications, etc., may be obtained on application to the engineer and manager, Mr. W. C. Ullman, M.I.E.E., Electricity Works, Nelson-street, East Ham. Tenders by Feb. 22.

RESULTS OF TENDERS.

Bury.—The Town Council have accepted the tender of J. Byrom, at £9,800, for the erection of a central tramway depôt in Rochdale-road.

Liverpool and Garston Light Railway.—The tender of D. Bruce Peebles and Co. has been accepted for supply of three 150-h.p. dynamos.

Blackburn.—The contract for the installation of electricity in the parish church has been placed with G. H. Woods, of Northgate, Blackburn.

Yarmouth.—The Town Council have accepted the tender of the Brush Electrical Engineering Company, Limited, for the supply of 14 cars, at £7,649.

Sunderland.—The County Borough Council have accepted the t ender of Dick, Kerr, and Co., for supply of 10 double-deck and four single-deck cars.

Bournemouth.—The Town Council have accepted the tender of Callender's Cable and Construction Company, at £20,669. 13s. 5d., for supply of cables.

Dewsbury.—The Town Council have accepted the tender of Siemens Bros. and Co. for the supply of two dynamos and one spare armature to the electricity works.

Hampstead.—The Borough Council have accepted the tender of J. Fraser and Sons, at £6,500, for additional condensing plant at the electric lighting station.

Battersea.—The Borough Council have accepted the tender of Callender's Cable and Construction Company, at £160, for supply of 2,000 yards of ·1 section cable.

Bradford.—The tender of the Brush Electrical Engineering Company for the supply of 100 electric tramcar trucks, at £5,000, has been accepted by the City Council.

Heckmondwike.—The tender of the Tudor Accumulator Company for the enlargement of the battery at the electric lighting works has been accepted by the District Council.

Batley.—The Town Council have accepted the following tenders: Clayton, Son, and Co., boilers, etc.; Carrick and Ritchie, travelling crane for the electricity generating station.

West London Tramways.—The contract for feeder and section pillars for the London United Tramway's extension has been placed with the Electrical Transmission Company, Bevor-lane, Hammersmith.

Cleckheaton.—Messrs. Thornton and Crebbin, Bradford, have secured the order for two electrically-driven boiler pumps and one electrically-driven supply pump for the Urban District Council's electric lighting station.

Epsom.—The Urban District Council have accepted the tender of H. J. Ede, of Epsom, for wiring the Council Offices, Bromley Hurst, at £90, and the tender of L. G. Tate for wiring the waterworks at £90 and the clock tower at £12. 10s.

Swindon.—The Corporation have accepted the following tenders for the supply, delivery, and erection at their electricity works, Swindon (Wilts), of three Lancashire boilers and economiser, two jet condensers, feed pumps, pipework, and accessories; water-cooling tower and 10-ton overhead travelling crane: Couper, Schwarz and Co., Old Hall-street, Liverpool, water-cooler, £535; Carrick and Ritchie, Edinburgh, travelling crane, £235; J. Carter and Sons, Stalybridge, boilers, economisers, etc., £6,667. 4s. 6d.

Hammersmith.—The Borough Council have received the following tenders for the supply, delivery, and fixing complete of the rolled-steel joists, steel rails, channel contact tail, and steel tie-bars, fish-plates, bolts, etc., required in the erection of the elevated track for electric travelling crane at the Council's wharf. Foreign manufacture: Pierson and Co., £130; G. Aston and Sons, £131; Homan and Rodgers, £135. English manufacture: J. D. Mackenzie, £136. 10s. (accepted); Dormer, Long, and Co., £175. 16s.

Hunslet (Leeds).—The Hunslet Board of Guardians have received the following tenders for the electrical equipment of new workhouse and infirmary at Rothwell Haigh, near Leeds. Contract No. 1 comprises electric lighting plant, combined engine and dynamos, booster, motor, storage cells, and switchboard. Contract No 2 comprises complete system of wiring and underground mains for the electric lighting of the various buildings, wiring for electrical clocks, and the supply and wiring of electric telephones. Accepted tenders: Greenwood and Batley, Limited, Leeds, Contract No. 1, £1,647. 6s.; W. B. Parker, Bond-street, Leeds, Contract No. 2, £1,455. 19s.

London County Council.—The following tenders have been received for the wiring, etc., of the Smack Boys' Home at Lowestoft, which is in course of erection:

Bush and Dryburgh (accepted)	£103	0	0
G. N. C. Mann and Co.	105	0	0
Jackson Bros.	122	16	0
Anti-Vibrator, Limited	130	0	0
J. G. Statter and Co.	135	0	0
National Electric Wiring Company	139	10	0
Tyler and Duncan	149	0	0
Barlow and Young	165	0	0

Cardiff.—The following tenders have been received for engines and generators:

Engines.

Ferranti, Limited	£9,381
Robey and Co.	11,260
Markham and Co.	11,330
Yates and Thom	11,412
D. Stewart and Co.	11,371
Combe, Barbour, and Combe	11,840
V. Coates and Co.	12,700
Beaver, Dorling, and Co.	12,837
Musgrave and Sons (accepted)	14,074
Cole, Marchent, and Morley	14,126
Hick, Hargreaves, and Co.	15,100
Davey, Paxman, and Co.	15,308
Ashton, Frost, and Co.	15,470

Tenders from English and American firms.

Electric Construction Company	7,305
Crompton and Co.	6,890
Mather and Platt	6,268
Bruce Peebles and Co.	5,990
Siemens Bros. and Co., Limited	5,760
Dick, Kerr, and Co. (accepted)	5,560
British Westinghouse Company	6,642
British Thomson-Houston Company	6,494
Johnson, Lundell, and Co.	5,294

Tenders from foreign firms.

Lahmeyer Electric Company	5,502
British Schuckert Electric Company	5,027
Witting Bros. and Co.	4,781
Von Kramer	4,680
F. Suter and Co.	4,078
International Electric Company	4,850

BUSINESS NOTES.

TRACTION.

Bournemouth.—The Mayor has consented to call a public meeting to discuss the tramway question.

Dundee.—It is decided that the cars on the Constitution-road tramway route shall be of the double-deck type.

West Sussex.—The County Council have sealed a petition against the Hove, Worthing, and district tramway scheme.

Torquay.—The Town Council have decided to oppose all the private schemes which have been submitted for electric tramways.

Aberdeen.—An agreement has been come to between the County Council and the promoters of the Aberdeen suburban tramways scheme.

Grimsby.—The Tramways Committee of the Town Council are urging the tramway company to run workmen's trams at ½d. per mile.

Isle of Axholme Light Railway.—The construction of this railway is progressing satisfactorily both in the Haxey and Crowle districts.

Greasborough.—A Tramway Committee has been appointed by the Urban District Committee to deal with all questions relating to tramways.

Lincoln.—A meeting of the Council in committee has been called to consider the question of the purchase of the Lincoln Tramways Company's undertaking.

St. Annes.—Specifications and plans submitted by the tramway company for the tramway poles and brackets have been approved by the Urban District Council.

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Sunderland.—The Town Council have fixed upon a scale of wages for their tramway employés.

Pemberton.—The Board of Trade have sanctioned the borrowing of £8,217 by the Urban District Council for the purchase of the tramways within their district.

Longton.—The town clerk has been instructed to lodge a petition against the Bill intended to be promoted in Parliament by the North Staffordshire Tramways Company.

Metropolitan District Railway Co.—The directors recommend a dividend for the past half-year on the 4 per cent. guaranteed stock at the rate of 15s. per cent. per annum.

Aberdare.—A public meeting held here on the 5th inst. has declined to pledge itself to support the electric tramway scheme proposed by the Urban District Council.

Cromarty and Dingwall Light Railway.—The Dingwall Town Council have agreed to meet the promoters of this scheme in committee and discuss the question as to Maryburgh crossing.

All-Night Trams.—The second reading of the North Metropolitan Tramways Bill in the Commons will be opposed owing to the refusal of the company to run all-night trams in North London.

Rowley Regis.—It is reported that the Urban District Council having failed to comply with the statutory rules, the application for an order for a light railway to Rowley cannot be proceeded with.

Bakewell.—The proposal of a syndicate to apply next May for an order for a light railway from Totley to Bakewell has been referred to the Lighting Committee of the Urban District Council for a report.

Rochdale.—Negotiations are proceeding satisfactorily in relation to the Mellor-street tramway route to Spotland, and the route to Norden. The matter has reference to the acquisition of some property along the line of route.

Portsmouth.—On Monday a collision occurred between two of the Corporation's electric tramcars, with the result that one vehicle was derailed, and the glass in the windows shattered. No personal injury was sustained.

Kilburn.—A public meeting, held under the auspices of the Kilburn Tradesmen's Association, has passed a resolution strongly opposing the London County Council's proposed tramway from Cricklewood to Marble Arch.

Bridlington and Flamborough Light Railway.—Notification has been made to the Bridlington Rural District Council of the intention of the promoters of this railway to ask for a further year's extension of the order of 1897.

Halifax.—Permission has been obtained to lay tramways through the Pye Nest Estate, and this week the agreement, in which the Corporation undertake to pay a nominal sum in acknowledgment of the concession, was approved.

Lowestoft.—The town clerk has been instructed to obtain the necessary consent of the Board of Trade to the construction of the tramway along Denmark-road to the electric light station, and also to the sale of portions of Smith's Marsh as a site for car-sheds.

Newcastle.—Last week the running of the electric cars resulted in a revenue of £1,403. This is the highest income yet obtained, being at the rate of 1s. 1¼d. per car mile. As an experiment one of the cars is to be fitted with four motors. Most of the cars are being fitted with slipper brakes.

Liversedge.—With regard to the proposed electric trams through the district, it was stated at the last District Council meeting that correspondence was in progress with the British Electric Traction Company regarding the acquisition of certain property at Littletown for road-widening purposes.

Bradford.—The Tramways Committee have authorised the tramways manager to make a charge of 1d. on every occasion when cars are stopped to enable letters to be posted in the boxes placed on the cars. Instructions have been given for the reconstruction and overhead equipment of the line in Cheapside.

Finchley.—It was reported at the last meeting of the Urban District Council with regard to the proposed Hertfordshire light railways, that an arrangement has been come to that the same terms with regard to widening roads should be granted as had already been agreed to by the Middlesex County Council.

Rotherham.—The consulting engineer has been asked to prepare specifications, etc., for the laying of tramways along the Sheffield-road to Tinsley. Twelve double-deck cars to carry 45 passengers, with reversible staircase, and three single-deck cars are to be provided for the proposed new tramway routes.

Brighton and Rottingdean Electric Tramroad.—A petition has been lodged in the Private Bill Office of the House of Commons notifying the intention of the Brighton Intercepting and Outfall Sewers Board to oppose the passage through committee of the Brighton and Rottingdean Seashore Electric Tramroad.

Manchester and Liverpool Monorail.—At a Wharncliffe meeting of the company promoting this scheme held in London on Wednesday, the shareholders sanctioned a Bill now before Parliament enabling the company to make a short deviation of their line through Salford, as required by the Salford Corporation.

Brighton.—The remaining sections of the Corporation's electric tramways—the Elm-grove and Queen's Park sections—have now been opened for traffic. The engineer has been instructed to prepare specification and bills of quantities for the construction of the proposed new tramway routes on the Old Steine and London-road.

Yarmouth.—The borough surveyor reports that matters are progressing in such a way that he has little doubt but that the tramways will be ready for electrical working in the early part of June. The extensions at the electric light station are complete, the two new boilers set, and the foundations for engines are ready.

Scarborough.—The Parliamentary Bills Committee of the Town Council have decided to adhere to their proposal to seek power in the Tramway Bill being promoted this session for a double line of tramways between Vernon-place and North-street, notwithstanding the opposition of the occupiers of property in this quarter.

Liverpool Overhead Railway.—Since the fatal fire in December the Dingle Station on this railway has been rebuilt and reopened for traffic. In the reconstruction wood has been practically omitted, and fire-extinguishing apparatus has been fitted throughout. Communication has also been established with the central fire brigade.

Perth.—The Town Council have rejected a motion which aimed at obtaining the opinion of counsel as to the competency of acquiring the tramway undertaking by arbitration, seeing that part of the tramways are outside the burgh boundary. The Council will thus proceed in the usual manner to settle the purchase price by arbitration.

Stepney.—The Borough Council have been notified with reference to the reconstruction for electric traction of the London County Council's (Northern) Tramways, leased to the North Metropolitan Tramways Company, that it is probable that the first sections to be reconstructed will be those between Aldgate and Bow and Aldgate and Poplar.

Branksome.—The Urban District Council have now agreed to support the scheme for an extension of the Poole and District Light Railway along the Parkstone-road, conditionally upon the company giving an undertaking to always maintain a six-car service for every 65 minutes each way along the Ashley-road route from Bournemouth to Poole on weekdays.

South Shields.—A long discussion took place in connection with tramway questions and the recent poll at Monday's meeting of the Town Council. A resolution was carried that the company's offer is inadequate, and that before a conference can take place between the British Electric Traction Company and the Corporation, the terms must be more fully stated.

Motor Factors' Association.—It is proposed to form an association, to be called the British Cycle and Motor Factors' Association, with the object of preventing unfair competition by bringing influence to bear on manufacturers to render impossible undercutting in their goods. It is suggested that a penalty of £100 should be imposed on anyone who violated the recognised rules.

London County Council Omnibuses.—The House of Lords have confirmed the decisions of the Court of First Instance and of the Court of Appeal respectively, to the effect that it is beyond the powers of the London County Council to carry on the business of omnibus proprietors in connection with its tramways, or to apply the "county fund" for the purpose of maintaining and working omnibuses.

Ayr.—The extension of the Corporation tramways to Burns's Monument is going on apace. The track has been opened over nearly half the distance, and the concrete bed laid in a large section of this, and a start has been made with the laying of the cables. The rails have, however, not yet arrived from America, though they were expected to be in Ayr early this week. There is still the expectation that the work will be completed in April.

Darlington.—It was announced at the last meeting of the Town Council that sanction had been obtained for the borrowing of the money for the purchase of the tramway undertaking. With regard to the light railway provisional order, the Light Railway Commissioners have issued the order, and it now only requires the confirmation of the Board of Trade. Arrangements for supplying electrical energy to the railway company have not yet been concluded.

Sheffield.—Authority has been given to the city surveyor to proceed as soon as practicable with the work of doubling the tramway lines in Church-street, from St. James's-row to the bottom of Bow-street. The through system on the West End sections is to be suspended while the lines are being doubled in Church-street, the city terminus to be at the bottom of Bow-street. The question of indicators to be placed on the Corporation tramcars is referred to the Tramways Committee for consideration and report

Cardiff.—At the last Town Council meeting it was announced that during January the tramways carried 583,221 passengers. The receipts were £2,583. 11s. 1d. and the expenditure £2,090. 16s. 1d., so that there was a profit on the month of £492. 15s. The Town Council have decided by a majority of one that all Sunday labour on the tramways should be prohibited, excepting only such work as the Public Works Committee may deem to be absolutely necessary.

Royal Motorcars.—The King has ordered two more motorcars, which are being built at Coventry. The first of these will be a pleasure car, which is to have a 22½-h.p. four-cylindered motor (making 720 revolutions at normal speed), under single-lever control. It is designed to carry petrol sufficient for 150 miles, and will be fitted with both tube and electric ignition. The motor is geared to 24 miles an hour. The second car on order is practically an omnibus.

Ashby, Swadlincote, and Burton Light Railway.—Colonel Boughey and Mr. H. A. Steward, Light Railway Commissioners, held an enquiry at Swadlincote on the 6th inst. into the merits of the above scheme. The Midland Railway Company opposed, on the ground that the scheme was not one which Parliament intended should come under the Light Railway Act. In the result the Commissioners decided to reject the application for an order.

Failsworth.—The clerk to the District Council has been instructed to obtain sanction for the borrowing of the money required for the purchase of the tramways from the Manchester Carriage and Tramways Company and the reconstruction of the tramways for electric traction. The Lancashire Electric Power Company are now prepared to enter into an agreement with local authorities to supply current in bulk under the terms of their Act of Parliament not later than Oct. 1, 1903.

Leyton.—By a large majority the Urban District Council have rejected a resolution objecting to the proposal contained in the City

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and North-East Suburban Electric Railway (No. 2) Bill to bring another railway through the district on embankments and in cutting. The ground of the proposed opposition was that the construction of the railway would dishouse a large number of people and create an addition to the nuisance arising to the inhabitants from the noise caused by the working of the existing railways.

Croydon.—The Norwood section of the Corporation electric tramways is now complete as far as Station-road, and the rails were to be linked up with the track on the Norwood side of the bridge by yesterday. Cars are running on this line as far as Selhurst New-road. The track from the present terminus at Melfort-road to the boundary at Norbury will now be laid. Subject to certain terms, the Town Council have agreed to support the proposals of the British Electric Traction Company for extensions to Sutton and Mitcham.

Electricity on British Railways.—Reuter's correspondent at New York ratifies the incorporation of the Great Britain Railways Development Corporation at Trenton, New Jersey. It is stated that the corporation will build or purchase electric lines in England in places where the transit facilities are inadequate or the equipment behind the age. The charter of the company calls for only 100,000dol., which sum, however, is merely nominal, since, as a matter of fact, the sum of 3,300,000dol. has already been subscribed.

Isle of Man Tramways.—The receiver and manager of the Isle of Man Tramways and Electric Power Company, Limited, has presented to the Chancery Court his accounts for the last year. In the first half of the year the receipts were £15,537, and the expenditure £20,642, and the December half-year showed an income of £38,191 and outgoings of £25,617. The balance on the year's working was about £7,568, which represents a credit balance of income over expenditure, after paying working expenses and debenture interest.

Mersey Railway.—The electric generating station in course of construction for the Mersey Railway Company at Birkenhead is to be completed three months hence, when the electrification of the system will be proceeded with rapidly. In view of the conversion to electric traction, the company have secured the services as engineer of Mr. J. Shaw, formerly secretary and manager of the Isle of Man Electric Power Company, who has had considerable experience of electric tramways. The general operations of the Mersey Railway will remain under the chief supervision of Mr. R. Bowman Smith.

Blackpool.—Plans submitted for extensions of the Marton tramshed have been approved by the Town Council, and tenders for the work are to be advertised for. The sum of £2,900 is to be borrowed. It is decided to appoint a tramway engineer, who is to be responsible to the borough electrical and tramway engineer in all cases of alteration of design or construction of any electrical equipment of the tramways or tramcars, but to be responsible to the tramways manager in all cases of repairs; all stores for the tramways department and accounts therefor are to be under the control of the tramways manager.

Lytham.—A special meeting of the Urban Council has been held to consider the proposed Bill of the Lytham-to-Southport Tramway Company, which applied for an extension of 10 years' time for the erection of a bridge across the Ribble Estuary from Southport to Lytham, and six years for the acquisition of the land. It was decided to oppose the application. The Parliamentary Committee of the Southport Corporation have also decided to oppose the Bill unless the promoters give a satisfactory undertaking to obtain for the Corporation a like extension of time for completion as they propose to acquire for themselves under the Bill.

Long Eaton.—It was reported at the last meeting of the Urban District Council that an agreement had been made between the tramway company and the Nottingham Corporation respecting running powers into the city, and that the Corporation had decided to support the scheme. The agreement was approved subject to some alterations. The Council decided that the Eaton terminus should be at Oxford-street, near to the Derby and Nottingham-road and Market-place. Several members urged the substitution of wood block paving between the rails instead of granite setts, as specified, so far as the scheme relates to Long Eaton parish, and the Council decided to ask the mpany to do this.

Tyne Electric Railway Scheme.—A detailed estimate of the cost of the proposed electric railway under the Tyne, between North and South Shields, has been deposited in Parliament. The railway, which will be only six furlongs in length, will run from Teignmouth to South Shields. The total estimated cost is put down at £172,400, of which the tunnelling under the river will cost £79,600, and the stations at North and South Shields will require the expenditure of £36,863. It is estimated that the cost of acquiring the necessary lands (1 acre 1 rood) and the buildings thereon will absorb about £19,037, whilst the laying of the permanent way as a single line will cost £4,268, which is at the rate of £5,000 per mile.

London-Brighton Electric Railway.—The Bill in connection with this scheme was to have come before Mr. Campion (one of the Examiners of Standing Order Proofs in the House of Commons) on Tuesday, but, owing to the indisposition of the examiner, the consideration of the memorials was postponed until Monday. The memorialists are the London and Brighton and South Coast, the London and South-Western, and the South-Eastern Railway Companies, and several private individuals. It is reported that Mr. F. B. Behr has made an offer to the London, Brighton, and South Coast Railway Company to construct an electric railway to Brighton on the monorail principle for three millions sterling.

Light Railway Orders.—The Board of Trade have recently confirmed orders authorising the construction of light railways in the county of Stafford, in the parishes of Wednesfield and Short Heath, and the abandonment of certain railways authorised by the Easington and Ashmore Light Railway Order, 1900; authorising the construction of light railways in the counties of Southampton and Surrey, from Aldershot to Farnborough; in the county of Southampton, from Lyndhurst to Lyndhurst Road; in the county of Suffolk, from Lowestoft to Kessingland; in the urban districts of Pemberton and Ashton-in-Makerfield, in the county palatine of Lancaster; and in the city of Worcester and the rural districts of Martley and Upton-on-Severn, in the county of Worcester.

Wolverhampton.—In accordance with the permission received from the Board of Trade, the electric cars commenced running on Thursday on the Bilston-road section of the new tramways, which has been equipped with the Lorain surface-contact system. The Corporation at their meeting on Tuesday decided to appoint an independent electrical expert to advise the Tramways Committee on the working of the system during the remainder of the 30 days' test. At the same meeting it was reported that during the four days the test line had been opened the number of passengers carried was 10,152, and 386 car miles had been run with practically no trouble. A recommendation that the tender of Messrs. William Griffiths and Co., Limited, of London, amounting to £1,062 for the construction of the Dudley-road track be accepted, was referred back.

Heston and Isleworth.—The General Purposes Committee of the District Council has received a deputation from the Southall Norwood District Council to confer upon the subject of the proposed light railway between Hounslow and Southall, by way of Lambton, Heston, and Norwood Green. It was urged that the two authorities should consent to the proposals of the London United Tramway Company for an order, on condition that they widened the roads through which they passed to 50ft., that the whole area of them was paved with wood from kerb to kerb, that they were scavenged and lighted by the company, and that after two years' time the company pay an annual grant of £500 to the councils. After hearing the views of the deputation the General Purposes Committee promised to consider them, but expressed a hope that they would in time be modified.

St. Helens.—Last Saturday another meeting was held of the Joint Committee of the Parliamentary Committee and the Tramways Committee to discuss the terms on which the St. Helens and District Tramways Company shall be permitted to carry goods on the tramways. An arrangement was proposed under which the tramways company will ultimately pay 20 per cent. of the gross receipts for the privilege of carrying goods on the tramways, in addition to a small charge per wagon. The Town Clerk pointed out that at a previous meeting it had been proposed that the charge should be 10 per cent., and that this was carried and communicated to the company. The fresh proposition was, however, carried, and the town clerk declared that it would be unprofessional on his part to communicate their decision to the tramways company, and declined to do so, after which the meeting came to a conclusion.

Reading.—It is estimated that the cost of reconstructing the tramways and the doubling of lines for electric traction will amount to a total of £42,350, and application is to be made to the Board of Trade for a loan not exceeding £45,000. At the last meeting of the Council the Tramways Committee reported the receipt of tenders for the supply and erection of plant, works, machinery, and rolling-stock, being the works comprised in the specifications for contract. Tenders were found to have been delivered by eight firms for the whole of the works comprised in the specifications, and by 70 other firms for one or more of the 14 sections into which the works are divided under the specifications, and after considering the matter, it was resolved that the tenders, the plans, and other communications accompanying the same, be referred to the borough engineer and Mr. Winslow for a report before the committee recommend the acceptance of any tender.

Tramway Competition.—At the meeting of the London and South-Western Railway Company this week, the Hon. H. W. Campbell, who presided, complained of the effects of the electric tramway competition in the suburban districts on the receipts of the company. With the advance which had been made in electric traction, such competition, he admitted, was inevitable; but he pointed out that it ought to be limited to the crowded districts, and ought not to be allowed to extend beyond the suburbs—districts which had been built up by the railways, which had spent millions to provide for the transit and accommodation of the public. He also considered this competition was unfair, as the tramways paid nothing for the use of the roads. So far as London traffic was concerned, the directors had deemed it desirable to issue third-class season tickets to certain stations, and the directors were watching the experiment to see whether or not the system should be extended.

Luton Light Railway.—On Wednesday of last week the Earl of Jersey, Colonel Boughey, and Mr. H. A. Steward held an enquiry into the application of the Luton, Dunstable, and District Light Railway Company for a light railway order. Among other opponents, the Great Northern Railway Company took exception to the scheme on the ground of competition. Lord Jersey said the Commissioners were of opinion that the competition that would occur with the railway company was of such a nature that they could not recommend that an order should be granted. It had been stated that there was hardly any intermediate population, and that made the competition very distinct and clear. The Commissioners would not be able to grant an order in the case of the district railway on the ground of competition. The Light Railway Act only provided for the establishment of a light railway provided the district was not already served. The application, as a whole, was accordingly refused.

Windsor and Maidenhead Light Railway.—The Bray Parish Council have received a letter from the Light Railway Commissioners stating that they propose to make special enquiry into the following matters, amongst others, in regard to the above scheme: (1) whether it would be practicable to construct the railway in such a manner as to avoid interference with the common lands; (2) if not, whether, under the scheme proposed, the least possible injury would be done to the common lands; (3) what alterations, if any, would be expedient in

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order to lessen the injury; (4) whether any relaxation of the general rule as to fencing the land taken shall be desirable; (5) whether provision should be made for access to any severed portions; (6) whether in the interests of the commoners and of the public it would be expedient and reasonable to require as a consideration of consent that the promoters should acquire other land to be thrown into the common in lieu of any portion which they might be permitted to take.

Further Extensions Westward.—Mr. Clifton Robinson, of the London United Tramways Company, has written to the Slough Urban District Council stating that he has been engaged in the preparation of plans for the extension of their system westward, and applications will be lodged with the Light Railway Commissioners in May next. The proposed extensions will go from Hounslow through Cranford and Colnbrook, and terminate near the Windsor road, Slough, while Datchet-on-Thames will be brought into communication with the Bath road by a branch line. Mr. Robinson has asked the Slough Council whether the proposals of his company, which will connect Slough with the whole of their extensive system of electric tramways are not far more advantageous for the residents of their district than the scheme of electric tramways proposed by the Metropolitan District Electric Traction Company connecting Slough with the District Railway at Hounslow. The Metropolitan District scheme will be considered by the Light Railway Commissioners to-day.

Hampstead.—A proposal, which was brought forward at the last meeting of the Borough Council, that the London County Council should be asked to consider the advisability of running a shallow tramway under the High-street was referred to the General Purposes Committee for consideration and report. With regard to the London County Council (Subways and Tramways) Bill, the General Purposes Committee called attention to the fact that in the event of a subway being constructed, the Council can call upon borough councils to remove into the subways all their mains, pipes, and wires at present laid in any street in which the subway is constructed The committee were of opinion that it is a bad principle to allow the London County Council to obtain such general powers of such important a nature throughout the whole of this borough, and that each scheme of subway should be dealt with separately, in order that proper protective clauses can be obtained It was therefore decided to present a petition against the Bill, for the purpose of amending the same. It was also decided to oppose the London County Council (Tramways and Improvements) Bill.

Hammersmith.—The Parliamentary Committee report having considered the revised print of the regulations in regard to the use of electrical power on the overhead trolley system on the London United tramways and light railways, in the form in which the Board of Trade propose to issue them, and find that the Board have adopted the suggestions which the Council on July 3, 1901, made upon the original draft regulations, suggesting that the speed at which the tramcars should run in portions of King-street, Uxbridge-road, and Goldhawk-road, should not exceed six miles an hour. They have also considered whether the question, raised by the deputation which attended before the Council on Jan. 15, as to the running of tramcars on Sundays could be dealt with by the regulations, and are satisfied that it could not. They have the question of regulating the running of cars on Sundays still under consideration, and will submit a report thereon in due course. The Public Health Committee recommends that further summonses be taken out against the Central London Railway Company for permitting black smoke to issue from the chimney shafts of their premises in Wood-lane in such quantities as to be a nuisance.

Leeds Appointment.—The Tramways Committee have resolved to recommend Mr. John Baillie Hamilton, of Glasgow, for the position of general manager of the Leeds Corporation tramways at a salary of £900 per annum, rising to £1,000 in two years' time. Mr. Hamilton, who is 46 years of age, is at present the traffic manager of the Glasgow tramways. He is a native of Hamilton, Lanarkshire, where he spent his youth. His first experience of tramways was with the London Tramways and Omnibus Company. He has been associated with the Glasgow tramways ever since they were taken over by the Corporation in 1894. Thenceforward he held the position of traffic manager and chief assistant to Mr. Young, the general manager of the undertaking. The conversion from horse to electric traction was effected in the early part of last year, but for three years prior to that electric cars were run experimentally on one route. Glasgow has now about 100 miles of track length worked electrically. The whole of the conversion and subsequent working of these tramways has been carried out with the active assistance of Mr. Hamilton.

Queensland.—A report has been prepared by the chief engineer for Queensland railways as to the running of trains by electricity on the suburban lines. So far as obtaining electric power is concerned, the engineer makes three suggestions: (1) the obtaining of all power required from the Brisbane tramways; (2) the obtaining of part of the power from that company, and the erection of a station at Nudgee to furnish the remainder; and (3) the erection of independent works near Nundah. From this power-house current for the entire system might be supplied, boosters being used where necessary to maintain the voltage. The approximate cost per mile of running electric trains is given at 8·34d., 3·58d., and 6·39d. by the three systems mentioned respectively. According to the estimate the most economical method of working would be for the department to supply its own power; but taking into consideration the large initial outlay which would be entailed, the report recommends that should it be decided to adopt electric traction, in the first instance, at any rate, an agreement be come to with the Brisbane Tramways Company to supply power at the rate offered by them. The estimated cost, estimated as follows, is: horse-power and plant, £20,650; rolling-stock, £18,954.

Ventilation and Vibration of the "Tube."—It was announced at the meeting of the Central London Railway Company last week that experiments were being made with a view to improving the ventilation of the railway. It now appears that the directors are trying what electric fans will do towards maintaining a constant circulation of pure air in the tubes. Mr. J. C. Cunningham, the general manager of the line, in an interview with a representative of the daily Press, is reported to have stated that the first electric ventilator will be working in a fortnight's time, and if it prove successful, similar contrivances will be installed along the line. He also stated, in regard to the peculiar odour of the tube, which has been likened to a graveyard, that it is due to the disinfectant with which each carriage is sprinkled at every second journey. Reports are going around this week with reference to the question of vibration on the tube, but there is no more in them than we have previously given in this journal—*i.e.*, that the gearless locomotives with their unspring-borne weights are the cause of the trouble. These will in time, we understand, be replaced by geared locomotives, and in certain cases by motor-carriages connected up on the multiple-unit system.

Southampton.—The borough electrical engineer (Mr. Street) has reported to his committee in connection with the breakdown which affected the whole system on Thursday, Jan. 9, from 6.45 p.m. to 8.28 p.m., that the cause was that the largest machine, on which they depend during the heaviest hours—from 4 p.m. to 8 p.m.—developed a short-circuit, and until it was put right there was not sufficient power to supply both lighting and tramway loads. Respecting two breakdowns on Jan. 24, during the latter part of the afternoon, the electrical engineer has reported that the cause was the falling of a guard wire, which disorganised the whole service. As this was a serious matter, he suggested that the tramway routes should be split up into small circuits, so that the failure at one point would not disorganise the whole system. He also pointed out that the cross-overs of the wires were uninsulated, and if one wire became faulty both wires were rendered useless. In his opinion, also, the guard wire stands were not of sufficient stability in the event of the wire falling. He stated that to this the second breakdown was due, and recommended that the overhead equipment should be so altered in order to obviate these unfortunate occurrences at an estimated cost of about £100. The electrical engineer also reported that the automatic circuit breakers were practically useless, and he has asked for instructions to remove them.

West London Tramways.—The rival agitations arising out of the local district councils' opposition to the speed and number of electric cars run by the London United Company have resulted in the company issuing a statement to passengers on the electric cars, in which they say: "The Chiswick, Brentford, and Acton District Councils, aided by a number of busybodies, are trying to restrict the car service and reduce the present speed. They want to put the clock back, and have actually had the audacity to propose that the cars should only run at the jog-trot speed of the old horse cars, regardless entirely of the 35 millions of passengers who are being carried annually on the London United cars." A petition to the President of the Board of Trade, which has been signed by 30,000 people, suggests that "if any alteration is to be made in the conditions regulating this valuable public service, it should rather be in the direction of giving facilities for running the cars at the rate of 12 miles an hour." A deputation from the Acton and Chiswick District Councils, and representatives of a number of religious bodies in the districts, waited upon Sir Herbert Jekyll, Mr. Trotter, and Col. Yorke, representing the Board of Trade, on Wednesday, to protest against the speed of the cars, but at the same time the above petition in favour of increased speed was presented. The Board of Trade representatives refused to make an order to reduce the number and speed of the trams, and overruled all the objections placed before them.

County Council's Electrical Engineer.—In dealing with the present organisation of the engineer's department of the London County Council, the General Purposes Committee have been called upon to consider the duties and position of Mr. J. H. Rider, who, early in the present year, was appointed as electrical engineer to the Council. On his appointment to this responsible office Mr. Rider was placed in the engineer's department, and the short result of the committee's deliberations is that he will in future carry on his duties under the tramways manager. A long report on the matter was presented at this week's meeting of the Council, in which the committee give their reasons for recommending the new arrangement. They point out that the engineering portion of the tramways staff (including the permanent-way engineer, the superintendent of works, etc.) is under the control of the tramways manager, and it seems to them to be not only desirable but natural that the same should be the case with regard to the electrical engineer if harmony of working and comprehensiveness of management are to be secured. It is to be remembered that this official will be responsible under the manager for the practical working of the lines when reconstructed, and many of the present tramways staff will be under his immediate supervision. In the view of the committee, therefore, it appears to be only consistent that Mr. Rider should be classed as an official in the department of the tramways manager, as is the permanent-way engineer, traffic manager, etc. This policy, it may be pointed out has been adopted in Glasgow, Manchester, Liverpool, and Leeds, among other large towns, and is said to have been found to conduce to efficiency of service. In coming to this conclusion, the committee realise that it will be necessary to arrange a course of procedure in the carrying out of schemes for the construction of new tramways or the reconstruction of existing tramways, so that there may be no misapprehension as to the scope of control by the chief engineer and the tramways manager. This is necessary, inasmuch as the schemes for new tramways or the reconstruction of existing tramways involve engineering works such as the widening of streets, construction of subways, interference with sewers, and the alteration of the headway of bridges. The course of procedure they suggest is as follows: (*a*) on the tramways manager submitting a proposal for a new tramway or the conversion of an existing tramway into an electrical tramway, the proposal shall be referred to

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the chief engineer for report from an engineering point of view ; (*b*) the manager shall prepare the drawings and specification of the electrical equipment portion of the work, and such drawings and specification shall form part of the complete plans and specification prepared by the chief engineer for the carrying out of the work ; (*c*) the chief engineer shall be responsible, in consultation with the electrical engineer as regards the electrical portion of the work, for the proper carrying out of the work by contractors, and on completion shall hand over the tramway to the tramways manager.

LIGHTING AND GENERAL.

Bootle.—Extensions of mains are to be made at a cost of £445.

Croydon.—Mr. A. Corner has resigned his position of assistant station superintendent.

Lytham.—Enquiries are being made as to the cost of laying down an electric plant at Lytham.

Macclesfield.—The Electricity Sub-Committee is to be called together at the earliest opportunity.

Monk's Kirby.—The Rural District Council have decided to oppose the Warwickshire Electric Power Bill.

St. Annes.—The committee have resolved that further incandescent electric lamps be fixed in a number of streets.

Nelson.—The electrical engineer is preparing plans showing the positions of feeder pillars for tramway purposes.

Boxhill.—The engineer has been instructed to extend the cables to Sunderland-avenue at an estimated cost of £150.

Wigton.—The Council have passed a resolution in support of the Leicestershire and Warwickshire Electric Power Bill.

Rugby.—The Urban District Council have decided to oppose the Leicestershire and Warwickshire Electric Power Bill.

Port Glasgow.—The Town Council have appointed a committee to consider the advisability of introducing electric light into the burgh.

Longton.—The output of electricity at the end of last quarter has reached a third of the capacity of the Town Council's present plant.

Nuneaton.—The Electric Committee are taking steps to interview the engineer of the Leicestershire and Warwickshire Electric Power Bill.

Blackpool.—The Electricity Committee of the Corporation have reduced the six candidates for the position of electrical engineer to three.

Elland.—An enquiry was held on Wednesday into the District Council's scheme for an electric installation and refuse destructor at a cost of £16,000.

Brompton and Kensington Electricity Supply Co.—The share transfer books of this Company will be closed from 22nd to 28th inst., both days inclusive.

Glasgow Association of Students, C.E.—At Tuesday's meeting Mr. Andrew Home Morton read a paper on "The General Arrangement of Power Stations."

Crook.—The electric lighting question is before the Urban District Council. It is thought that about £200 per annum could be saved on street-lighting by its installation.

Romford.—An offer from Messrs. Crompton and Co., Limited, to take on lease the Urban District Council's electric lighting provisional order is being discussed by a committee.

Worksop.—The Urban District Council recently reduced the price of current to 5d., and they are now being urged by the traders' association to make a further reduction of 1d. per unit.

Limerick.—Mr. Baker, engineer at the gasworks, has prepared plans and specifications for the foundation of the electric installation power-house. Advertisements for tenders will now be issued.

Felixstowe and Walton.—At the monthly meeting of the Urban District Council the opinion of counsel and correspondence with respect to the electric lighting order was discussed in committee.

Glossop.—The Urban District Electric Supply Company, Limited, have agreed to purchase a plot of land at Dinting as a site for a proposed generating station, with the approval of the Corporation.

Bristol.—The salary of Mr. F. W. Prosser, the secretary and accountant of the electrical department, has, on account of the growth of the undertaking, been increased to £300 per annum as from Jan. 1, 1903.

Epsom.—The Lighting Committee in their last report state that additional applications have been received for energy equivalent to 963 lights of 8 c.p., making a total equivalent to 2,013 8-c.p. lamps to date.

Broughty Ferry.—Mr. George Balfour has prepared an elaborate report regarding the two proposed sites for a generating station, which will be discussed after the Council have had an interview with him on the subject.

Tunbridge Wells.—Mr. David Smith has been appointed assistant electrical engineer. The erection of a number of new arc lamps is proposed. The salary of Mr. H. Bates, one of the assistant engineers, has been increased.

Telegraph Construction and Maintenance Co.—The directors propose paying a dividend of 10 per cent. (£1. 4s. per share), together with a bonus of 5 per cent. (12s. per share), in addition to the 5 per cent. already paid, making 20 per cent. for 1901.

Southgate.—At the usual monthly meeting on Monday of the Urban District Council, it was decided to oppose the North Metropolitan Electrical Power Distribution Company's application for a provisional order to supply the district with electrical power.

Sleaford.—The Electric Lighting Committee's last report states that they have borrowed £6,797, of which £5,452 has been expended. The total loss on the half-year's working amounts to £48. A further loan of £1,000 for extending the electric light plant has been sanctioned.

Eastbourne.—Action in the municipal telephone question has been deferred for nine months. In the meantime a canvass of the town will be made, and the town clerk has been instructed to secure a full note of the proceedings of the Local Government Board enquiry at Tunbridge Wells.

Farnham.—The Urban District Council have decided to invite Edmundson's Electricity Corporation, Limited, to submit their proposals in detail for giving effect to the Council's electric lighting provisional order, together with draft contract and agreement for lease of the undertaking.

Electric Construction Corporation, Limited.—Mr. A. B. Blackburn, who for several years has held the post of manager to the Electric Construction Corporation, Limited, Bushbury, has resigned. Mr. E. S. W. Moore and Mr. William Bullock have been appointed joint managers in succession.

Glasgow.—At the last meeting of the Town Council the refusal to admit the new Corporation telephones into the Glasgow Royal Exchange was considered. It was stated that the refusal was not due to the members of the exchange, but to the National Telephone Company, who were the lessees of the top flat.

Frome.—The committee appointed to deal with electric lighting have recommended the Council to apply for sanction to borrow £16,400, and to appoint Mr. F. H. Medhurst as consulting engineer at a commission of 5 per cent. on the original scheme and 3 per cent. on extensions, exclusive of out-of-pocket expenses.

Stamford.—A special committee of the Council is dealing with public lighting. No definite arrangement has been made, but it has been decided that, at any rate at present, no contract be entered into with the Urban Electric Supply Company, Limited, nor with the Stamford, etc., Gas Company for more than one year.

Morley.—The last report of the borough electrical engineer (Mr. Drewett) states that the output from the electricity works during the five weeks ending Jan. 18 was 16,214 units, against 12,531 units for the corresponding period last year, being an increase of 3,683 units, or 29·39 per cent. The total lamps to date was 8,375.

West Ham.—An agreement has been entered into with the National Electric Wiring Company, under which a system of free wiring is being instituted in the district. The accounts of the Council's installation show that during the past three months they were able to show a profit and to pay amortisation of capital and interest.

Batley.—In view of the erection of a refuse destructor close to the electricity station, it has been decided to make provision for the raising of the chimney to a height of 30ft. in excess of that shown in the original plans. The destructor will entail an expense of over £5,000, including new apparatus at £3,000, duplicate cells, etc.

Salford.—The Electric Light Committee recommended at the last meeting of the Town Council the shutting down of the Walness-road station. The Mayor said with regard to the complaints about this huge waste of money, that he was bound to believe that all the gentlemen who had been interested had acted with the best of intentions.

Ware.—At the last meeting of the Urban District Council the Chairman reported that the Lighting Committee had inspected the electric light works at Hertford, and there appeared to be no difficulty in the way of that company doing what was required at Ware. A storage station could be built at Ware, and the electricity distributed from that station.

Lutterworth.—A committee of the Urban District Council have reported upon the Warwickshire and Leicestershire Electric Power Bill, and the Urban District Council have agreed that practically no opposition be made to the Bill otherwise than by lodging a dissent in order for the better protection of the district roads, and to give the Council a voice if found necessary.

Taunton.—The Local Government Board have now given their decision in reference to the item of £2,000 for motors to be let out on hire, included in the original estimate for a loan. The Board, while recognising the advantage to a corporation of letting out motors, stated that under their present arrangements with the Board of Trade they had no power to sanction the item.

Pemberton.—A large number of applications have been received for current. Tenders for arc lamps and cables and tubing have been accepted. The law clerk has been instructed to write to the Local Government Board on the subject of office wiring, particularly calling the attention of the Board to the case of Walthamstow, where a loan for this purpose had been sanctioned.

New Firm.—The Safety Concentric Wiring Company, Limited, have changed their title to the Holloway Electric Supply Company, Limited, with an address at 6, Bovay-street, Holloway. The directors have decided to confine the business of the company to the electric supply station, where, we notice, they keep direct current up to 220 volts available day and night for charging motorcars or accumulators.

London Electric Lighting.—In the House of Commons on the 6th inst., Mr. G. Balfour, President of the Board of Trade, brought in a Bill to provide for the adjustment, in accordance with changes of boundary effected under the Local Government Act, 1899, of the areas within which local authorities and companies are authorised to supply electricity. The Bill was read a first time without discussion.

Battersea.—Application is to be made for sanction to the borrowing of the sum of £670 to defray the cost of electrically wiring and supplying the necessary fittings to the central and branch libraries. Ball-and-socket joints are to be provided to pipes for condensing plant at the central electric generating station in lieu of the ordinary face-to-face flanges as provided for in the contract, at an additional estimated cost of £96.

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Rotherham.—Mr. Edward Cross, the borough electrical engineer, has been instructed to prepare a report as to the cost of putting up arc lamps and posts and of lighting the streets by electricity, such information to be accompanied by particulars of the expenditure entailed by the system of lighting at present in vogue—viz., that of gas.

Wednesbury.—The Corporation intend to exercise all the rights and privileges conferred upon them under their electric lighting order. The delay which has taken place in carrying the order into effect is due to the protracted negotiations which have been going on for supplying electricity in bulk. The Gas and Water Committee, however, hope before long to present to the Council a scheme for the electric lighting of the town.

Agency.—We are informed that Messrs. Easton and Co., Limited, successors to Easton, Anderson, and Goolden, Limited, engineers, Broad-sanctuary, S.W., have appointed Mr. G. D. Seaton, 36, Islington-row, Edgbaston, Birmingham, their representative for the Midland Counties, including Derby, Herefordshire, Leicester, Lincolnshire, Northampton, Nottingham, Shropshire, Staffordshire, Warwickshire, and Worcester.

Charing Cross and Strand Electricity Supply Corporation.—The directors have decided to recommend a dividend for the half-year ended Dec. 31, 1901, at the rate of 12 per cent. per annum, making with the interim dividend already distributed, 10 per cent. for the year (as against 9 per cent. last year), and carrying forward £10,650, as against £3,485 last year. The equivalent of 75,957 8-c p. lamps have been added during the year.

Airdrie.—The Board of Trade having given their consent to the transfer by the Town Council to the Scottish House-to-House Company, Limited, of their electric provisional order, the company are now prepared to proceed with laying down the cable and other works for supplying the burgh with electric light. Positions for 181 ordinary and 15 all-night lamps, ranging from 16 c.p to 2,000 c p. nominal have been fixed.

Lift Accident.—Mr. John Troutbeck held an enquiry on Monday night at the Westminster Coroner's Court with reference to the death of Harry Black, aged 16 years, of 11, Nottingham-street, Marylebone, who was fatally injured by an electric lift at 79, Davies-street, Berkeley-square, where he had been employed as page boy for three weeks. The jury returned a verdict of accidental death, and exonerated the owners of the lift from all blame.

Dover.—Messrs. Bennett and W. P. Thompson and Co., Manchester, have written to the Council suggesting that the Council should apply for a telephone license, and when obtained, transfer it to the applicants, who would recoup the Council and work telephones in Dover at rates not exceeding £5. 10s. per annum. At the end of five years the Corporation to have the opportunity to repurchase the undertaking plus 20 per cent. on the outlay. No action has been taken so far.

Private Bills.—In the House of Lords the following Bills have been read a second time: Charing Cross, Euston, and Hampstead Railway (No. 3), Central London Railway (New Lines), Great Northern and City Railway. In the House of Commons the following Bills have been read a second time: Manchester Corporation Tramways, Norwich Corporation (Electricity, etc.), Brighton and Rottingdean Seashore Electric Tramroad, and South Wales Electrical Power Distribution.

Electric Motorcar Exhibition.—Niagara skating rink has been acquired by Mr. Paris Singer, chairman of the City and Suburban Electric Carriage Company, manufacturers of electric carriages to her Majesty the Queen. This company only started business in April last in their large building in Denman-street, but owing to lack of accomdation the Niagara building will shortly be opened as a permanent exhibition for the sale of electric carriages, and will accommodate about 800.

Bournemouth. — The following recommendations have been adopted: "(*a*) that the Telephone Company be informed that unless a substantial reduction is made in their rates in the borough, the Council will apply to H.M. Postmaster-General for a license to enable them to provide a municipal telephone exchange, and that an early reply be requested"; "(*b*) that the surveyor be authorised to lay down extra spare ducts in accordance with his report"; "(*c*) that the matter be referred to the Tramways and Parliamentary Committee to carry out."

Kent Power Bill.—At the adjourned meeting of the local authorities of Kent at the Westminster Palace Hotel last week the paragraphs of the Bill were carefully gone through, after which it was decided to appoint a small committee of five of the representatives of some of the chief places in the county to meet the promoters of the Bill and explain their views. In the meantime it was decided to go on with the opposition to the Bill. The representatives will be called together again to receive the report of the committee.

Post Office Telephones.—The Post Office expect that at the end of this week or at the beginning of the next a small portion of the new telephone system will be opened to the expectant subscribers, but it will probably be another two months before all the eight exchanges are in working order. Each portion will be opened, without further ceremony than that of calling the subscriber, as soon as it is completed and has passed the tests. Provision has been made for 30,000 subscribers, but up to the present only 2,000 have been persuaded to join.

Hackney.—At the meeting of the Borough Council last night an estimate submitted by the Electric Lighting Committee in respect of revenue and expenditure for the period Nov. 1, 1901, to March 31, 1902, which shows a loss of £3,000 on the five months' working, was submitted. The committee did not desire to offer any observations upon the estimate further than than that no provision had been made in the estimates of the Council for the year ending Lady Day, 1902, and accordingly recommended that the consent of the Council be given to such expenditure.

Northampton Electric Light and Power Co.—We have been asked to state, in reference to the issue of ordinary and preference shares now being made, that prospectuses and forms of tender can be obtained at the Company's offices, 2, St. Giles-square, but that, as far as possible, existing shareholders will be considered to have the first claim. Four per cent. debentures, at a premium of 2 per cent., will be issued from time to time, and applications will be dealt with in order of date.

Keynsham.—The Bristol Corporation Lighting Bill proposes to enable the city to light that part of Brislington which is in the district covered by the Keynsham Urban District Council, and, if passed, will prevent any other persons from providing electric light for that area. The Urban District Council have decided to petition against the Bill unless the Corporation consent to a clause enacting that the powers which the Bill seeks to confer on the Corporation shall not be exercisable within the Keynsham rural district without the consent of the District Council.

Walker.—The Newcastle Electric Supply Company have laid and completed all the distributing cables for private lighting in this district, with the exception of Scrogg-road, and can now supply current for light and power. The company will also erect a sub-station to meet further developments. This sub-station is needed to meet the probable demand for energy by the Newcastle Corporation, and is in addition to the Council's works, and will be at the supply company's cost, and at the termination of the agreement the company will remove the sub-station and plant and machinery which may then be in the sub-station.

Colchester.—A notice has been given of a motion calling the Council's attention to the telephonic facilities at present existing in the borough, and to ask that a committee be authorised to consider and report upon the question of establishing a municipal telephonic service. The last report of the Electric Light and Power Committee specially mentions the promptitude and capability displayed by Mr. F. J. Humphrey (an articled pupil) in an emergency. The report also showed that the output of electricity in units during 1901 was 28,732. against 19,443 in the previous year, and that the consumers had increased from 150 to 240.

Institution of Electrical Engineers.—A meeting of the Glasgow Section of the Institution of Electrical Engineeers was held on Tuesday in the hall at 207, Bath-street, Prof. Magnus Maclean in the chair. The chairman explained that Colonel Crompton had arranged to give an address on electrical matters connected with the war in South Africa, but could not do so owing to the fact that the War Office had determined that no one who was employed by them on confidential scientific work should, for the present at any rate, lecture on any military subject. The discussion of Mr. John C. Ward's paper on "Continuous-Current Distributing Mains" was then resumed.—*Glasgow Herald.*

Stock Exchange.—The Stock Exchange Committee have ordered the Folkestone Electricity Supply Company's £50,000 4½ per cent. first debenture stock to be quoted in the official list. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to the London United Tramways (1901), Limited, 5 per cent. cumulative preference shares of £10 each, fully paid, 5 per cent. cumulative preference shares of £10 each, £5 paid, 4 per cent. first mortgage debenture stock and provisional certificates of 4 per cent. first mortgage debenture stock. The committee has also been asked to allow the following securities to be quoted in the official list: Central Electric Supply Company's £250,000 4 per cent. guaranteed debenture stock, and Central London Railway's £698,201 4 per cent. debenture stock in lieu of the provisional certificates now quoted.

London County Council.—Notices under Electric Lighting Acts and orders have been agreed to as follows: from the Metropolitan Electric Supply Company, under the Mid-London Order, 1889, and the Metropolitan Electric Lighting Act, 1899, to lay low-tension armoured mains from Sardinia-street along Little Wild-street, Great Wild-street, Great Queen-street, across Drury-lane, and along Long-acre to Upper St. Martin's-lane, from the County of London and Brush Provincial Electric Lighting Company, under the Wandsworth Order, 1892, to lay low-tension mains along Mount Ephraim-road and Woodfield-avenue, and high and low tension mains along Sutherland-road and Melrose-road, and to construct a transformer box in Melrose-road; and from the Brompton and Kensington Electricity Supply Company, under the House-to-House Electric Light Supply Order, 1889, of intention to lay low-tension mains along a portion of Elm-place.

Ipswich.—At Wednesday's meeting of the Town Council, the Electric Lighting and Tramways Committee presented reports from Messrs. Kennedy and Jenkin, the consulting electrical engineers to the Corporation, and plans showing the general arrangement of the generating station, car-sheds, and destructor on the Seven-Acre Field site. They recommended that a siding from the Great Eastern line should be run into the field, for which purpose they had entered into negotiations for acquiring the necessary land from Mr. Edward King, the present lessee; and, finally, that application should be made to the Local Government Board for leave to borrow £70,300—to be repaid, £22.000 in 35 years and £48,300 in 25 years—for the following purposes: boilers of the dry-back marine type, £5.000; six engines and dynamos, with condensers, economiser, crane, steam, feed, and all other pipe work, and accessories, £19.100; water-softening plant, £2,500; one battery of 400 ampere-hours capacity, £1,400; one switchboard, with boosters and connections, £2,400; station buildings, £22,000; distributing mains and feeders, including also lighting of generating station, £10,900; meters and house service connections, £800; 85 arc lamps and posts, with all leads and connections, £2,900; engineers' and architect's charges, £3,300. The previous estimate was £58,400. The general arrangement of the generating station, car-sheds, and destructor were approved.

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Spennymoor.—The electric light company has for some time past been making every effort to complete the laying of the cables, and it is anticipated that the electric light will be switched on before the Urban District Council makes the next contract for street-lighting. It will then be a question for the Council, the tradespeople, and residents of Spennymoor to decide as to which light is to be generally adopted. Already the electric cables are completed for a distance of over two miles.

Bury St. Edmunds.—The last report of the resident electrical engineer stated that since the January meeting of the Electric Lighting Committee, 22 street lamps had been converted and erected, making a total of 107. Applications had been received equal to 136 8-c.p. lamps. The engineer also reported that, with the approval of the chairman and vice-chairman, he had placed an order with Messrs. Callender and Co. for nine miles of cables on very advantageous terms. These cables would complete all the street-lighting, and allowed two miles for private consumers. The committee had instructed the engineer to obtain tenders for extending the engine-room.

Aylesbury.—The Electric Lighting Committee of the Urban District Council are considering a statement from the North Metropolitan Electrical Power Distribution Company upon which it is suggested that the contract with the company should be based. A former resolution of the Urban District Council, to the effect "that the Council enter into negotiations with companies for the execution and maintenance for a term of years of the works needed for the supply of electricity within the urban district of Aylesbury and for the supply of electricity within such district, etc.," has been rescinded as far as it referred to the question of the site of the station being the property of the Council.

Ayr.—The electrical engineer, Mr. A. J. Fuller, has reported that arrangements have now been made for the connecting up of consumers to the new direct-current system. The whole of the material is now forward for the extra arc and incandescent lamps along the tramway route. The new electric and steam pumps for the extensions are now on the site and being erected. The number of consumers, as per last report, was 502; number of consumers connected during month, 5—total, 507. Number of lamps connected, as per last report, 21,378; number of lamps connected during the month, 301—total, 21,679. Units generated, as per last report, 401,571; units generated during month, 92,969.

Coseley.—The Midland Electric Corporation for Power Distribution, Limited, have informed the Council that their charge for public lighting would be 1s. 6d. per unit for incandescent arc lighting, and where the company found mains, posts, lamps, cleaning, repairs, etc., during 3,600 hours per annum for each 25-c.p. lamp, it would be £2. 18s. 6d. Deductions were referred to should the Council provide the requisitions, and for each arc lamp equal to 2,000 c.p. nominal, the local authority providing all capital expenditure, and the company the current, carbon, etc., the cost would be £16. 10s. It will probably be necessary to lay down 20 miles of mains to supply all the streets. No decision has been arrived at on the matter at present.

Barrow.—The City Council have adopted the following report of the Electricity Committee: "Resolved to recommend that the borough electrical engineer write to the British Electric Traction Company informing them that it is the intention of the Corporation to lay electricity mains in certain streets during the present year, and that it is desirable that the cables required by the company for the working of the tramways should be laid at the same time, the Corporation are prepared to do the necessary opening and reinstatement of ground in such streets." Application is to be made to the Local Government Board for their sanction to the Corporation borrowing a further sum of £20,000 for the purposes of electric lighting.

Canterbury.—The receipts of the Lighting Committee for the quarter ending Dec. 31 last were £1,697. 13s., which, deducting works expenditure (£707. 4s. 7d.) and loan repayment and interest (£459. 5s.), leaves a net profit of £531. 3s. 5d. The committee hope by the end of the end of the financial year in March to be able to show a profit of something like £1,000 on the electric light, including revenue from all sources, both public and private. The public light is charged for at a reduced price of 2½d. per unit, as compared with 6d. per unit paid by private consumers. The committee have received from private sources revenue to the amount of £1,298. 5s. 7d., for public lighting £363, and meter rents £36, making a total of £1,697.

Cardiff.—The electrical engineer and manager stated at the last meeting of the Electric Lighting Committee that the receipts up to December practically amounted to more than was estimated for the whole 12 months. From the returns it appeared that they were going to have an increase of over £4,000 in revenue instead of £1,750 as estimated. In other words, they had up to date made over £11,000, and the heaviest quarter's receipts had yet to come in, and these would probably amount to £4,000 odd, making approximately a total for the year of £15,450—over £2,000 above the amount estimated. It was agreed to extend the mains from Tudor-road to the junction of the Penarth and Corporation roads at a cost of £270.

Doncaster.—The Electricity Committee last October reduced their charges for current for lighting purposes from 5d. per Board of Trade unit to a sliding scale of from 5d. to 3d., depending upon the length of time the maximum demand of current is used, that for power purposes being reduced from 3d. to 2d., and for large consumers to even 1½d. per unit. Of the accounts for the quarter ending Dec. 31 sent out no less than 89 per cent. reach the 4½d. rate on the sliding scale, while 62 per cent. reached the lower or 3d. rate. These figures show that the long-hour consumers obtain a great reduction in their accounts. The average price obtained by the Corporation for the current sold last quarter works out to 4½d. per unit.

Southport.—The Town Council are corresponding with the Ormskirk District Council, who have asked whether the Town Council were prepared to supply them with energy in bulk. Negotiations have been entered into with the District Councils of Ormskirk, West Lancashire, Lathom and Burscough, and Skelmersdale, with regard to the proposal of the Corporation to establish a telephone exchange. Consequently a resolution has been passed fixing the area included into the application to the Postmaster-General for a license to establish a telephonic exchange for the townships of Southport, Birkdale, Ainsdale, Bickerstaffe, Formby, Altcar, Downholland, Scarisbrick, Halsall, North Meols, Aughton, Ormskirk, Skelmersdale, Latham, Burscough, Bispham, Hesketh, Lydiate, Maghull, Melling, Rufford, Simonswood, and Tarleton.

Wireless Telegraphy.—The following "Dalziel" is making the round of the daily Press: "The *Corrier della Sera* publishes an account of an interview its London correspondent has had with Mr. Marconi. The latter is reported to have said that he was ready to pay £100 to anyone who could interrupt and read one of his messages; and that he intended to begin by cutting the Transatlantic cable rates by one half, and afterwards reduce the present rate for short-distance inland telegrams. Asked why he left Italy, Mr. Marconi said the Italian Government gave him every encouragement, but it was only in England and America that he could find the capital he required, the experiments alone costing £200,000. His company had now a 15 years' contract with the British Government for a wireless naval service at £10,000 a year."

Newport.—A special meeting of the County Council was held on Monday for the purpose of considering the new proposals of the South Wales Electrical Power Distribution Company to acquire additional lands, etc., and to authorise the presentation and prosecution of a petition against the proposals. It was explained that the Corporation successfully resisted the company's Act of 1900, and obtained protection from Parliament against the company coming into Newport either by way of erecting a generating station or laying mains to compete with the supply of electrical energy the Corporation were themselves creating or had taken powers to create. The new proposals of the company asked for leave te establish generating stations anywhere within their area of supply, and their area of supply by the Act of 1900 included Newport. After discussion, it was decided to petition against the South Wales Electrical Power Company's proposal.

Hampstead.—The Borough Council have asked the London County Council for a loan of £7,480 (part of £7,630), repayable within 42 years, for expenditure on electric light mains during the year to March 31, 1901, the borrowing of such sum having been sanctioned by the London County Council. A number of works are to be carried out and goods obtained during the ensuing financial year, in order to provide for the probable additional demand for electric current during next winter, and in order to improve the supply, at a total estimated cost of £5,566. The electric lighting of Heath-street has been referred to the Lighting Committee. The same committee have reported that Part 11 of the same Bill seeks to give power to any metropolitan borough council authorised to supply electricity to expend money upon wiring and fitting the premises of their consumers and to make charges for them. The committee are of opinion that this is an excellent provision.

Floating Dock.—The great floating dock, said to be the largest in the world, which has just been launched from the yard of the builders, Messrs. C. S. Swan and Hunter, Limited, of Wallsend-on-Tyne, has been built to the order of the Admiralty, and will probably start for its destination at the beginning of the summer. An electric light installation, with its own generating plant, is provided in one wall for lighting all the interior compartments of the dock, and in addition 12 arc lamps are carried on gallows on top of the towers, which light up when required the whole dock and ship, whilst further mains are led along the dock's sides from which hand-lamps may be taken off to light up any particular spot where special work is being carried on. A very useful fitting for handling weights either on the dock or ship will be found in the travelling and swinging electric cranes which run along the whole length of each wall. The dock will remain in the Tyne until the fittings are completed, and in the early spring she will be towed to Chatham, where her trials will take place.

Hammersmith.—On Wednesday the electrical engineer submitted the following particulars of the number of applications received, connections made, and other information, corrected to the date of the meeting held on 31st ult.: total number of applications received, 1,206 for 60,506 8-c.p. lamps; duplicate applications (change of tenants), 78 for 3,009; applications for premises beyond mains, 18 for 732; applications withdrawn, 25 for 682; duplicate applications (extensions), 17 for 774; new applications since Jan. 16, 1902, 12 for 2,324; applications to be dealt with, 1,163 for 59,092; total number of connections made, 1,154 for 52,602; awaiting connection, 9 for 6,490; consumers disconnected, 187 for 8,139; consumers connected since Jan. 16, 1902, 5 for 103; net number of consumers now taking supply, 967 for 44,283 8-c.p. lamps. Statutory notice is to be served upon the Kensington and Notting Hill Electric Lighting Company to abate, and to take the necessary steps for preventing the recurrence, of the nuisance caused by the emission of black smoke from the chimney shafts of their premises in the borough.

Plymouth.—The return for the December quarter of the electricity works shows the total sold 259,065 units, and the receipts at £3,748. The total takings last year were £6,800, and the chairman of the Electric Lighting Committee on Tuesday said they would find this year that they would be at least £6,000 in excess of that sum. At the present rate of progress, next winter they would be in a very serious difficulty in furnishing the supply of electricity as they wished and were bound to do by their order. Therefore they had now to look ahead to the proposed extension, at a cost of £22,000, and as the new machinery would take nearly 12 months to fix, they must order at once in preparation for next winter. Of the total, £10,000 would be for the extension of mains and giving greater facilities of service. It was thought that for the next 12 months an expenditure of £12,000

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would be sufficient. During the last few days there had been a great many enquiries for electricity for illuminating purposes during the Royal visit, and the committee would put in the necessary services at cost price, and not charge consumers more than the current rate of 4½d. per unit.

Swansea.—The last report of the electrical engineer, Mr. C. A. L. Prussman, states that the total number of units sold since the time when electrical energy was first available at Swansea was 196,306, with an average price of 3·493d., which figures are exclusive of the street-lighting from midnight to dawn. The average price obtained from customers during one light and one dark quarter was 3·47d. The resignation of Mr. Bayntum, one of the assistant engineers, who is going abroad, has been accepted. The sub-committee's report and the engineer's statement respecting the proposed addition to the plant at the electric lighting station were adopted by the Electric Lighting Committee last week. This extension involves an expenditure of £20,700, and provides for doubling the present capacity of the station. The amount already expended on the scheme has been about £59,000. It is understood that the additional plant will be obtained with all possible dispatch. It has also been agreed to charge for electricity for power and heating purposes 2d. per unit for the first five hours of maximum demand, and 1½d. for all current consumed beyond their five hours.

Westminster.—The City Council are now carrying out a contract originally entered into by the Vestry of St. George, Hanover-square, for lighting that parish by electricity. The area covered extends from Down-street, Piccadilly, where the County Council improvement scheme ends, to Bond-street and Regent-street on the east, and north of Piccadilly as far as Oxford-street, which is under the jurisdiction of St. Marylebone Borough Council and lighted by incandescent lamps. A portion of the district, extending from Hamilton-place to North Audley-street eastward, is already illuminated by electricity; the standards and carriers have been fixed in the remainder of the streets and Hanover-square, and in the course of a few days the arc lamps will be supplied and the electric light turned on. Hamilton-place and Park-lane are already lighted by some 30 arc lamps, the candle-power varying from 60 to 100, and on Tuesday workmen were engaged removing the old lamp-posts. The contiguous parishes of St. James and St. Martin have been lighted by electricity for some time (including Regent-street, the east end of Piccadilly, and Whitehall as far as the Horse Guards.—*Pall Mall Gazette.*

Electrical Pumping.—We gave some particulars of electrical pumping in our last issue. We are now informed that an extensive electrical pumping plant has just been completed by Messrs. Ernest Scott and Mountain, Limited, of Newcastle-on-Tyne, for the Eldon Colliery, near Darlington, of the South Durham Coal Company, which, it is stated, will be the largest electrical pumping plant in the North of England. The plant consists of a compound horizontal engine of 450 h.p. with a generator of 250 kw. capacity, the E.M.F. at the terminals being 500 volts. The generating plant is situated at one of the company's pits, about 800 yards from where the pumping is required, the current being carried overhead by conductors on poles and taken down the shaft by heavily-armoured cables to two sets of three-throw horizontal pumps, each set of pumps delivering 500 gallons per minute, or, collectively, 1,000 gallons against a head of 400ft. Each pump is driven by a motor of 120 effective horse-power by means of cotton ropes, as it is found that an elastic medium such as ropes or belts is an advantage between pumps and motors, as it takes off the shock when working under heavy loads.

Accident.—At about 11 o'clock on Saturday morning one of the mains belonging to the Hydraulic Power Company, laid from East-cheap up Rood-lane, in the City, burst, and flooded the whole neighbourhood. The water soon stood several inches deep in the tunnel of the Underground Railway, between Monument and Mark-lane Stations. The flood interfered considerably with the electric lighting arrangements at a time when the City, owing to the atmospheric conditions of the moment, was plunged into almost complete darkness. At the Customs House the whole of the electric lights suddenly went out, and business during the remainder of the day had to be transacted by the aid of candles, the scene in the great hall being an extraordinary one. Many offices and business places also suffered from a similar cause, while a number of lifts depending on the hydraulic power were for the time rendered useless. In the Underground tunnel the services of a fire-engine were requisitioned for the purpose of pumping the water out, but fortunately no great delay of the passenger traffic was occasioned. It is believed that the burst was due to the settlement of the ground after repeated excavations near the spot.

Lowestoft.—The Electric Lighting Committee's last report states that their receipts during the half-year ended Dec. 31 amounted to £1,761, and the working expenses to £839. 9s. less than that sum. The works received a contribution of £930 from the general district rate, but for the half-year ending June 30 next the committee estimated they would only require £916. They would this half-year have to pay £1,650 instalment of principal and interest on loans of £50,000, but would realise £1,761 by sale of current to private consumers and public lighting. The resident electrical engineer's report is to the effect that there are now 10,350 8-c.p. lamps connected to the mains, 159 additional lamps having been connected during the last month, representing eight more consumers, giving a total of 214 consumers. The average price obtained was 5·2d. per unit private lighting, and 2½d. for public lighting. The committee's recommendations that the Corporation should take over the work of laying in the house services and other small extensions, that the matter of further street-lighting be deferred, and that, in case it should become necessary to light particular streets, each street should be dealt with upon its merits as it arises, and the cost charged to the loan, have been adopted.

The Manchester Switchgear.—The Manchester Corporation recently placed a very large contract for switchboards with Messrs. Ferranti, of Hollinwood. This contract includes a switching gear for a capacity of 12,000 h.p. to be generated at the new Stuart-street station, and it also includes complete high and low tension equipment for 10 sub-stations, which are to contain motor-generators for traction and lighting loads. The whole is to be delivered complete in nine months, and, comparing it with the previous contract, the cost must be quite £30,000. This is a typical example of the progress made in this country by large contractors. Messrs. Ferranti, anticipating a large demand in the future for their well-known apparatus, are equipping an extensive building with the latest machinery, and in order to be ready to meet demands for switchgear, which must shortly be required by the many power transmission and distribution schemes now in course of construction, their new building will be large enough to engage over 500 men. It is expected that this new factory will be in complete working order within six weeks. In view of the keen foreign competitors, it is with satisfaction that we note switchgear industry in this country is being dealt with in a way that will ensure economical production, and will maintain the supremacy in design, which has hitherto been the characteristic of British production.

Hull.—The Council and representatives of the National Telephone Company are to confer with regard to the threatened telephone stoppage. Mr. William E. L. Gaine, of the National Telephone Company, has written to the Corporation with respect chiefly to the notice served upon the company by the Corporation determining the way-leaves, complaining that the Corporation appeared to intend to leave the company alone until their duplicate plant is ready, and then to change competition into a monopoly by ordering the company away, and destroying their property. This position his company would not accept, and he asked "whether (1) the Corporation require the company now to remove its wires from under the streets, or is the company to regard the notice as withdrawn? and (2) is the Corporation willing to meet the representatives of the company to discuss the whole question?" With regard to the threat of the company to bring the service to a stop in Hull in the event of the Postmaster-General granting the Corporation a license, Mr. Gaine said: "My Board instructs me to make it perfectly clear, not by way of threat, but simply as a matter of settled policy, that if a license is granted to the Corporation, and no relief from the present position can be obtained, it will not go on providing the telephonic service of Hull as a trespasser with the risk of having its property confiscated when the Corporation think fit so to do."

Hereford.—The Town Council have adopted a report of the Electric Lighting Committee stating that the engines and machinery continue to give satisfaction, and that the engineer is much pleased with the 250-kw. engine, which has been working now for nearly three months. The cable in Widemarsh-street having given trouble, the Silvertown Company, on having its defects brought to their notice, at once agreed to lay a fresh cable at their own cost, and the committee have determined to take the opportunity of laying one two sizes larger than the existing one. The cost of the cable, with some additional connections, will be £138. 5s. 1d., from which has to be deducted the cost of the existing cable, £64. 7s. 9d., leaving a net cost to the Corporation of £73. 17s. 4d. The financial results of the undertaking for the year 1901 are as follows: total units sold, 95,476; of these there were charged at 6d. per unit, 66,090, £1,652. 5s.; there were charged at 4d., being the rebate after one hour's use of the maximum demand, 20,425, £340. 8s. 4d.; there were supplied for power and charged at 3d., 6,691, £83. 12s. 9d.; and supplied for power and charged at 2d., 2,270, £18. 18s. 4d.; meter rents, £91. 1s. 9d.—total, £2,186. 6s. 2d. The working expenses for the year, including wages, salaries, oil, coal, waste, and sundries, were £981. 15s. 10d.; interest, £528; leaving a profit towards repayment of capital of £676. 10s. 4d. The current supplied is in excess of that supplied in 1900 by nearly 30,000 units, but the increase in the receipts is only £580, a smaller increase than the enlarged consumption would suggest, but this is principally due to the reduction to 4d. per unit after the first hour's use of the maximum demand. The committee have also determined to supply current for power only on the following terms: for the first 3,500 units in each year, 3d. per unit; for any excess to the same customer, 2d. per unit.

Brighton.—The report of Committee of Selection on the subject of telephonic communication in the Brighton telephone area states that the Postmaster-General has granted to the Brighton Corporation a license for the establishment of telephonic communication over an area comprising that county borough, the borough of Hove, the urban districts of Portslade, Southwick, New Shoreham, and Burgess Hill, and also certain parts of rural districts adjoining them. The area was that which was comprised within a straight line drawn from the sea coast at a point about three-quarters of a mile east of Portobello coast-guard station in Rottingdean to Mount-pleasant in East Chiltington, thence to near Bride's Mill about 1½ miles to the north-west of Burgess Hill railway station, thence to near Lashman's Hill about a mile north-west of Henfield, thence to a point about a mile west of Steyning, thence to a point near Applesham Farm, in Coombe parish, and thence to the sea coast nearly due south of the Norfolk Bridge near Shoreham; and it took in parts of the rural districts of Newhaven, Chailey, Cuckfield, Steyning East, and Steyning West. The powers given could not be exercised by the licensees without the consent in any urban district (including boroughs) of the urban district council and elsewhere—*i.e.*, in the rural part of the telephone area—of the county council, and were to be exercised subject to any terms and conditions which the urban district councils or county council respectively might attach to such consent. The County Council of East Sussex—within which much the greater part of the telephone area was situated—have given their consent by an agreement, the substantial provisions of which were that the Corporation of Brighton were to pay a wayleave of 5s. per mile per annum to the road authority for the use of the main and district roads respectively within the area; that the poles shall be of such a descrip-

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tion as the road authority's surveyor should approve (subject in the case of a difference as to poles on district roads to the decision of the county surveyor), and should be fixed to the satisfaction of the road surveyor, all damage to the road being made good; and that the charges for the use of the telephone to subscribers in the administrative county should not exceed those made for similar services to subscribers within the county borough of Brighton. The power was also reserved to the County Council to require the removal of all or any of the works. The committee thought that these terms were very satisfactory, and had approved an agreement on the same terms for the benefit of the road authorities and County Council of West Sussex, as regarded so much of the rural area as was in West Sussex, and had authorised the common seal to be affixed thereto. As the National Telephone Company would now be subject to competition with the Brighton Corporation as licensees of the Postmaster-General within the Brighton telephone area, the committee thought it reasonable that the charges for wayleave made to the National Telephone Company should in future be the same as those made to the Brighton Corporation, and recommended accordingly. The report was adopted at the last Council meeting.

PROVISIONAL PATENTS, 1902.

FEB. 3.

2682. Improvements in or in connection with shade-holders for incandescent electric lamps and the like. Herbert Farrar, 62, Market-street, Manchester.

2689. Improvements in apparatus for turning or grinding in position the commutators of dynamo-electric machinery. Wesley Sutton and Samuel Lord, 34, Castle-street, Liverpool.

2694. Improvements in or relating to knobs or buttons for electric switches. Frank Greig Bucher, 115, St. Vincent-street, Glasgow.

2700. Telephone exchange circuit. Gustav Lambert, 62, St. Vincent-street, Glasgow.

2701. Improvements in telephone line jacks. Gustav Lambert, 62, St. Vincent-street, Glasgow.

2720. Improvements in car platform adjusters. The British Electric Car Company, Limited, 83, Cannon-street, London. (James A. Trimble, United States.)

2732. Improvements in coin-freed electricity meters in part applicable to other purposes. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

2736. Improved magneto-electric ignition apparatus for gas-engines. Gottlob Honold, 322, High Holborn, London. (Complete specification.)

FEB. 4.

2763. Adjusting appliance for electric tramcar trolleys. Edward Hall Lawson, Crown-chambers, Side, Newcastle-on-Tyne.

2774. Improvements in electrical switches. Robert Frederick Hall, 24, Temple-row, Birmingham. (Complete specification.)

2820. Improvements in voltmeters. Pompeo Garuti and Riccardo Pompili, 55, Chancery-lane, London. (Complete specification.)

2825. Improvements in time electric switches. Henry James Cogswell, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2828. Improvements in rail bonds or connecting strips for electric railways. Morris Fearing Whiton, 45, Southampton-buildings, Chancery-lane, London.

2840. Improvements in street lamps or lanterns for incandescent electric light. Eadley Stanley and the British Prism Globe Electrical Company, Limited, 173, Fleet-street, London.

2847. Improvements in or relating to electric cables. Samuel Bibby, 111, Hatton-garden, London.

2869. Improvements in and relating to automatic fuse cut-outs and cut-ins. Albert Vandam and Thomas Herbert Marsh, 322, High Holborn, London.

FEB. 5.

2950. Improvements in and relating to electric distribution systems. Charles George Watson, 322, High Holborn, London.

2959. Improvements relating to telephone systems. Albert Koch Andriano, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2984. Improvements in apparatus for use in starting and controlling electric motors. Arthur Henry Adams and John Thomas Mould, 11, Southampton-buildings, Chancery-lane, London.

FEB. 6.

2990. Improvements connected with incandescent electric lamps. James Swinburne and Maurice Solomon, 82, Victoria-street, London.

2999. Improvements in and relating to casings or conduits for electric wires. Charles John Wightman and Arthur Hudson, 2, Market-street, Bradford.

3024. Improvements relating to electric traction by the surface-contact system. Baptistin Cruvellier, 34, Belvoir-street, Leicester. (Complete specification.)

3059. Improvements in and connected with current collectors for electric vehicles. Louis Lavagne and Louis Bertrand, 6, Lord-street, Liverpool.

3061. Improved automatic shunt coil core for arc lamps. A. E. Carter, 64, Church-street, Brighton.

3063. A double-acting arc-lamp brake for the perfect feeding of the carbons at a uniform rate. Frank Carter, 2, St. James's-street, Brighton.

FEB. 7.

3116. Improvements in safety fuses for electric circuits. Arthur Denby Smith, Sunbridge-chambers, Bradford.

3134. Improvements in or relating to trolley heads used in connection with overhead wires for electric traction. John Greenwood and Joseph Hartley, 33, Chancery-lane, London.

3141. Apparatus for repeating semaphore signals by electric bell in cab of engine during foggy weather or falling snow. Ernest Twaits, 21, South Everard-street, King's Lynn, Norfolk.

3142. Improvements in or relating to safety devices for electric overhead conductors. Alfred Julius Boult, 111, Hatton-garden, London. (Luigi Negro, Italy.)

3153. An electromagnetically operated switch for opening and closing an electrical circuit. Claude Edward Gillett Gilbert, Chingford, Essex.

3154. Improvement in sockets for uniting two telegraph wires. Salomon Frank, 36, Chancery-lane, London. (Complete specification.)

3157. Improvements in arc lamps. Haydn Thies Harrison and the Improved Electric Glow Lamp Company, Limited, 1, Queen Victoria-street, London.

3163. Improvements relating to the secondary circuits of alternating currents. Robert Grisson, 45, Southampton-buildings, Chancery-lane, London.

3165. Improvements in and relating to multipolar electrical machines. David Bergman, 18, Buckingham-street, Strand, London.

3176. Improvements relating to telephony. Thomas Joseph Rorke and Edwin Rorke, 45, Southampton-buildings, Chancery-lane, London.

FEB. 8.

3224. Improvements in switch systems for telephone circuits. Luigi Cerebotani and Moriz Baumer, 111, Hatton-garden, London. (Complete specification.)

3227. Improvements in or relating to electrical ship log apparatus. Thomas Ferdinand Walker and Thomas Sydney Walker, 55, Chancery-lane, London.

3248. Improvements in electric signal register and telephone systems. Peter Jensen, 77, Chancery-lane, London. (The Yurgae Signalphone Manufacturing Company, United States.) (Complete specification.)

3256. An improvement in the terminals of electric fittings. Charles Morrison Johnston, 70, Chancery-lane, London.

3259. Improvements in mercury vapour electricity lamps. Ernest Schattner, 55, Chancery-lane, London.

3272. An improved method of making carbons for arc lamps and the like. William Phillips Thompson, 6, Lord-street, Liverpool. (C. Conradty, Germany.)

3273. Improvements in processes for making carbons for arc lamps and the like. William Phillips Thompson, 6, Lord-street, Liverpool. (C. Conradty, Germany.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Feb. 27.

1900.

21827. Sealing wires into electric incandescent lamps and other glass apparatus. Soc. Edison per la Fabricazione Delle Lampade Ing C. Clerici et Co. (Date applied for under International Convention, June 16, 1900.)

1901.

2834. Telegraph apparatus. Creed and Coulson.

4501. Electric switches. Coxson.

5496. Electric meters. Batault. (Date applied for under International Convention, Aug. 17, 1900.)

5719. Bearings for trolley heads on electric tramcars. Birkby and Birkby.

5764. Obtaining zinc by electrolysis and apparatus for that purpose. Mond.

6042. Printing telegraphs. Kamm.

24052. Globes or shades for incandescent electric lights. Fleming.

24557. Fuse plugs for electric cut-out blocks. Sachs.

25143. Telephone transmitting instruments. Sensenschmidt.

25219. Controlling devices for electric motors. Johnson. (Electric Controller and Supply Company.)

25942. Surface-contact electric railways. British Thomson-Houston Company, Limited. (Potter.)

26131. Electric insulators for high-potential lines. British Thomson-Houston Company, Limited. (Barry.)

26690. Electric arc lamps. British Thomson-Houston Company, Limited. (Thomson.)

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26698. Systems of electric distribution. British Thomson-Houston Company, Limited. (Steinmetz.)

26729. Electric battery. Bain and Hunt.

26743. Electric arc lamps. Hallberg.

1902.

77. Method and means of registering the consumption of electric current or other forms of energy developing heat. Isham.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	Feb. 8	566	528	+ 38	26,924	24,819
Birmingham Tramways	—	—	—	—	—	—
Blackburn Corporation	,, 7	591	396	+ 195	3,357	2,855
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 8	153	139	+ 14	883	814
Bolton Corporation	,, 2	1,360	1,242	+ 118	7,465	6,654
Bradford Corporation	,, 2	1,168	655	+ 513	5,146	3,588
Bristol Tramways Company	,, 7	3,587	3,320	+ 267	—	—
Carlisle Tramways Company	,, 8	109	100	+ 9	698	631
Central London Railway	,, 8	6,534	6,129	+ 405	39,413	36,707
City and South London Railway	,, 9	3,091	2,027	+ 1,064	18,168	12,037
Cork E. T. and L. Company	,, 6	291	334	+ 43	1,852	1,843
Darwen Corporation	,, 7	173	130	+ 43	947	853
Darwen-Hoddlesden	,, 7	24	—	—	—	—
Dover Corporation	,, 8	161	152	+ 9	974	927
Dublin & Lucan Electric Railway	,, 9	89	87	+ 2	500	422
Dublin U. T., electric cars	,, 7	3,269	2,963	+ 306	—	—
Dublin S. District, Electric	,, 7	653	631	+ 22	—	—
Dundee Tramways Company	Jan. 29	613	444	+ 169	—	—
Glasgow Corporation	Feb. 8	10,225	8,188	+ 2,037	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 8	1,526	1,509	+ 17	76,107	62,319
Liverpool Corporation	,, 1	8,453	7,370	+ 1,083	44,653	39,329
Liverpool Overhead Railway	,, 9	1,245	1,515	− 270	8,112	8,913
Newcastle-on-Tyne Corporation	—	—	—	—	—	—
Portsmouth Corporation	,, 8	919	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 9	3,328	—	—	—	—
Southampton Corporation	,, 6	668	563	+ 105	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £228 decrease.
Barcelona Ensanche y Gracia, £5 decrease. Barcelona, £331 increase.
Brisbane, £294 increase (month of Jan., £28 increase).
Buenos Ayres and Belgrano Electric, £276 increase.
Calcutta, £20 decrease.
Cape Town (month of Jan.), receipts, £17,064; expenditure, £6,802.
La Capital Traction and Electric, Buenos Ayres (month of Dec.), £1,394 increase.
Mexico Electric (month of Jan.), receipts, £17,000; expenditure, £10,600.
Perth Electric, £239 increase.
Port Elizabeth (month of Jan.), receipts, £3,898; expenditure, £1,898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Tramways.—	£	£
Anglo-Argentine, 1-260,007	5	4⅛-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100	124-127
Blackpool and Fleetwood Tramroad	10	12½-13½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	2¾-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	7-7½
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	9¼-9¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	100-102 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	14-15
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12½-13
—— 5 per cent. Perpetual Debenture Stock	100	126-129
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1¾-2
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100	103-106
—— Prov. Cert., all paid	100	97-100
Cape Electric Tramways, Nos. 1-400,000	1	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	11¼-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10	15-16
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	97-100
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb. Stock	100	112-114
Kidderminster and District Lighting and Traction, Pref.	5	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100	102-104
New General Traction, Ordinary	5	2½-3½
—— 6 per cent. Cum. Pref.	10	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10	10½-10⅝
—— 5 per cent. Cum. Pref.	10	11¾-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	97-100
Potteries Electric Traction, Ordinary, 26,667-40,000	10	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	10s.	½
—— £50,000 " "	1	1
—— £500,000 4½ per cent. Debenture Stock	50 p.c.	50 p.c.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	⅝-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1	⅛-⅜
—— Ordinary, 1-125,000	1	⅜-⅝
British Insulated Wire, Ord., 1-70,000	5	8¼-9¼
—— 6 per cent. Cum. Pref., 1-40,000	5	5¾-6¼
—— 5 per cent. Mortgage Debentures	100	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	5¼-6
Brush Electrical Engineering, Ordinary	2	1⅜-1⅝
—— Nos. 90,001-105,731	2	1⅜-1⅝
—— Non. Cum., 6 per cent. Pref.	2	2-2¼
—— 4½ per cent. Debenture Stock	100	102-105
—— 4½ per cent. 2nd Debenture Stock	100	97-100
Callender's Cable, Debentures	100	111-115
—— Ordinary	5	16¼-17½
—— 5 per cent. Pref.	5	5¼-6
Crompton and Co.	3	3-3¼
—— 5 per cent. Debentures	—	99-104 p.c.
Edison and Swan United, Ordinary	3	⅛-⅜
—— 5 per cent. Debentures	5	2-3
—— 4 per cent. Deb. Stock, Red.	100	78-83
—— 5 per cent. Second Deb. Stk. Prov. Crts.	—	83-88
Electric Construction, Limited, Nos. 1 to 112,100	2	1½-2
—— 7 per cent. Cumulative Pref.	2	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	97-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	99-102
W. T. Henley's Telegraph Works, Ordinary	5	17-18
—— 4½ per cent. Preference	5	5¼-6
—— 4½ per cent. Debentures	100	112-116
India Rubber, Gutta Percha, and Telegraph Works	10	21-22
—— 4 per cent. Debentures	100	100-103
Parker, Thos., Limited, Ordinary	10	15½-16½
Telegraph Construction and Maintenance	12	37-40
—— 5 per cent. Bonds	100	102-104
Telegraph Manufacturing, Ordinary	5	10½-11½
—— 5 per cent. Cum. Pref.	5	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5	9½-10½
—— 6 per cent. Cum. Pref., 30,001-60,000	5	6¼-6¾
—— 4½ per cent First Mortgage Debenture Stock, Red.	100	106-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	100-105
Bournemouth and Poole, Ordinary	10	12-13
—— 4½ per cent. Cum. Pref.	10	9½-10½
—— Debenture Stock, Red.	100	102-105
Brompton and Kensington, Ordinary	5	9¼-9¾
—— 7 per cent. Preference	5	9-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	7½-8½
—— Nos. 20,001-30,000	5	7½-8½
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14¼ xd
—— " " £10 Ord.	6	10¾ xd
Charing Cross and Strand	5	8¼-9¼
—— 4½ per cent. Cum. Pref.	5	5¼-5¾
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	103-105
Chelsea Electricity Supply	5	5½-5¾
—— 40,501-50,936	5	5-5¼
—— 4½ per cent. Debentures	100	109-112
City of London, Ordinary	10	9½-10½
—— 6 per cent. Cumulative Pref.	10	12-13
—— 5 per cent. Debenture Stock	100	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	101-104
County of London and Brush Provincial, Ordinary	10	8¼-9¼
—— 6 per cent. Cum. Pref.	10	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	106-109
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	5¾-6¼
—— 6 per cent. Cum. Pref.	5	5¾-6¼
—— 4½ per cent. First Mort. Deb.	100	105-108
Electric Lt. & Tractn. Co. of Aust., Ltd., 6 p.c. Cm. Pf., 1-20,000	5	4¼-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	5¼-5¾
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	11-12
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9¾-10¼
London Electric, Ordinary	3	1¼-1⅜
—— 6 per cent. Pref.	5	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	95-100
Metropolitan, Ordinary	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9¼
—— Preference	4	6¼-6½
Notting Hill Electric Lighting	10	15-16
Oriental, 1879	1	1¼-1⅜
—— £5 Shares	5	7¼-8
—— £4½ Shares, New	4½	6¾-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6
—— 4 per cent. Debenture Stock	100	99-102
River Plate Electric Light and Traction, Deb.	100	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	104-106
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	1¾-2¼
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	2-2¼
St. James's and Pall Mall, Ordinary, 101-20,080	5	15¼-16¼
—— 7 per cent. Pref.	5	8¼-9¼
—— 3½ per cent. Deb.	100	97-100
Westminster, Ordinary	5	12-13
Electric Railways.—		
Central London, Ordinary	100	106-109
—— 4 per cent. Pref.	100	106-109
—— " " deferred	100	106-109
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	116-118
City and South London, Consolidated Ordinary	100	65-68
—— Ordinary	10	—
—— Nos. 60,001-70,000	10	—
—— 4 per cent. Debenture Stock	100	112-116
—— 5 per cent. Pref. Stock '91	100	127-132
—— " " " '96	100	122-126
Liverpool Overhead, 5 per cent. Pref.	—	13-13¼
—— Ordinary, 1-50,000	—	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	92-95
Telephones.—		
National Telephone, Ordinary	5	—
—— 6 per cent. Cum. First Pref.	10	12-14
—— 6 per cent. Cum. Second Pref.	10	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	4¼-5
—— 4 per cent. Deb. Stock, Red.	100	93-96
—— 3½ per cent. Deb. Stock, Red.	100	101-105
Oriental Telephone and Electric Company	1	¾-1

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NOTES.

Institution of Civil Engineers.—We are informed that Sir William Roberts-Austen, K.C.B., will deliver the tenth "James Forrest" lecture, on "Metallurgy in Relation to Engineering," at the above institution on Wednesday, April 23, the date having been unavoidably altered from that originally proposed.

Personal.—We are pleased to congratulate Mr. J. R. Salter on his appointment as engineer-in-chief to the South Lancashire Electric Traction and Power Company, Limited, and subsidiary companies. He has, therefore, resigned his appointment as chief engineering assistant to Mr. J. Clifton Robinson in connection with the London United, Bristol, and Middlesbrough electric tramway schemes. Mr. Salter, who for years was assistant to the late Dr. John Hopkinson, has done good original research work in connection with the interference of electric tramways on magnetic obesrvatories.

Electro-Harmonic Society.—We have pleasure in announcing that the next "ladies' night" concert of this society will take place next Friday, 28th inst., at St. James's Hall Restaurant (Banqueting Hall). The solo vocalists will include Madame Edith Hands, and Messrs. James Leyland and Dalton Baker. As usual, Mr. Alfred E. Izard will preside at the piano. The other artists engaged are Dr. Byrd-Page, Miss D. Zingler, and Mr. Astley Weaver. Mr. W. E. Langdon, president of the Institution of Electrical Engineers, has consented to preside at this concert.

Retirement.—We understand that Mr. Jas. Hookey, engineer-in-chief to the Post Office, will retire next month owing to the age clause, which affects equally all Government servants. Mr. Hookey has been connected with the telegraphs of the country for over 47 years, and entered the Government service with Mr. R. S. Culley in 1870, when the various telegraph systems were taken over. While always holding highly responsible posts, it was not until 1899, on the retirement of Sir William Preece, that Mr. Hookey succeeded to the highest honour open to telegraph engineers in this country.

The Paternity of Wireless Telegraphy.—In another column will be found an article on the above subject by a Continental authority. In it he repeats interesting comments which are being circulated largely on the Continent, and draws certain conclusions which are against the credit for priority which has previously been given to Dr. Branly as the inventor of the coherer. Any conclusions on matters of this kind are difficult to arrive at, and in certain respects we fail to follow our contributor in his argument. It seems to us that the work done by Dr. Branly was of a more critical nature, and resulted in much more definite information than was shown in the anticipations on which our contributor relies.

To Locate Insulation Faults.—It may truly be said that one of the most troublesome faults for electric tramway engineers to locate is the deterioration of the insulation on the coils of the electric motors. The *Street Railway Review* records a device, known as the Conant coil-testing instrument, which is said to locate faithfully such defects by comparing the magnetic strength of the winding. It is claimed that this method is far superior to measuring the resistance, as it is not affected by the temperature of the motors, and the coils often appear perfect if tested cold. Our contemporary further states that the method has been adopted by some of the most prominent roads in America, after thorough tests, which, among other things, have shown it to be extremely simple in operation.

Reduced Telegraphic Rate to India.—A reduction in the tariff for telegrams to India is announced by the Eastern Telegraph Company, to come into operation on the 1st prox. The charge for these messages will thenceforward be 2s. 6d. per word. Following close on this announcement, Sir Edward Sassoon put a question to Lord George Hamilton in the House of Commons on Monday as to what was the understanding between the Government and the Eastern and Indo-European Telegraph Companies with regard to this matter. The Secretary of State for India, in reply, stated the arrangement in question to be that, if at any time after the introduction of the 2s. 6d. rate the average revenue of the companies' Indian joint purse of the three preceding years, whether wholly at 2s. 6d. or partly at 4s. and partly at 2s. 6d. a word, shall amount to £360,000, a rate of 2s. a word will be at once introduced, provided that the necessary arrangements can be made with the foreign administrators interested.

Test of Aluminium Bronzes.—Mr. Tetmayer has recently published an account of tests of aluminium bronzes carried out in the Zurich Polytechnic School at the request of the Neuhausen Aluminium Company, who provided the samples. The specific gravity first rises and then falls as the percentage of aluminium increases. The maximum strength for soft alloys was obtained with 3·4 per cent. Al, and for hard alloys with 1·4 per cent. Al. For brass, the electricity decreases with the increase of Al, and is extremely low with 2 per cent. of the latter. Silicon increases the specific gravity, and reduces the elasticity. Iron, in the proportion in which it was present in the alloys, was not observed to sensibly influence the physical characteristics. Aluminium bronze, containing 10 per cent. Al with 1·5 per cent. Si and Fe, is too brittle to be of any practical value. As regards the abrasion by friction, the hard alloys, with less than 89·6 per cent. Cu, lose little in weight, while the soft alloys, with less than 6 per cent. Al, heat and wear away rapidly.

Test of a Telephone Cable.—An account of a test of a telephone cable between Dusseldorf and Elberfeld made by Mr. Breisig is abstracted from the *Electrical World* of New York. It appears that the cable in question contains 28 double conductors, seven consisting of wire of 2mm. diameter, the others of wire of 1·5mm. diameter. In the design of the cable it was desired to give it a relatively small capacity and a certain amount of self-induction, by keeping the twin cores of each pair in a certain distance, and by using insulated iron wires in connection with the conductors. The copper wires are first enveloped by iron wires in spiral form, they are then covered with paper, and two such cores are then twisted. The result is quite satisfactory. Elaborate tests were made by engineers of the German Telegraph Office, in order to investigate to what degree the distribution of self-induction in the cable had been accomplished. A full account of these tests is given, from which it appears that the distribution of self-induction has been successfully accomplished to the following degree: for the 2mm. wires it is about 0·0038 to 0·004 henry per kilometre.

Rail Feeder Construction.—Mr. Foster contributes an illustrated discription to the *Street Railway Journal* of the methods used for improving the rail return on the electric tramway system at San Francisco. The rails as originally laid were connected by fishplates and bonded by three bonds of 85 square milimetres; but as the load of the system increased the return became inadequate, and the company decided to increase the capacity of the return

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circuit. For this purpose a number of old horse-car rails bonded by iron rivets were buried in the ground to connect the negative 'bus bar with the track, and the joint was made by surrounding it by a copper tube. It was immersed in water for four months, at the end of which time the joints showed 17 per cent. more conductivity than an equal length of rail, or a loss of only 5 per cent. over its original conductivity. The soil in which the rails were laid was clay, which was practically neutral chemically. At the ends of this auxiliary negative return of old rails, copper waterproof cables were connected to join the ends of the track rails. As a result of these alterations a reduction in energy output of 2¼ per cent. has been obtained.

Post Office Telephones.—It is announced that the Post Office authorities hope to have their central telephone exchange in full working order some time this week, which will enable the City subscribers to have the benefit of the Government service at once, and also to exchange messages with the subscribers to the National Telephone Company. In fact, the delay in the opening of the Post Office service was considered advisable until the system of interchange with the National Telephone Company had been carried out. The above announcement was substantiated by a statement from Mr. Austen Chamberlain in the House of Commons on Monday. The subject was raised by Sir E. Spencer, who asked the Secretary to the Treasury whether the Post Office exchanges would be opened simultaneously both in the City and other parts of London. Mr. Chamberlain replied to the effect that it was hoped the connections with the National Telephone wires would be completed in the course of the present week, when it would be possible to give an exchange service to those subscribers to the Post Office system whose lines have already been completed, and to others as their lines are completed from day to day.

The Tunbridge Wells Enquiry.—In our last week's issue we gave a brief *résumé* of the Local Government Board enquiry which was opened at Tunbridge Wells to consider a further loan of £15,000 for telephone purposes. We have now before us a full report of the first day's proceedings, which stand adjourned till March 6. A perusal of the same is by no means edifying, and we think the personalities shown in the cross-examination of Mr. Bennett disgraceful. In this cross-examination an attempt was made to throw great discredit on all the past work which Mr. Bennett has carried out. When it is remembered that his work has necessarily been always in opposition to the National Telephone Company, it will be understood how unfair it is to give the opinions of the officials of that company with respect to the same. The enquiry is attracting great attention at Tunbridge Wells, where some faint-hearted ratepayers are inclined to hamper the municipal telephone scheme by opposing further grants of capital. We trust that when the enquiry is resumed on March 6 the inspector will keep the tone of the proceedings at a higher level than obtained last week, when he had repeatedly to object to the personalities introduced.

Stability of Operation of Converters.—The digest of the *Electrical World* for the 25th ult. gives a short abstract of a paper by Mr. Leblanc, which deals principally with some peculiar unstable conditions in the running of converters. The first experiment described by the author was made with a converter which was supplied with direct current from a storage battery that also furnished the exciting current. It gave out three-phase alternating currents, which were raised in voltage by a transformer and then lowered again in voltage by a second transformer, and were then consumed in three rheostats. When the load of the converter was gradually raised by varying the resistance of the rheostats, a time was reached when the speed of rotation ceased to be constant, and began to vary between limits which were the greater the greater the load on the machine was. The second experiment described by him is as follows. A converter was used for converting alternating current into direct current for charging a storage battery. The converter operated well at full load, when its transformer was directly connected to an alternating-current supply circuit. When it was desired to vary the voltage of the direct current, an alternating-current booster was connected in series with the primary of the transformer. Oscillating movements of long period then arose in the converter, when the load attained half the value which had been obtained without difficulty without the converter. He gives the explanation, with the mathematical theory, of these phenomena. He shows that the critical limit of the load at which the oscillations arise, depends upon the coefficient of self-induction of the circuits through which the alternating currents flow. The armature reaction of the tested converter was very high.

Lord Rayleigh on Electrical Developments.—Lord Rayleigh delivered the first of a course of six lectures at the Royal Institution last Saturday afternoon on "Some Electrical Developments." Much interest was added to the lecture by a number of experiments with which Lord Rayleigh illustrated his remarks. For instance, the electrical excitation caused by sounds passing along the wires of a telephonic circuit was made visible to the audience by the employment of a jet of common gas. This jet burnt with a steady flame when silence prevailed, and flickered in a curious manner when any sound was made, the flame rising and falling with the inflections of the lecturer's voice, which was never raised above the conversational pitch. The utility of Hughes's balanced induction coils for the purpose of discovering short-circuit was next explained and illustrated—a matter not easy to accomplish without some very sensitive form of electrometer. Lord Rayleigh said that during the past six months he had been studying some difficult points developed by the use of the condensing plate in connection with the Ruhmkorff coil. The fact that the gap between two terminals could be extended from ½in. where no condenser was used to three times that length was probably due to the fact that an electrical discharge, when once set up, had a tendency to persist over a gradually increasing space when once the arc was started. In order to produce the same effects without the introduction of the condenser, to which there were certain objections, the lecturer experimented with a piece of lead suspended by a thread over two terminals at various distances up to as much as 12ft. above, and suddenly released by burning the thread. The fall of the weight effected a sudden rupture of the circuit, and produced the spark as in the experiments with the condenser. Other experiments were shown, in which similar disruptive discharges were produced without the condenser by suddenly breaking the circuit by the discharge of pistol and rifle bullets. This latter experiment with pistol bullets was several times successfully made by the lecturer. Lord Rayleigh will give his second lecture on this subject to-morrow afternoon at three o'clock.

Niagara Power Plant Development.—A fresh and important development of the great Niagara power plant is announced. Up to the present the work of harnessing the waters of the Niagara Falls has been practically confined to the American side, and the utilisation of the water power on the Canadian side of the great cataract has hitherto been unattempted. This work, how-

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ever, is now to be taken in hand. We learn from our American contemporary, the *Electrical World*, that the Niagara Falls Power Company have just placed a contract with the General Electric Company for three immense generating units of 10,000 h.p. each, to be installed on the Canadian side of the Falls. These machines, it may easily be credited, will be the largest electric generators ever built. They are, it is stated, however, but the first units in a plant which it is probable will ultimately reach an aggregate of 200,000 h.p. or more within a few years. The machines contracted for, apart from their immense capacity, will also be remarkable for the high speed at which it is intended they shall work—*i.e.*, 250 revolutions per minute—which is the same as that now used with the smaller 5,000-h.p. generators on the American side. The external diameter of the 10,000-h.p. units will be not quite 18ft., and the total weight of each about 400,000lb. They are intended to return 98 per cent. of the shaft horse-power in the form of current, and the inherent regulation will be such that the voltage variations, it is said, will not exceed 8 per cent. with maximum possible changes of load. Two other important elements in these machines may be mentioned. The first is that they will have internal revolving fields, while the older machines have external fields; and, secondly, they will not depend on transformers for raising the pressure of the current from 2,200 to about five times that figure for the line, but will generate themselves current at a potential of 12,000 volts, thus dispensing entirely with any transforming apparatus. It is anticipated that the adoption of these large units in place of the smaller 5,000-h.p. generators will result in a great saving in the cost of producing power. The size of the power-house, it is said, is thereby reduced to about half, and a very material reduction in the cost of electrical apparatus per horse-power is also effected.

New Patent Law.—We have now before us the full text of the recommendations of the committee appointed by the Board of Trade to enquire into the working of the Patent Acts, which recommendations are embodied in the new Bill to be introduced into Parliament this session. The duties of the committee were to ascertain, among other points, whether any additional powers should be given to the Patent Office to control, impose conditions on, or otherwise limit the issue of letters patent. The first of the new provisions of importance is to the effect that if the comptroller is not satisfied that no objection exists to the specification on the ground that the invention claimed has been wholly or in part claimed by a previous specification, he shall, after hearing the applicant, and unless the objection be removed by amendment, determine whether a reference to any, and, if so, what, prior specifications ought to be made in the specification by way of notice to the public. An appeal shall lie from the decision of the comptroller to the law officer. The Board of Trade, with the sanction of the Treasury, may prescribe an additional fee not exceeding £1 in respect of the investigation mentioned above, which is reasonable. The alteration as regards priority of patent should go far to prevent the present duplication of patents for the same article. The second part of the new Bill repeals Section 22 of the principal Act, relating to the grant of compulsory licenses by the Board of Trade. It is proposed that in the event of an inventor neglecting or refusing to work his patent or grant licenses on reasonable terms, the court shall have authority to order the patentee to grant licenses on such terms as to the duration of the license, the amount of royalties, security for payment, etc., as the court, having regard to the nature of the invention, may deem just. The section also provides that the court may, if it thinks fit, on the request of any party to the proceeding, call in the aid of an assessor specially qualified. The order of this court is open to an appeal to the court of appeal, but, except by leave of the latter court, no appeal shall lie with the House of Lords. It is intended that this section, subject to which all matters of practice and procedure in relation to the grant of compulsory licenses are to be regulated by rules of court, shall apply to patents granted before as well as after the commencement of this Act, which is proposed to come into operation on Jan. 1, 1903.

Sunderland Electricity Department.—The second annual dinner of the electric lighting staff of the Sunderland Corporation, at which Mr. John F. C. Snell, the borough electrical engineer, presided, took place in Sunderland one night last week. We have received an account of the proceedings, which seem to have been most successful. Additional interest was aroused this year by a presentation to Mr. Snell, which came from the members of his staff. It took the form of a handsome photograph of himself framed in oak, and Mr. Snell, in returning thanks for the gift, said he regarded it as an evidence of the kindly feeling that existed between the staff and himself. The tone of the after-dinner speeches was also a telling proof of the friendly relations existing between the members of the Electric Lighting Committee and the head of the electric lighting staff. The Mayor, in the course of his remarks, spoke in complimentary terms of the department in which many of those present were engaged, and characterised its progressive work as marvellous. In submitting the toast of "The Borough Electrical Engineer," Alderman Bruce also spoke in eulogistic terms of Mr. Snell. When that gentleman first came to Sunderland, five years ago, there were only 12 miles of cable laid, now there were nearly 55 miles. At that time the Dunning-street station was only half developed, and at the present moment there were over 3,900 h.p. installed, and, in addition, 2,000 h.p. had been installed at the new station. The system had been carried out with scarcely a hitch, and the Corporation had spent, or were committed to spend, £190,000. The results, he continued, had justified the committee's confidence in Mr. Snell. Last year the department made a profit of £1,900, and in the current half-year a profit of about £1,500 was expected. In acknowledging the toast, Mr. Snell paid a high tribute to the loyal services rendered him by his staff. Referring to the progress of electricity in this country, he remarked that at present 20 millions sterling were invested in electric lighting, apart from tramways, of which about 1,200 miles of track were laid in different parts of the country. He believed they would live to see, and perhaps anticipate in, the electrification of our railways. In conclusion, he referred to the development of the use of electricity for industrial purposes and also for lighting. In regard to the latter, he thought that recent improvements would have the effect of revolutionising electricity for lighting purposes, and would bring it within reach of the poorest.

The Bremer Arc Lamp.—These lamps, which are now being placed on the English market by the British Westinghouse Company, are arousing great interest among electrical engineers in consequence of the good distribution of light obtained from them, and also the fact that the lamp gives out a much greater proportion of orange rays than the ordinary arc. This renders it much more suitable for street-lighting, as the light is able to penetrate fogs to a much greater extent than the ordinary arc rays. We have this week been able to inspect the mechanism of these lamps, and hope in the near future to give an illustration of the same. In the meantime, the

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following brief *résumé* of the working will be of interest in order to compare it with the details given in our issues for Aug. 17 and 24, 1900, when the lamp was not yet fully developed. At that date a continuous feed of carbon was provided, but now this has been done away with in favour of an intermittent feed. The carbons are placed into two slightly inclined metallic tubes, at the ends of which are the clutches which make connection with them. Before the lamp is switched on, a metallic stop swings under the ends of these tubes and supports the carbons, which are otherwise loose in the tubes. Immediately the current is switched on, the carbons are clutched, and at the same time the metallic stop is withdrawn from under the carbons, thus striking the arc. An electromagnet is then used to deflect the arc between the two carbons in a downward direction, so that it takes the form of a bow. This brings the crater of each carbon on to the horizontal end of the same, and secures a wonderfully good distribution of light. The carbons project about 1in. from the tubes, and are surrounded by a small cup, which soon becomes covered with a white deposit of the salts used to impregnate the carbons. This cup acts as a brilliant reflector of the light. The operation of feeding the carbons is as follows: As they burn away the arc moves up nearer to the pole of a small electromagnet, the force of which eventually interrupts the circuit. Immediately the metallic stop swings back under the carbons, which fall down on to it, and are again in this way correctly spaced with a projection of about 1in. from the tube. This feeding interval, during which the light is interrupted, is almost inappreciable, and we are told that when the lamps are properly adjusted they only feed about once every quarter of an hour. Apart from the flicker at the time of feeding, there is a slight unsteadiness in the light when viewed in a room, which, however, is not noticed with the lamps outdoors. We presume that this is due to slight inequalities in the mixture between the carbon and the metallic salts. The whole mechanism for securing an arc between two almost vertical carbons is most ingenious, and the lamp when manufactured in quantity should have a great future.

Hewitt's Electric Gas Lamps.—In April of last year Mr. P. C. Hewitt exhibited before the American Institute of Electrical Engineers for the first time his vapour lamps of high candle-power, in which the light is produced by the passage of the electric current through vaporised mercury contained in long cylindrical glass tubes. The lamps were then fully described by us in this journal. By subsequent experiments Mr. Cooper claims to have improved his invention, and he presented a paper before the American Institute last month dealing with his investigation of the phenomena of the electrical resistance of gases. He also at the same time exhibited some of the improved mercury-gas lamps, which were operated on the standard Edison 118-volt direct-current circuit installed in the building. Lamps of this class, he remarked, consumed amounts of current varying from one to six amperes, and the efficiency was approximately one-half watt per spherical candle-power. Under better conditions, as high an efficiency as one-fourth watt per spherical candle-power had been obtained, determined by careful and accurate measurements. With regard to the size of the lamps, the author said there appeared no reason why lamps might not be made of any size required, and of any desired candle-power per inch within wide limits, the only limitation appearing being that imposed by softening of the glass when too many candle-power per inch were produced. Dealing with the question of the colour of the light produced by pure mercury gas, the author referred to the absence of the red. For some purposes the absence of the red in the spectrum was objectionable, but for many uses it was a positive advantage—say, for shop work, drafting, reading, and other work where the eye was called upon for continued strain. Assuming the absence of the red to be objectionable, however, it was possible to transform some waves of this light, especially the yellow light, into red light, and thus in a measure to overcome this defect where required for ordinary incandescent indoor illumination. A moderate amount of incandescent light interspersed with the mercury-gas electric light served to supply the deficiency, and the mixture might be made most satisfactory. For ordinary street-lighting purposes, the mercury light was available even without the red, and it was to be noticed that this light had very great penetrating power, and seemed to be effective through greater distances than an equivalent amount of measured candle-power from the ordinary incandescent lamp. This might be due to the fact that the waves of the red light were less penetrating than those waves which were present in the mercury light, and hence the least valuable portion of the spectrum having such illuminating effects was omitted, and the energy was practically expended in the more useful portions of the spectrum. The author further stated that he had succeeded in making lamps in which this colour objection had been overcome, sacrificing in some cases, however, the extremely high efficiency obtained in this particular lamp. But apart from this, he asserted that when it was considered that this light, when obtained from mercury gas, had an efficiency at least eight times as great as that obtained by the ordinary incandescent lamp, it would be appreciated that it had its use in places where lack of the red was not important, for the economy of operation would much more than compensate for the somewhat unnatural colour given to illuminated objects. Mr. Hewitt concluded his paper with a reference to some of the phenomena that had to be unravelled before it was possible to establish the laws governing the operation of electric gas lamps.

Water Undertakings and Electricity Supply. On Saturday last there was concluded at the Westminster Palace Hotel, London, an important arbitration, which at intervals for more than a fortnight has been going on before Mr. Hawksley, the well-known water engineer, for the purpose of determining the price that the Airdrie, Coatbridge, and District Water Trustees shall pay to the local water company for the latter's undertaking. The subject of the enquiry is a most interesting one to electrical engineers, connected, as it is, with the Clyde Valley electric supply scheme. Between the sum claimed for the water undertaking by the sellers, on the one hand, and that offered by the compulsory purchasers, on the other hand, there is a difference of no less than about £180,000. But from the electrical point of view, the most important feature of the enquiry was that the introduction of electric energy into the district under the Clyde Valley Electric Supply Act of last year was strongly pleaded by the proposed purchasers in depreciation of the value of the water undertaking. The Act in question gave to the company which it incorporated the power to supply the district, and to set down a generating station within half a dozen miles miles of Airdrie and Coatbridge. The two strongest witnesses put forward by the water trustees on this part of their case were Mr. James Watson, water engineer to the Corporation of Bradford, and Mr. Robert Robertson, of the firm of Strain and Robertson, electrical engineers to the promoters of the Clyde Valley scheme, both of whom gave their evidence on Friday last. In the course of his evidence, Mr. Watson said he remem-

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bered when there were in Bradford 140 or 150 lifts and "jiggers" for lifting timber by hydraulic power. The Corporation electrical department, however, had now practically taken all that branch of their supply from the water authority. These cranes were now all worked by electric motors, and in that particular the revenue of the water department had suffered to the extent of upwards of £2,500. Electric motors were also being fitted to many of the machines running in Bradford engineering shops, and there again steam was being saved and the water supply correspondingly reduced. There was no doubt that the trend of the times was to do away with steam-boilers, and instead to utilise electric motors, and this was bound sooner or later to have a very considerable effect on the use of water for trade purposes almost everywhere. Mr. Robertson in his evidence explained the powers which the Clyde Valley Company had obtained from Parliament last year to supply electrical energy to the district here in question. The promoters, he said, were almost all owners of large works in the district, which was admittedly a manufacturing one. When their works were established they looked forward to giving off a very large amount of motive power there; indeed, they looked upon the locality as a most important one for electrical supply. There was no doubt that the introduction of electrical energy would diminish the necessity for steam power, and correspondingly diminish the trade consumption of water. Since their Act got the Royal assent in August of last year, they had been busily engaged in the necessary preliminary arrangements. They had completed the surveys of the sites of their proposed works, they had issued the specifications to the contractors, and they expected the tenders in at the beginning of the following week. The promoters had not raised any capital yet, because they first of all required definite information as to the amount of capital necessary, and, indeed, they had such a strong body of promoters that they might be able to raise the capital among themselves without going to the public at all.

Alloys of Iron.—Lord Kelvin was present at the meeting of the Institution of Electrical Engineers on Thursday, last week, and opened the discussion on Prof. Barrett's very important paper on the subject of the electrical conductivity and magnetic properties of different alloys of iron. As Lord Kelvin stated, the practical results of Prof. Barrett's exhaustive research into this matter are of the utmost importance, and no one can say of how much value they may prove in the future, especially in connection with the use of iron in transformers. The paper is the outcome of several years of research which Prof. Barrett has made with the assistance of Mr. W. Brown in his laboratory at the Royal College of Science at Dublin, and during that time the electrical conductivity and the magnetic properties of upwards of 100 different alloys of iron have been determined. The discussion which followed the excellent abstract which Prof. Barrett gave of his paper last week was, however, concerned only with two or three of the alloys mentioned by the author. Thus, Lord Kelvin's remarks referred principally to the aluminium alloy. In his opinion the enormous increase of the permeability in iron produced by 2½ per cent. of aluminium, as stated by the author, was certainly a magnificent result, while, in connection with the use of iron in transformers, no one could quite foresee of how much value the very great diminution in the retentiveness of the iron might be. Previous to the discussion Prof. Barrett made a short experiment, in which the heating effect on the different irons was compared, and it was shown that much greater sound was produced in the case of the aluminium iron than in that of the ordinary Swedish iron. Apropos of this experiment, Lord Kelvin asked the author how much less heat there was in the aluminium iron than in the Swedish iron? Prof. Barrett stated that at the present time experiments were actually in progress in his laboratory in this matter, and he gave a table in which he compared four different brands of iron in order to show the superiority of the aluminium alloy. From this it seems that the density of this iron is 7·56, as against 7·66 and 7·76 for silicon iron and Swedish iron respectively. The interesting point, however, from the electrical engineer's point of view is the hysteresis. Expressed in watts per pound at a frequency of 100 and an induction of 9,000, the watts per pound for the aluminium iron are 0 75, as against 0·95 for the silicon iron and 1·35 for the Swedish iron. At the low induction of 4,000, which is more like that employed for transformer work, the watts per pound are found to be 0·21 for the aluminium iron, as against 0·27 for the silicon iron and 0·38 for the Swedish iron. Another figure of comparison at this density is that of the "Lohy" iron, in which case the watts per pound are found to be 0·32. This iron, which has been introduced by Messrs. J. Sankey and Sons, of Bilston, is said by the makers to have an exceedingly low hysteresis loss, and hence, using the first two letters in the words "low hysteresis," they term their product "Lohy" iron. Prof. Barrett stated that this iron was now being compared experimentally in his laboratory at the College of Science with the silicon and aluminium alloys and with the Swedish iron. In his concluding remarks, Lord Kelvin thought there was large promise here of improvement in iron for transformers, and also for the armatures of continuous-current dynamos. Mr. R. T. Glazebrook suggested that it might be worth while to institute a microscopic examination of some of the alloys mentioned, with a view to seeing what was the small internal change which took place in the iron to give such striking results. Such an examination, he thought, might enable them to get even further than the author had done in reducing the values of the hysteresis loss for a given induction. A very appropriate question was put by Captain Creak, R.N., who wanted to know whether the author could mention an iron which was non-magnetic and at the same time workable for building ships. Later on, Prof. Barrett answered that manganese iron and several of the other alloys referred to could be filed and drilled, and were therefore suitable for that purpose. The discussion was taken up by Mr. A. Campbell, who expressed the opinion that, in addition to its splendid magnetic qualities, the aluminium iron would probably serve to get rid of eddy currents in transformers to a large extent. Mr. R. K. Gray, while giving expression to the indebtedness of the Institution to the author for his paper, thought that a research of this character should be taken in hand by the National Physical Laboratory, now that it had been established. As regards this suggestion, Dr. Glazebrook promised to give Prof. Barrett every assistance in his power, and the author himself said he was looking forward to the time when he would be able to pass over to the National Physical Laboratory the whole of this work. In his general reply to the discussion, the author remarked that the effect of rusting was very serious in some of these alloys, especially silicon. He quite agreed with Mr. Campbell with regard to eddy currents, and he also thought that the use of the aluminium alloy in transformers might reduce the need for laminations. With reference to annealing, he stated that ordinary iron had to be reannealed very frequently in transformers, as it rapidly lost its good qualities. As regards the aluminium alloy, experiments must be carried out to see the number of hours it must be annealed before it attained its best condition.

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THE PATERNITY OF WIRELESS TELEGRAPHY.

BY A SPECIAL CONTRIBUTOR.

There is a belief in France which, rightly or wrongly, is common to all deep thinkers, that the inventor of the electric telegraph without wires, or at least of that small apparatus, the coherer, which is indispensable for the same, is Dr. E. Branly, of the Institut Catholique de Paris. This question seems to be definitely settled, although perhaps not in the above way, when at the same time two distinct facts are brought forward for discussion, the one being the last trials of Mr. Marconi to communicate across the Atlantic without wires. These trials are of a nature to render wireless telegraphy a brilliant success. The other question to be considered conjointly is a note on wireless telegraphy published by Mr. Poincaré, a member of the Institute of France ("L'Annuaire du Bureau des Longitudes" for 1902).

Mr. Poincaré writes to the effect that the coherer, or radio-conductor, was discovered independently in France by Dr. Branly, and in England by Dr. Oliver Lodge. Dr. Branly seems to despair, as, when asked by the editor of *Figaro*, he has replied: "The statement of Mr. Poincaré moves me most because it would have the effect of taking away from me at the same time the paternity, not of wireless telegraphy, but of the discovery which renders that possible." According to Dr. Branly, therefore, the honour of France was in danger. Happily for that country, its honour and glory do not depend on so small a thing. Dr. Branly relies strongly on two things for his claim of priority to the discovery of the properties of metallic filings—first, that it is, thanks to this discovery, that he has obtained the title of Laureat de l'Académie des Sciences; second, that Dr. Lodge has written to him the following letter dated Jan. 8, 1899: "Permit me to express to you my admiration of your discovery of the variability of the conductivity of metallic powder under the influence of electric sparks at a distance, and my desire that full justice should be given to your claims of priority in this matter . . and I would ask you to accept one of my present type of tube of metallic filings as a sample sent in homage to the inventor." The questions to be decided are: (1) if it is Dr. Branly who first discovered the property of metallic filings; (2) if the electric telegraph without wires is not possible without these metallic powders or filings to indicate the presence of electromagnetic waves by their influence on imperfect contacts; (3) if there are other arrangements which are exceedingly sensitive to act as the receivers of electromagnetic waves without having recourse to imperfect contacts; (4) if one is able to replace the metallic filings or other imperfect contacts by other arrangements for revealing the presence of electromagnetic waves and to employ them to act directly on to a receiver, such, for instance, as the telephone.

In reply to the first question, if one has to choose between Dr. Branly and Dr. Lodge, the evidence of the latter is in favour of the former. As Mr. Poincaré has remarked to the same editor of *Figaro* who interviewed Dr. Branly, it is simply a question of dates. Thus the work of Dr. Branly dates from 1890 and 1891, while that of Dr. Lodge does not appear in print until 1894, a time when he published his opinion that electric waves could be observed at a distance of half a mile, thanks to the coherer; but there is another person to be noted, Mr. Calzecchi Onesti. Let us take on this subject the statements of a French author, Prof. André Broca, who is professor of physics to the faculty of medicine in the University of Paris. In his work "La télégraphie sans fil," p. 110, he says: "In 1885 Mr. Calzecchi Onesti in Italy had observed a curious fact. It is that iron filings contained in a glass tube placed between two metallic electrodes became suddenly conducting when put between the electrodes communicating with the two secondary terminals of a Ruhmkorff coil. This research passed completely unnoticed." In this we are in agreement with Prof. Broca. If the experiments of Mr. Onesti passed unknown, it is no doubt due to the fault of the modesty of this investigator. But we are no longer in agreement with Prof. Broca when he says "this research was not in effect capable of application, and did not present any theoretical importance" This is not so, as it is by these experiments of Mr. Onesti that he discovered the properties of metallic filings. In what in effect does this property consist? It is that metallic filings put, for example, between two metallic electrodes present a high electric resistance. But, if for any reason whatever, one causes to pass through the filings a current of a higher tension than a certain value, the resistance of the filings falls to a value which is very much

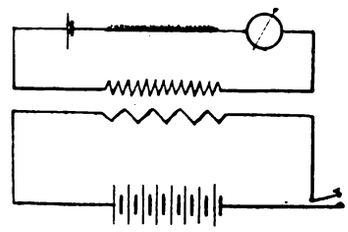

FIG. 1.

less. The experiments of Mr. Onesti prove well that while the tension in the secondary of a Ruhmkorff coil several millions of volt was higher than the critical tension of the coherer several volts. In effect, when the primary circuit of the coil was closed, the needle of the galvanometer (Fig. 1) inserted in the secondary circuit with the filings was deflected by the current of the battery. Dr. Branly in 1890 proved no more, but much less, than Mr. C. Onesti.

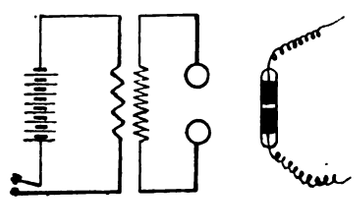

FIG. 2.

Dr. Branly discovered the change of conductivity of the filings when an electric spark took place near them (Fig. 2). This property had previously been discovered by the Italian experimenter. Again, Dr. Branly had proved much less than Mr. Onesti, because this last gentleman had investigated the general properties of the metallic filings, while Dr. Branly had only investigated one special property—*i.e.*, that of becoming a conductor under the influence of waves produced by the electric

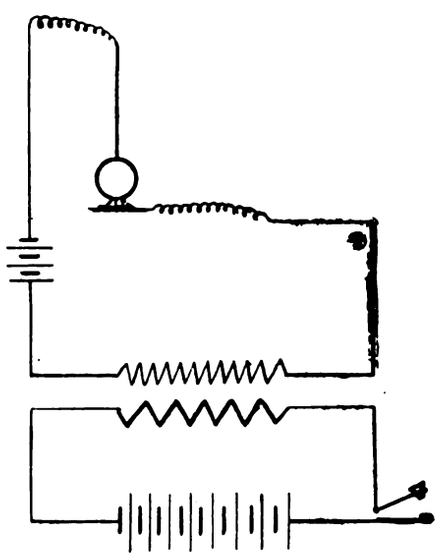

FIG. 3.

spark. It is just there where so many make the mistake of believing that an electric spark is indispensable for making a tube of filings a conductor. It is not so, as a variable current of any kind whatever is able to influence at a distance a coherer, or radio-conductor, provided that the current induced in the circuit of the same is of a higher tension to that which is required to render the coherer a conductor—*i.e.*, it is higher than the critical value for the coherer in question. A sufficient tension can be obtained by using a transmitter with a high-voltage

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current, or by making use of a transmitter with a low voltage and transforming up at the receiving end,* or by making use of a transformer at the transmitting end. This last method, actually employed by Mr. Marconi, has the disadvantage over that proposed by Mr. Guarini that dangerous voltages are used. It is through the use of alternating currents influencing at a distance coherers that Messrs. Guarini and Poncelet have been able to communicate between Brussels, Malines, and Antwerp with the Guarini repeater (*Electrical Engineer*, vol. xxviii., pp. 47 and 83). It is also by the arrangements investigated by Mr. C. Onesti that Mr. Thomas Tommasina has been able

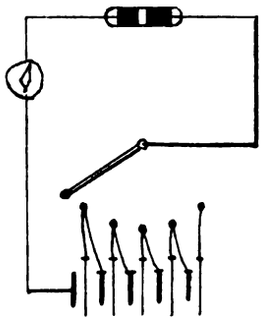

Fig. 4

to use the chains of filings (Fig. 3), 105mm. long with brass filings, and 39mm. long with iron filings (*Archives de la Société des Sciences Physiques et Naturelles*, Geneva, vol. vii., January, 1899).

It is not even necessary to have a variable current to make a tube of metallic filings a conductor, as a continuous current will suffice. With these it may be possible to advantageously employ a coherer in telegraphy with wires, notably in submarine telegraphy. The coherer would act as a very sensitive relay. For instance, if one puts a coherer with a critical voltage of five in a circuit with a voltage of 10, the coherer will become conductor. Here is a very simple arrangement to verify this fact. If one puts

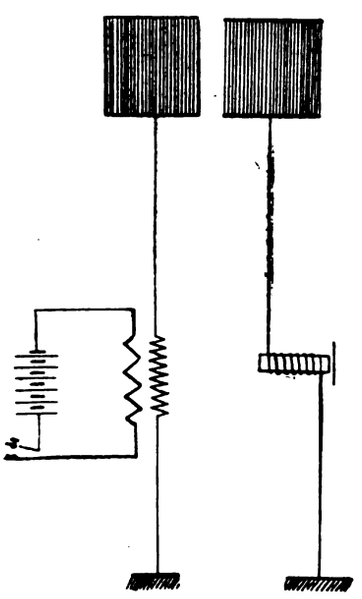

Fig. 5.

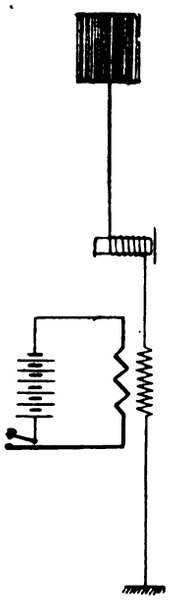

Fig. 6.

in circuit a coherer with a critical voltage of two, and five cells each of one volt in series put successively in the circuit of the coherer, the latter will not become a conductor until after three cells have been inserted (Fig. 4). This being so, it is necessary to admit that the knowledge of the properties of metallic filings is due to the Italian Calzecchi Onesti, and not to Dr. Branly.

With respect to the second question, metallic filings are not indispensable for the success of telegraphy without wires; any imperfect contact will do—for instance, Messrs. Tommasina, Popoff, and Ducretet employ carbon contacts. By the aid of this very sensitive apparatus, Mr. Tommasina has been able to record storms 250 to 300 miles away, and Messrs. Popoff and Ducretet have sent messages without wires for over 63 miles. It was in 1879 that the late Prof. Hughes discovered that sharp electrical impulses sent into the atmosphere, as, for instance, the extra current of an induction coil or by a frictional machine, affected a microphone contact.

In reply to the third question, instead of a coherer or other imperfect contact, the electromagnetic waves may

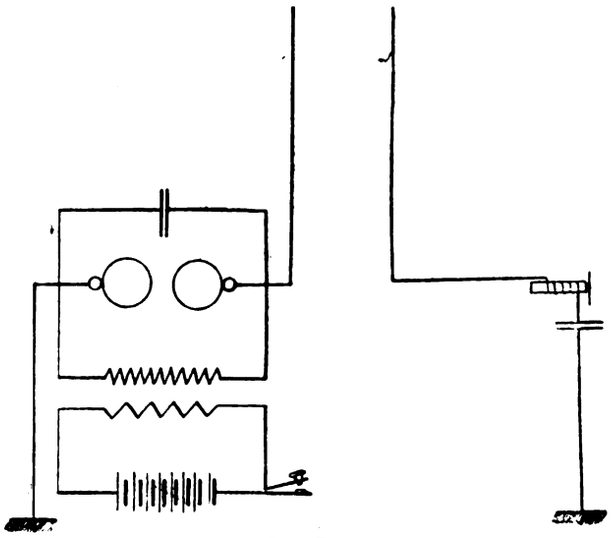

Fig. 7.

be indicated by the electro-capilliary electrometer, as has been shown by Messrs. Armstrong and Orling.

In reply to the fourth question, electromagnetic waves are able to induce in circuits, either opened or closed, currents capable of working sensitive receivers, a galvanometer, or, better still, a telephone. Thus, for example, in 1891, Edison, as shown by his American patent, No. 465,971 of that year, employed the currents from the secondary of an induction coil, connected on one side to a condenser and on the other to the earth, to produce at a distance

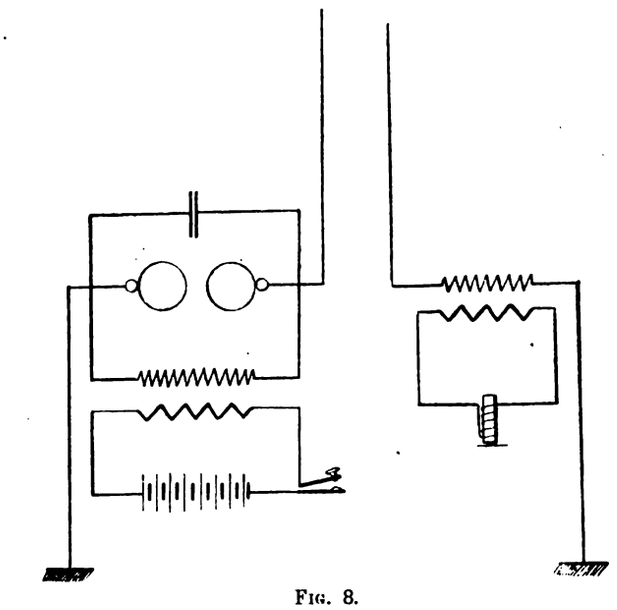

Fig. 8.

and without wires, vibrations in a telephone diaphragm (Fig. 5). The electromagnetic circuit of this telephone was connected also between the earth and a condenser. In order to get communication in the oppos te way, Edison inserted a winding of the telephone (Fig. 6) in the circuit of the antennæ, which makes Edison the inventor of the vertical antennæ. It is still necessary to recall other systems, notably that of Sir W. H. Preece, for obtaining telephonic communication without wires, and numerous other inventors. The Hertzian waves have also been employed for acting directly on a receiving telephone by Mr. Guarini (*Journal Télégraphique de Berne*, Jan. 25, 1901). With the arrangement shown in Fig. 7, or, better still, by that of Fig. 8 also with an arrangement absolutely like that of Mr.

* See Guarini's English patent, No. 1,555, of Jan. 24, 1900.

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Guarini, Mr. E. Ruhmer has been able since to exchange signals at a distance of 1¼ miles with antenne 98ft. long. The future of wireless telegraphy, especially on land, depends on the power of being able to work directly a sensitive relay, and perhaps a registering the working on a Morse code, as Mr. Guarini describes in his English patent, No. 1,555/1900.

Dr. Branly is not the only French expert who has made researches on the paternity of wireless telegraphy. There is another, Mr. Ducretet, who, with Mr. Popoff, claims to be "the father of a son without wires," which, if

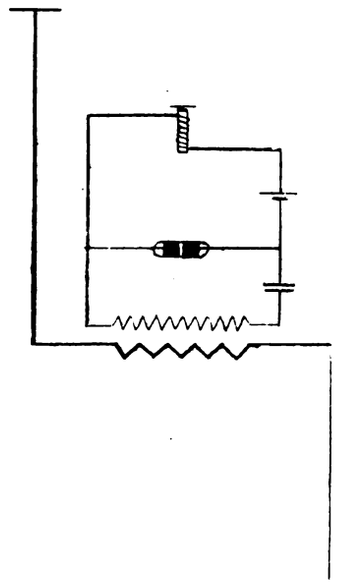

FIG. 9.

not promising great things for the future, promises no less in the present than communication between armed forces on land and sea. Mr. Ducretet claims the priority for the combination of the coherer with a telephone. Thus on Jan. 19, in reply to the editor of a Paris newspaper, he said, "Really the telephone receiver made by me and used by the Russian engineer, Mr. Popoff, in his celebrated experiments in the Gulf of Finland are the most sensitive; these receivers were used by Mr. Marconi in his Transatlantic experiments at Newfoundland. The connections of these with a coherer are shown

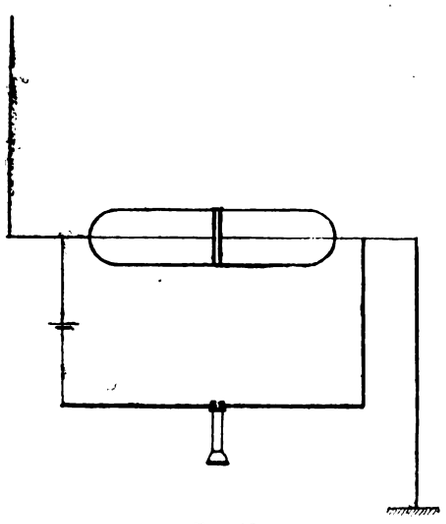

FIG. 10.

in Fig. 9. It is doubtful if this use of the Ducretet apparatus was authorised. Thus Mr. De Fonvielle, in *Cosmos* of Jan. 25, says that he is informed that while Messrs. Ducretet and Popoff will not hinder scientific experiments made by Mr. Marconi, they will have to interfere when commercial arrangements are made to work the system. Looking into the justice of the claim of Mr. Ducretet, we find at once that the combination of a telephone and coherer is not really his. Thus, on Aug. 16, 1898, Mr. Blondel sent a sealed communication to the Académie des Sciences de Paris, entitled "Perfectionnements à la télégraphie san fil." In this Mr. Blondel describes the

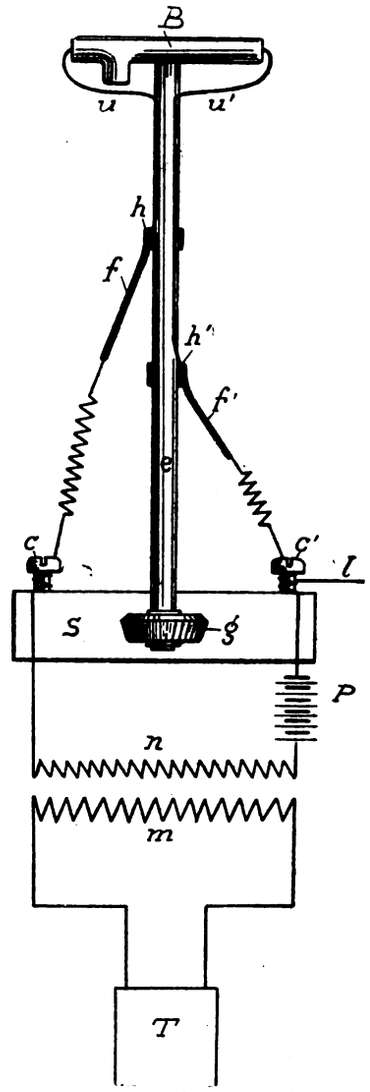

FIG. 11.—B is the coherer arranged to rotate and connected to the transformer, *n m*; *l* is the antennæ; and T a telephone.

combination of antennæ and earth-plates with an open tube (a special coherer) in circuit with a telephone and

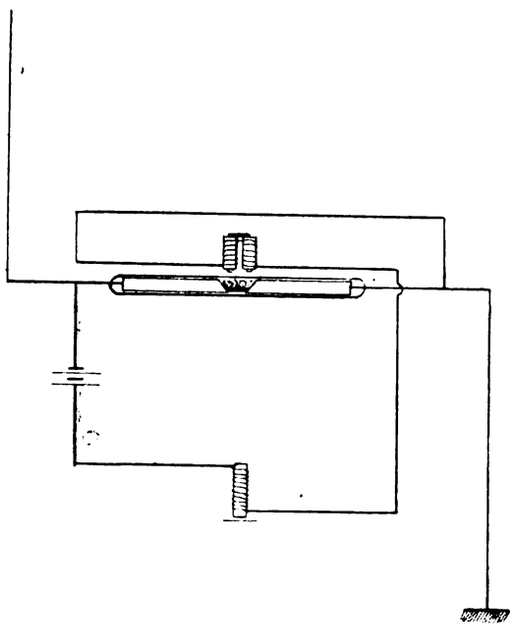

FIG. 12.

battery (Fig. 10). This communication was not opened until May of 1900, and thus does not affect the patent about to be mentioned. On Jan. 5, 1899, Mr. Tommasina

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stated before the Société des Sciences Physiques et Naturelles de Genève that he had used a telephone in place of a relay. On June 24, 1899, in his Belgian patent, No. 143,444, Mr. Guarini claimed the arrangement shown in Fig. 11. In this illustration a telephone is shown in circuit with a battery and the primary of an induction coil, of which the secondary contains a telephone. Mr. Guarini obtains the decohesion by keeping the coherer

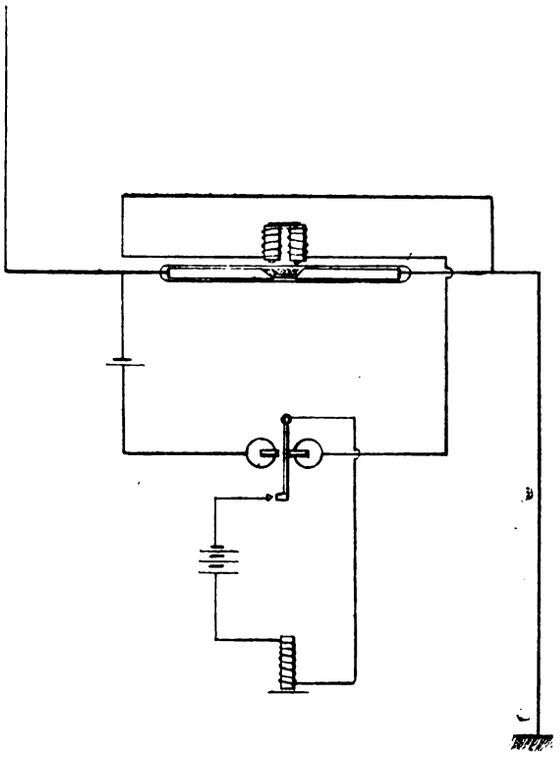

FIG. 13.

always in motion (the theory of this action is described in the English patent, No. 1,555 of 1900). On Nov. 21, 1899, Mr. Collins (American patent No. 644,497) patented in the United States the arrangement shown in Figs. 12 and 13. It was only on Jan. 22 of 1900 that Mr. Popoff patented in France (No. 296,354) the arrangement shown in Figs. 14 and 15. A similarity will be noticed between Fig. 15 and that of Mr. Guarini (Fig. 11). This

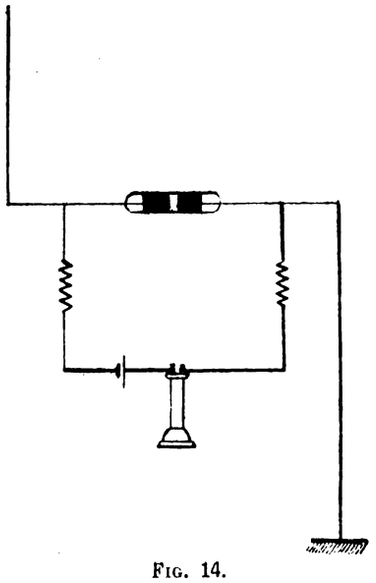

FIG. 14.

gentleman's Belgian patent was described by him in a pamphlet on the transmission of electrical energy by one wire and without wires, which was published in July, 1899, at Liège. Mr. Guarini tells us that this pamphlet was sent to Mr. Ducretet, who acknowledged the receipt of the same on July 28, 1899. This shows without further comment that it was Mr Tommasina who first suggested the use of a combination of one coherer and a telephone, and that Mr. Guarini has described the first arrangement with a telephone and another coherer, so that Mr. Ducretet (and Mr. Popoff) have not the right to interfere with Mr. Marconi. It follows clearly from the above that the paternity of electric telegraphy without wires does belong to Dr. Branly. Thus, Hughes, Edison, Calzecchi Onesti, Branly, Lodge, Popoff, Marconi, Preece, Slaby, Arco, Tommasina, Braun, Guarini, etc., have all in one way or other contributed to the discovery and perfection of wireless telegraphy. If, on the other hand, in speaking of wireless telegraphy, one is confined to that which renders possible great results over long distances—*i.e*, imperfect contacts rendered conducting by electromagnetic waves—the invention should be credited to the late Prof. Hughes.

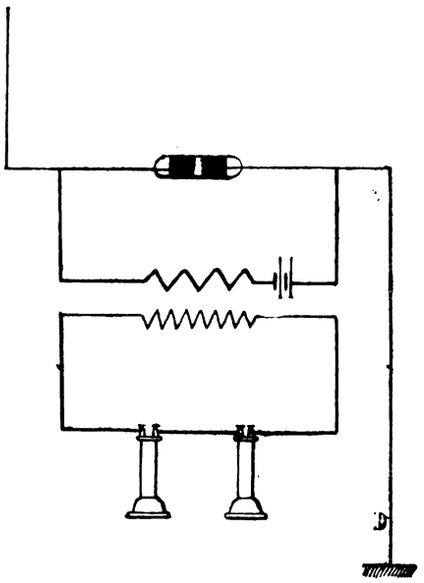

FIG. 15.

Science is the patrimony of the whole human race, and it is not well to raise in connection therewith paltry questions of nationality.

SOME NOTES ON THE INFLUENCE OF THE SUB-STATION EQUIPMENT AND TRANSMISSION LINE ON THE COST OF ELECTRICITY SUPPLY.*

BY ANDREW STEWART, ASSOCIATE.

(*Concluded from page 227.*)

Among other considerations, the question of depreciation in the high-tension cables, and the losses in their dielectric, are problems of considerable importance. Experience has fixed the depreciation in cables working at lower E.M.F.'s; but can we be certain that under the new conditions their life will be equally long? Not only so, but a much larger amount of money is spent on insulation, which has no scrap value; hence I think the figure of 5 per cent. is, if anything, low. The fact that energy is absorbed by the dielectric proves that some work is being done upon the insulation. What really does happen? The insulation may be chemically stable under the influence of high E.M.F.'s, or it may not. It may be that the rapidly alternating polarisation of the dielectric will cause the formation of new organic compounds, rendering the insulation at no very distant date incapable of withstanding the stress due to the working pressure. Were this so, long-distance transmission by underground cables would prove a financial failure, and one of two alternatives would be forced upon us—viz., overhead wires or a multiplicity of small stations. American experience with overhead wires and high voltages proved that the insulators were the crux of the question, and are not we in this country likely to have a similar experience under more difficult conditions? It may be urged that the question of dielectric hysteresis is dealt with in a rather arbitrary manner. I have done so on purpose, as although it is not my intention to dogmatise on a question as yet far from being satisfactorily settled, it is necessary to take something for granted in order to give the paper definite shape. The capacity of the ·015 square inch cables has been taken at ·125 microfarad per mile and the power factor ·023. This gives rather less than 1 per cent. loss. It should be noted that in Table III. 1 per cent. is allowed for the dielectric loss, which is, however, much too high, as 25 ⌒⌣ would be the periodicity in the line as against 40 to 50 in the other cases.

While collecting data for this paper, particularly with reference to the performance of the sub-station plant, I obtained some interesting

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, Jan. 27.

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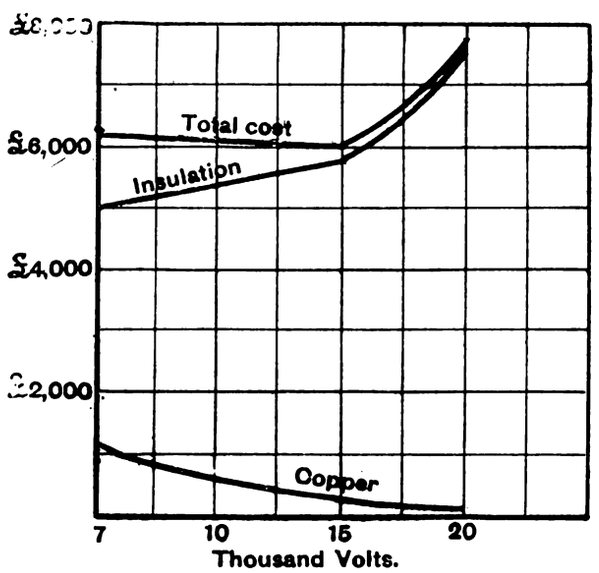
figures on the cost of labour and repairs chiefly on systems employing converter sub-stations. In eight stations of which I had full particulars, 43 to 65 per cent. of all the labour charges on the system (generation + distribution) represented labour costs in the sub-stations, four stations were between 50 and 55 per cent. Of the repairs, in few cases was more than 5 per cent. spent in the sub-stations, often less. One engineer said his three sub-stations had been in operation 18 months, and two had cost nothing in repairs. Of course, such data as are available have only been from stations of recent growth, and experience has been obtained chiefly with new plant, where the repairs are generally small; nevertheless, the figures are interesting.

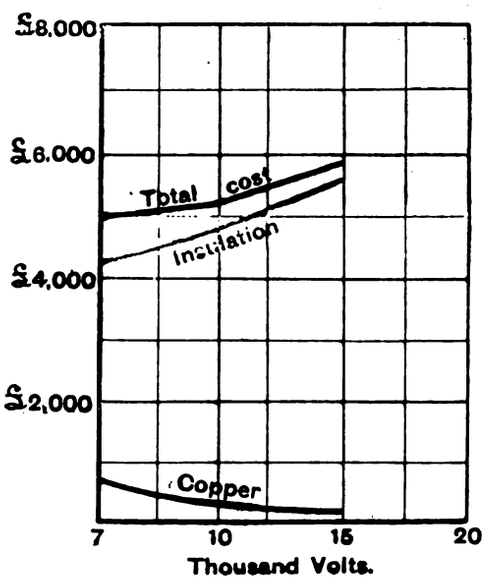
The distribution of polyphase currents as such in the low-tension network has not been touched upon in the paper, chiefly through lack of time; nevertheless, the writer is of opinion that the present system of converting alternate to direct current is bound, in the natural process of evolution, to be superseded by the simpler method of transformation from high to low pressures without conversion. Nothing can justify the investment of money in apparatus which converts alternate to direct current merely to pander to popular fancy. Anyone having experience of a system where polyphase motors and lights are supplied from the same generator cannot fail to be impressed with the steady light from the incandescent lamps, and if 300 h.p. can be distributed as motive power by means of polyphase motors, and nearly 200 h.p. for lights in a large works, with every satisfaction to the drawing office—and that from *one* three-phase generator—there is no reason why, with a little more care than is exercised on a three-wire network, polyphase current for mixed light and power should not be distributed in a large town. Two outstanding advantages would be the elimination of a considerable proportion of the labour costs at the sub-station and a reduction of the capital invested therein.

In conclusion, the writer has to express his thanks to the Westinghouse Company, the British Insulated Wire Company, and numerous friends in this country and in America for information on various points.

Appendix A.

The annexed curves have been added since the main part of the paper was written. These show the relative cost of copper and insulation plotted for 300 kw. and 600 kw. transmitted 10 miles with 10 per cent. line loss. It is apparent that the economic voltage is determined chiefly by the maximum power transmitted by any one cable. From the curves, it follows that if the maximum power transmitted by one cable be 300 kw., 7,000 volts is more economical than the other voltages considered. With 600 kw., 15,000 volts appears best. This latter figure does not, however, seem absolutely correct. From the diagram it appears that a very small increase in the cost of insulation would put the economic voltage back to 10,000. On consulting some very recent prices for high-tension cables by an English firm, I find that the quotation for cables at a voltage of 15,000 or 20,000 volts are higher than those used in plotting the curves in Fig. 2, placing the economic voltage for 600 kw. at 10,000 instead of 15,000, a more likely figure, while 15,000 volts remains the most economical voltage for 1,000 kw. Curiously enough, insulation becomes so costly that even at 3,000 kw. per cable 20,000 volts would not be economical, so that unless with bare wires or excessively long distances, the latter is not at all probable in this country, and 15,000 volts is likely to remain the upper limit of good practice.





A remark made some time ago by Mr. Ferranti occurs to the writer. It was to the effect that the voltage which was best at one stage of a company's development, would not necessarily be most economical at a later stage. This is supported by the curves given in the paper, for if a company wished to transmit 900 kw., say, 10 miles by means of three cables, each carrying 300 kw., 7,000 volts would evidently be best. If, however, later developments necessitated the transmission of, say, 2,000 kw., and four cables were employed, each carrying 500 kw. 10,000 to 15,000 would be more economical than the original voltage. Bearing in mind the lines along which power distribution is likely to develop in this country, the choice of E.M.F.'s between 5,000 and 10,000 volts seems to be along safe lines, as the power transmitted per cable is more likely to be under 300 kw. than over that amount.

Appendix B.

List of some Electric Power Distribution Companies and the E.M.F. Employed, or to be Employed, in Transmission.

Company.	Voltage.
Central Electric Supply Company, London	6,000
Clyde-Valley Electric Power Company	6,000
Cleveland and Durham Power Company	—
County of Durham Electric Power Distribution Company	—
Derbyshire and Nottinghamshire Company	—
Lancashire Electric Power Company	—
Midland Electric Power Corporation	7,000
Newcastle-upon-Tyne Electric Supply Company (Wallsend)	5,500
Shannon Water Power Company	—
South Wales Electric Power Distribution Company	10,000
Yorkshire Electric Power Company	—

Where the voltage has been omitted the writer has been unable to gain any information on the point, or the question has not been settled.

Discussion.

At a special meeting held on Monday, 3rd inst., Mr. John F. C. Snell in the chair, the above paper was discussed.

Mr. A. W. Heaviside said that the paper raised many interesting points, not the least of which was the enormous capital necessary for equipment outside the generating station; the large power schemes seemed to sink enormous sums in mains and sub-stations. He suggested that Mr. Stewart might give them the cost of the four stages in detail—viz., generating station, transmission line, sub-station, and, if possible, also low-tension distribution—for the lecturer had concluded his investigations at the low-tension 'bus bars of the sub-station. This would enable them to take a bird's-eye view of electric power distribution. The lecturer had brought home very forcibly to their minds the fact that overhead wires for transmission and no conversion, only transformation, was the true solution of the problem, the latter getting rid of all moving apparatus and consequent heavy labour costs in the sub-station; while as for overhead wires, he was at a loss to discover any real reason why they should not be permitted. It had been shown that the pressure on the overhead trolley system in large cities could kill a man, and if overhead wires admittedly dangerous were permitted in the streets of large cities, why prohibit high-tension overhead trunk lines for power? It mattered nothing to the man who was killed whether he was killed with 500 or 5,000 volts—the result was the same; and in country districts there was not the slightest doubt that high pressures were less dangerous than trolley wires in our streets.

Mr. R. S. Dobbie thought the paper of great value at this stage, and was very much impressed with the enormous sums necessary for insulation. He could not help thinking that were American work limited in the same manner as British practice was, the great developments which have taken place in that country would never have been known. The lecturer had very ably summed up the relative merits of various types of sub-station equipment. One point, however, he had overlooked was that, given all three types similarly rated as regards temperature rise, etc., the rotary converter was capable of withstanding much more severe overloads than either synchronous or induction motors. The latter would fall off in speed to a serious extent, and the former drop out of step with a 25 per cent. overload, but the converter would stick to its work even under much more difficult conditions. The question of supplying consumers with polyphase instead of direct current was a question of no small importance. Supply authorities must supply the kind of current which consumers wanted, and there was a distinct preference for direct current. The problem of satisfactory speed regulation with alternate-current motors had not yet been solved, and as many industries required wide speed variation, he considered that all-round satisfactory service could only be given with direct current. From his American experience he felt quite sure the day had not yet arrived when the consumer would uncomplainingly accept polyphase current from a supply authority. Moreover it

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was still a fact that polyphase alternate-current motors cost more than direct-current machines, which was another reason against them. An interesting point raised by the lecturer was the wave form of the apparatus. He quite agreed with Mr. Stewart on this point, although it was generally overlooked. Many types of alternators did not give waves approximating to a sine curve, and different makers' apparatus gave different wave forms, and the result was anything but satisfactory when several makers had supplied plant for one installation. Some considerable time ago, while in the States, he designed an alternator which he flattered himself gave a sine curve. He was interested, however, some little time ago to receive from a friend in London an unusually good oscillograph curve showing that there was a distinct step in the E.M.F. as each slot came within the magnetic field. There were apparently relatively few slots.

Mr. John F. C. Snell said the author seemed to have made out an excellent case for the rotary converter; his diagram went further, however, and did not make out a case for long-distance electric power transmission at all. Apart from all other considerations, the enormous cost of duplicating a feeder—and that was a necessity—was so great, that it must act as a deterrent to the development of long-distance transmission. He also noted that the line and sub-station cost nearly twice as much as the generating station. Mr. Snell then proceeded to point out that in central-station work the curve of total costs was hyperbolic in its nature, and after a certain critical point had been passed, capital charges become almost a fixed figure. Opinions differed as to where the critical point was; from calculations he had made he thought that in the region of five million units would be found the critical point for many low-tension stations. He would like to know whether the author had devoted some time to that point. Mr. Snell questioned if it were possible to generate at ·3d. per unit. Taking the lowest costs he could think of, it seemed almost impossible to generate at that figure. Rates and taxes in most towns swamped the figure with a charge of about ½d. per unit. The lecturer had concluded his investigations at the low-tension 'bus bars, hence the figures given did not represent cost to the consumer. It must be borne in mind that that would add about another third to the figures given—in fact, it did not seem possible even on the most advantageous terms, to supply a consumer at less than 1½d. per unit. After referring to the incidence of insulation on the cost of cables, Mr. Snell pointed out how interesting it was to note the critical limit to the pressure, and asked if there was any critical limit to the pressure when bare wires were used. Referring to the life of extra high-tension cables, they knew that both rubber and paper suffer from molecular strain, and he thought that the dielectrics of these high-tension cables would age much more rapidly than had been expected. Rubber, for instance, aged rapidly under high alternating E.M.F.'s; paper might do so more slowly, but it could not be doubted that it suffered in the same way. He suggested that some attention might be given to the question, and one might formulate a law for molecular fatigue in a dielectric, as was done for iron and steel. He did not agree with Mr. Stewart's figure of 38 per cent. for a load factor. In Sunderland they had 800 h.p. to 900 h.p. of motors, giving a load factor of 18 per cent.; the tramways gave a load factor of 35 per cent., but the whole load factor was only 15 per cent. Taking any large power scheme, they could only expect a good load factor due to diversity, and not to steady demand from consumers. His own opinion was that power schemes could not expect over 20 per cent. He believed that one station in connection with a power company obtained a load factor of over 40 per cent., but that, Mr. Snell thought, would certainly come down as the area of supply was extended to include smaller consumers; this was, in his opinion, the weak spot of all power schemes. The mere fact that at the moment a station supplying works, etc., close at hand had a good load factor, did not prove anything; he was quite sure that such schemes could not compete with well-managed stations of moderate size. Sunderland, for instance, had been left entirely out of account by one of the power companies, as it was admitted that they could not compete with the town supply. The paper was, he thought, most interesting at this stage, and shed new light on one of the subjects, regarding which little was known. He had great pleasure in calling upon Mr. Stewart to reply.

Mr. Stewart, in reply to Mr. Heaviside, gave as the figures asked for £20·8 for generating station, £26·5 for line, and £10·8 for sub-station plant and buildings capital cost per kilowatt of maximum demand; and taking the energy at the high-tension 'bus bars as 100, the energy delivered at the sub-station from the line was ·95, and at the low-tension 'bus bars ·854 of energy delivered at high-tension 'bus bars, an over-all efficiency of ·812. This was approximately for Table I., and assuming full load of 750 kw. He quite agreed that there was, comparatively speaking, little to be feared from overhead wires, and expressed the opinion that they must come; they were, indeed, an economic necessity: to legislate against them was putting an indirect tax on industry. He did not altogether agree with Mr. Dobbie on the necessity for direct current in the low-tension network, especially in small towns, where the motor load was not of great importance. The price of polyphase motors, raised by Mr. Dobbie, was not so serious as it looked; unlimited competition had pulled down the price of direct-current motors, and with the expiry of the Tesla patents, doubtless the small difference in the case of polyphase motors would be equalised. The author's own experience with polyphase apparatus led him to think that the question of satisfactory speed was only a question of time; he could not think that the resources of our engineers would be beaten at one point with what was otherwise a very satisfactory motor. In reply to Mr. Snell, Mr. Stewart said he did not start out with a bias in favour of converters, but rather in favour of synchronous motor-generators; he was, however, driven to the conclusion that in most cases converters were best. Mr. Snell's opinion on the difficult problem of one station *versus* several was of value, representing a mature judgment, the result of years of observation. Perhaps the most remarkable case was Glasgow, where Mr. Chamen had arrived at the conclusion that a multiplicity of small stations was under the circumstances superior to one, and instead of going outside the city to build one very large station had built two large low-pressure stations, one on the north side and the other on the south side of the city, making a total of four low-pressure stations owned by the Glasgow Corporation, exclusive of battery sub-stations. A striking contrast was the tramway power station of the same city—one large station with polyphase distribution. The difference in operating conditions made comparisons difficult, but, nevertheless, the point was one of great importance. On the question of generating costs, Mr. Stewart gave details of two very large stations, one giving with an output of 19 million units a works cost of ·288d. and another with 20½ million units ·243d., and gave satisfactory replies to several questions upon these. He agreed with much Mr. Snell had said on the influence of the low-tension network on the cost per unit, but it must not be forgotten that under more favourable conditions the low-tension network was earning money over a longer period. The load factor chosen had been arrived at after a comparison of a works load in a certain district, and could be achieved. The law governing the fatigue of dielectrics would doubtless prove of interest, but, unlike iron and steel, most dielectrics had a rather complex chemical composition. He had discussed the question with cable manufacturers, chemists, and others. Some said they could not have molecular fatigue, only chemical change; others said the former was more likely. Doubtless, with the absence of data, such discussions might easily rise to the level of a purely academic discussion, but the problem was there all the same. Doubtless experience would soon settle the point. There were many points yet to settle in connection with cables, one of which was the law of maximum economy. The point would, however, be dealt with in a contribution to the *Journal*.

INSTITUTION OF CIVIL ENGINEERS.

At the ordinary meeting on 18th inst., Mr. Charles Hawksley, president, in the chair, the paper read was "Electrical Traction on Railways," by Messrs. W. M. Mordey and B. M. Jenkin, M.I.C.E.

In view of the questions arising out of the recent Inner Circle arbitration as to the practicability of the general application of electrical working to railway systems, the authors considered the present time a suitable one for a general review of the various electrical systems applied to or proposed for railway working. Short and busy railways were now being successfully worked by electricity, and longer lines were calling for attention. As the distinction between railways and tramways was rather arbitrary, much of the paper was to be taken as referring to tramway work as well as to railway work.

The principal features of existing systems were classified and described under three heads—viz: (1) direct-current methods; (2) composite direct and alternate current methods; and (3) alternate-current methods. It was shown that in the first-named class—viz., purely direct-current methods—the principal alternative to the simple 500-volt two-wire system was the three-wire system in various modifications, which were explained. This was followed by a description and diagram of the method adopted on the City and South London Railway, which was the only important example in actual practice of a purely direct-current system using other than the simple 500-volt arrangement. This system was a three-wire distribution combined with feeders supplied at 2,000 volts. The composite method—that used on the Central London Railway—was next described, in which high-tension three-phase alternate-current transmission was combined with step-down transformers and rotary converters to give direct current to the railway. The existing alternate-current methods were all described under three-phase working, and it was shown that on the Continent there was a decided tendency to work out the more difficult traction problems by the use of three-phase alternate currents, not only for transmission, but also for working the trains themselves. A table was given containing particulars of the principal three-phase electric railways.

The authors then proceeded to discuss the comparative advantages and disadvantages of these three classes or methods, giving curves to illustrate the efficiencies of the sub-stations according to the methods adopted, and a table showing corresponding costs of the plant, etc., required. The advantage to the direct-current and composite methods of their easy use of accumulators was pointed out, but the possibility of also using these on alternate-current systems was considered. The systems were also compared in their

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relations to number of conductors, speed, effect of variation of voltage, and relative complexity of the sub-stations.

The paper next considered the starting torque of single-phase alternate-current motors, with illustrative diagrams of curves, after which consideration was given to the increased electrical resistance of the rails with alternate currents, according to the periodicity. Some tests made by Mr. Blathy on this matter were communicated by the authors. The effect of these results on the use of alternate currents was considered rather fully, the limitations imposed being pointed out, and conclusions being drawn as to the probable advantage of using copper return conductors in place of the rails. Attention was drawn to the choice of periodicity as affected by lightning, rail resistance, and effects. A short section followed on lightning. The return of energy to the line when running down gradients and when stopping the train was dealt with. It was pointed out that efforts to do this with direct currents had not had any success, but with alternate currents the problem was much easier; in fact, the method was used on most of the existing alternate current lines, not so much with the object of economising energy, but for the sake of obtaining a very convenient brake. The importance of variable-ratio control was next considered, the special need for such a process being shown by the fact that with the present methods, direct-current or alternate-current, the maximum losses of power and the maximum output of the generating station occurred when the power developed at the train was least.

The authors summed up under the following 12 heads the requirements that should be met in any general system of electrical railway working: (1) extra high pressure for feeding sub-stations; (2) avoidance of moving machinery in the sub-stations; (3) on longer lines a high-pressure distribution to the trains—making necessary (4) overhead conductors; (5) easy extension of distributing system; (6) ability to supply trains having different systems of motors and control; (7) high acceleration when starting; (8) the return of energy on gradients or when stopping; (9) possibility of using different speeds; (10) a variable-ratio arrangement for starting, for speed regulation, and for returning energy; (11) possibility of using motors on a locomotive or distributed on the train; (12) the train equipment and control to admit of extension and modification to work on other systems. The first six of these referred to the distribution of power, and the last six to the equipment of the trains themselves. The first five led to single-phase alternate-current working as the only method that fulfilled all the conditions.

The authors accordingly proceeded to discuss whether any system of utilising single-phase current was possible, and they described in considerable detail a method originally proposed by Mr. Ward Leonard. In this system a single-phase motor on the train would drive a direct-current dynamo provided with means for separately exciting it, and for varying its E.M.F. over any desired range. The current from this dynamo would be taken to a separately excited direct-current motor; by this means there would be provided a most flexible variable-ratio transformation; and the advantages of such a system were pointed out. It was then shown that such a system satisfactorily met the other seven requirements laid down, and offered at least a practicable solution of the problem of a comprehensive general system of electric traction for railways.

CRYSTAL PALACE AND MOTOR TRADERS' CO-OPERATIVE SHOW.

An exhibition of motorcars and cycles and accessories was opened at the Crystal Palace on Feb. 14. The exhibition will close on Feb. 22, and thus just coming between the two publication days of the electrical technical Press does not give much time to its readers to take advantage of any description which otherwise might be of value. As usual in motor exhibitions, there are very few electrical exhibits. The prize for electric motorcars was awarded to the British Electromobile Company, Limited, 4, Bloomsbury-square, W.C., who exhibit a number of carriages fitted with Leitner accumulators, and tested to go from 50 to 95 miles without recharging. The batteries are fitted in the car body under the seats, and in front, and are not removed when charging. There are three brakes on every car. The electric brake has been divided into an emergency electric brake applied through the controller, and a recuperative medium electric brake worked by a foot lever. By the introduction of an arrangement which is practically a loose-handled switch, the former has been made easier to handle, at the same time becoming more reliable to the touch. All wires are easily accessible. The recuperative brake above referred to is an arrangement of the motors as generators to return current to the batteries. The momentum of the car is thus absorbed and utilised to increase its mileage. This form of brake can be brought into play at any moment by pressing a small foot lever with the left foot and then depressing the large foot lever with the right foot. The further this lever is depressed the stronger the braking effect. When the small foot lever is not pressed simultaneously with the large foot lever, the large lever first cuts off the current and then applies the band brakes. Thus, either the emergency or the medium electric brake may be brought into action simultaneously with the band brakes. The double-acting band brakes act on the back wheels. An additional safeguard is provided in the form of an ordinary "sprag." The stand is handsomely lighted by the same type of accumulator. The specification of the Tonneau car, which has accommodation for four, and is listed at £355, is as follows: accumulators (A) "Leitner" 6 u. type, 42 cells, £115; (B) "Leitner" 6 c. type, 42 cells, £145; horse-power (A) 8, (B) 12; distance on one charge at an average speed of 12 miles of hour, (A) 60 miles, (B) 90 miles; speed up to 25 miles per hour; wheel base, 6ft. 9in.; track, 4ft. 9in.; weight without occupants (A) 28cwt., (B) 36cwt.; charging rates (A) 25 amperes, and (B) 38 amperes for eight hours; voltage at end of charge, 110; cost of full charge at 3d. a unit (A) 5s. 6d., (B) 8s. The same firm also exhibit neat portable hand lamps with dry accumulators, manufactured by Accumulator Industries, Woking; also carriage lighting sets, with dry accumulators in a wooden box, miners' lamps, ignition cells, cycle lamps, and pocket accumulators. Of the former we noted type F 2, with two cells, weighing from 3lb. to 5lb., and giving seven to eight hours' light with a 3½-volt lamp.

Messrs. Haycraft and Son, Limited, Broadway, Deptford, show two electric carriages, or, as they call them, Mackenzie electro-carriages, fitted on the Ricker system. The battery space is under the front seats, and the carriages are constructed to run 50 miles with one charge

The Imprimis Motorcar Company, 78, Queen Victoria-street, E.C, exhibit two electric business wagons and one passenger wagon.

The Dumont Electric Ignition and Self-Starting Company, Limited, 27, Eldon-street, E.C., show a car fitted with their special electric ignition gear and self-starter, by means of which engines of car may be stopped and restarted at will by the driver without leaving his seat, by simply pushing an ingenious combined switch and push attached to the steering pillar.

The United Motor Industries, Limited, 42, Great Castle-street, Oxford-street, London, W., exhibit a variety of items, including coils in great variety, both for cars and motor-cycles, accumulators, dry batteries, "Castle" volt-meters and ampere-meters, and a large collection of sparking plugs, including the U.M.I. cementless, the most easily repaired plug on the market, genuine De Dion, imitation in two qualities, Demontable, Reclus, B. and M., H. P., Panhard, etc.

Accumulators for electric ignition of motors are shown by the General Electric Battery Manufacturing Company, 461, Coldharbour-lane, Brixton, also portable accumulators, and pocket accumulators for electric jewellery, reading, testing, and theatrical work, running small motors, and lighting purposes, etc. The accumulators for motorcar consist of single cells, giving two volts each, and are usually supplied in four-volt sets, consisting of two cells. We also noticed very inexpensive electric lanterns for use with pocket or ignition accumulators, very useful for

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inspecting gear, etc., and four or six volt incandescent lamp, mounted in a holder with flexible cords, for testing ignition accumulators, etc. Le Carbone, 36, Lime-street, E.C., have the Sans Pareil dry cell and the Paris hermetically-sealed wet cell for ignition apparatus for cycles and cars. The life of the latter is stated at 3,000 miles, without reference to power, however.

The Motor Power Company, Limited, 14, Regent-street, show some light motor carriages with electrical ignition generated by accumulators. Edward de Poorter and Co., Limited, 9, Great Tower-street, London, E.C., have special accumulators and coils for motor bicycles, the "Bougie Moulin" sparking plug for motor bicycles, and Wydt's allumeur electro catalytique.

Amongst the accessories we find motor chronographs, speed indicators, etc., by S. Smith and Son, Limited, 9, Strand, and a very handy jack, or, as it is called, McCurd's patent instantaneous motor cycle support, by W. A. McCurd, 21, Clapton square, N.E.

During the course of the exhibition lectures are given, illustrated by interesting cinematograph views, on the Paris-Berlin international motorcar race.

THE GENERAL ELECTRIC DINNER.

The feature of the annual dinner of the General Electric Company on Saturday last was the return to the chair of Mr. G. Byng, who for some years has been prevented by illness from taking an active part in either the festivities or the work of the firm, which owes its success to his great organising capabilities. Everyone was delighted to welcome him back to England, and to hear that he was now taking up to a certain extent his old responsibilities. This delight was shown by the fact that it was impressed in all the speeches, irrespective of the toast under discussion. The dinner was again held in the Grand Hall of the Hotel Cecil, between 400 and 500 taking part. While the larger proportion of these were the staff of the company, there were, as usual, representatives of all branches of the profession, including Royal Engineers, consulting engineers, borough electrical engineers, and electrical contractors. A good number of ladies, also representing the home element of the profession, were present.

Mr. G. BYNG, as chairman, coupled the two Royal toasts into one, and after this had been duly honoured he proposed "The Imperial Forces."

Captain LLOYD, in the absence of Colonel Crompton, replied, but did not express an opinion on Mr. Byng's humorous suggestion that every man in this country should be a compulsory volunteer. Instead, he instanced the great field which electrical engineers now had in the three services, and to the good work which our Electrical Engineer Volunteers had done in South Africa. The value of the services rendered was evident from the fact that the more of these volunteers Lord Kitchener got, the more he seemed to want.

The toast of the evening—*i.e.*, "The Staff"—was also proposed by the CHAIRMAN (Mr. G. Byng), who expressed his thankfulness at being again permitted to preside. He was also grateful that the business had not suffered in his absence, but instead had made great progress. In his travels he had met one gentleman who attributed this to the foundation laid by himself (Mr. Byng), but he considered that it was due to the effective working of the staff. While congratulating them on this, he would remind them that the present was not a time to rest upon their oars. They had to fight unfair competition, owing to the free-trade policy of the country. He held that they were engaged in what might be termed a non-civilised commercial warfare. It therefore behoved every member of the staff to strenuously uphold their native industries. This, he held, their firm was doing, and no less than 5,000 employés were personally interested in the result of the struggle. He should not be satisfied until the manufacturing interests of this kingdom were more protected.

Mr. A. BROOKER replied for the staff, which was scattered over the whole world, and included some members on a civilising expedition to Patagonia. He spoke of the freedom with which the directors of the company acknowledged what they owed to their staff, and without doubt they, as a staff, were deeply indebted to the directors for the ready acknowledgment of individual effort. As showing the confidence which the staff, down to the office boy, had in their directors, he quoted the following expressions of opinion by junior members—*i.e.*, "That within three years Mr. G. Byng will have knocked out that free-trade business." "That Mr. Hirst made the treaty with Japan." "That Mr. Bevis was to take over the remount department for the War Office." Mr. Brooker concluded his humorous speech by wishing success to the Witton Works.

Mr. H. HIRST, in proposing "The Guests," expressed a feeling of thankfulness that so many of our most intelligent engineers had not chosen to be manufacturers. The success of the firm was due quite as much to the kind offices of their friends as to their organisation and to the efforts of their staff.

The toast was replied to by Prof. PERRY, Prof. BERRY, and Mr. HAMMOND.

Amongst the few personal toasts which followed was one of "The Health of Mr. G. Byng." The proposer of the same urged that gentleman to take up his old responsibilities slowly, and to husband his strength so that he might be spared for many years to preside over the company.

The dinner was followed by a smoking concert, at which a most excellent programme was discussed, while general conversation among the guests was possible. The General Electric Company are to be congratulated on the success of the entertainment provided, which was as well organised in every way as is their business.

LONDON ELECTRICAL CONTRACTORS' ASSOCIATION DINNER.

Although this association has only been in existence for five months, it numbers already 70 firms on its lists of members. About 200 of these took part in a dinner on Thursday, Feb. 13, at the Hotel Cecil. The president of the association, Mr. R. W. Woodward, held a reception at 6.30 p.m., after which an adjournment was made to the Grand Hall. The menu having been discussed, and the partakers thereof duly snapshotted, the loyal toasts were proposed and honoured in the customary manner. After an interval for music the toast-list was attacked by Mr. G. DOUGLAS BATE, who in a very humorous manner proposed "The London Electrical Contractors' Association." He referred shortly to the electrical manufacturing and supply association of houses about to be formed. He thought, as one of the 38 units who had pledged themselves to do their utmost to promote in their various districts the objects of the association, that the contractors were asking too much when stipulating that manufacturers should only deal with purely electrical contractors. The definition was too narrow, as there were many firms who combined other businesses with that of electrical contracting. He also wished for a definite *quid pro quo* to be stated.

The PRESIDENT (Mr. R. W. Woodward), in responding, said they asked nothing from the manufacturers; they were not aggressive, and the definition quoted was not their own. They intended to their business in a legitimate, honest, straightforward manner. Mr. Bate had stated that at present only half the manufacturers' business came through electrical contractors; the sooner all of it did, the better it would be for everybody. It was through the contractor that the business of the country should be done. He had no objection to municipalities taking the control of large undertakings like water, lighting, or trams, but objected to the shopkeeping done by some of them. The association was prepared to meet the manufacturers on their own ground.

The "Visitors" were welcomed by Mr. W. W. STRODE, A.M.I.E.E., a toast which elicited a reply from Prof. PERRY in his most felicitous vein. He agreed that there had been too much poaching upon other people's preserves. If the association were successful in their aim to do away with

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the lot of cheap and nasty work often found nowadays, and ensure a profit at the same time, the whole country would benefit.

Mr. THEODORE BEVAN, president of the Electrical Traders' Association, U.S.A., gave some of his experiences of the co-operation of electrical interests in America, and said that it had in that country resulted in the benefit of all concerned.

Mr. W. W. GILLARD proposed the president's health, and the latter, who was most enthusiastically received, after his reply eulogised the services rendered by the indefatigable secretary, Mr. E. J. Hogan. This was supported, on behalf of the manufacturers, by Mr. OPPENHEIMER. Mr. HOGAN very modestly tried to put all the merit on the shoulders of the Dinner Committee. Whoever is answerable for it deserves a word of recommendation, for the arrangements for the evening were well made and equally well carried out. The programme, which contained a number of good songs, was long, and the toasts were few and short.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

457. (*a*) Say how the position of points for connecting return cables to rails of an electric tramway is best determined. (*b*) What percentage increase of resistance over and above that of the rail itself is due to the bonding of, say, 90lb. rails in 45ft. lengths with ordinary 24in. six-bolt fishplates, two 4/0 bonds, each 30in. long, being used at each joint?—J. A. M.

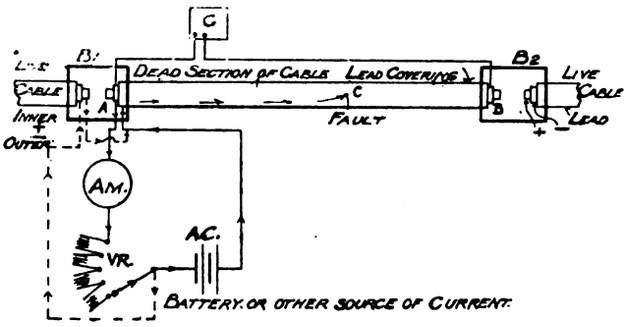
458. At a 100-volt installation it is required that the accumulators (56 cells) shall be charged at the same time as motors and lights (200 amperes) are being supplied. The dynamo is a 50-kw. machine, and can be run at 100 to 150 volts. When used for charging, the current for the motors and lights is taken off the fortieth cell. An ordinary charge and discharge switch is provided for the battery, but the cells from 1 to 40 do not appear to get properly charged. How can this be remedied, having in mind that 200 amperes are being used day and night? No further expense can be incurred.—A. G.

N.B.—As all changes must cost something, the best remedy should be described.—ED. *E. E.*

ANSWERS.

Question No. 451.—Given a lead-covered, armoured concentric cable, say, 1,000 yards long, having a fault between outer and lead covering. By means of the loop test the fault is located within a length of, say, 10 yards. How can the exact position of the fault be found with a minimum of interruption to the supply?

Best Answer to No. 451 (*awarded* 15*s.*).—As the faults mentioned in the two questions can both be located by the following test, one answer will suffice for both. As shown in sketch, A B is the faulty section of cable laid dead between the section boxes, B_1 and B_2. The insulation between the different cores and lead sheathing is not shown. We will first treat the fault between the lead covering and the outer conductor. Join up two or more accumulator cells, A C, a variable resistance, V R, and a portable ammeter, Am, in series between the end of outer conductor at A in box B_1 and the lead covering at same end, so that a known current may flow through the lead from A C by way of fault at C to outer conductor through Am and V R, thus completing circuit. If two accumulators, A C, are not handy, then current may be taken from line end of cables in section boxes, and connections will then be as shown dotted. In this case, with a low resistance fault, probably a few incandescent lamps, as well as V R, will need to be put in circuit to give a workable current on Am, and strength of current will require to be made suitable for area and length of cable, such current being used as will give a readable deflection on galvanometer, G, due to drop from A to C. If "J. D." has a Kelvin testing set, the galvanometer of it may be used, the "battery" terminals of testing set being connected between two ends of outer conductor as shown. This connection may be made by a pilot wire or other main if its insulation is good; if not, then a temporary main will need to be run. In using galvanometer of Kelvin set use it unshunted, with selecting switch on "earth" terminal, and controlled by earth's field alone if necessary.



To make test, connect as shown, and get deflection on G due to drop between A and C. Then remove battery, A C, V R, and Am to end B_1, or if live end of cable in box has been used at A, then connect up at other end, B_2, to live end of cable in box, B_2. Adjust resistance until current is preferably the same as when at A, and note deflection on G due to drop between B and C. The galvanometer, G, or testing set, if used, and its connections, must not be altered in any way. If battery is joined up when testing, so that current at either end passes to earth at fault, this will prevent any error due to electrolysis, but this only applies to a fault between lead and outer. The distances, A C and B C, are directly proportional to the deflections obtained over respective lengths of cable if current is adjusted to be the same in both cases.

Let d_1 = deflection at A, say 30 divisions;
d_2 = deflection at B, say 20 divisions;
l = distance A B = 1,000 yards.

Then
$$\text{distance A C} = \frac{l\, d_1}{d_1 + d_2} = \frac{1{,}000 \times 30}{30 + 20} = 600 \text{ yards.}$$

If currents used at A and B are different in value, then the distance A C may be worked out from following equation:

Let C_1 = current at A;
C_2 = current at B.

Then
$$\text{distance A C} = \frac{l\, d_1 C_2}{d_1 C_2 + d_2 C_1}.$$

In the case where the fault lies between the outer and the inner conductor, then, of course, the connections will be made between those conductors instead of between lead and outer, the same tests being gone through at each end of cable. I have known this test to locate faults such as these in long lengths of concentric feeders, laid on "solid system," to within a foot or two, which is near enough for digging up a road.—R. S.

Answer to No. 451 (*awarded* 5*s.*).—There would seem to be no need to interrupt the supply at all in order to locate and rectify the fault between the outer and lead covering above mentioned. The cause is most likely to be the usual navvy's pick, and the commonsense course is to examine the ground within the 10 yards' region for recent tracks of house services, trenchings, etc. If there are any (and a mains man should be able to spot the track of a year-old trench at a glance) the ground can be opened up, the appearance of the damage noted for reference, and after cutting the lead clear of the fault by about 6in. on each

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side, an iron joint-box can be put on over the foot or so of the denuded cable, filled up with the usual waterproof compound, and thoroughly coated itself to prevent rust. Should, however, there be no marks on the ground surface to guide, the obvious course would be to excavate along the 10 yards line and have the cable thoroughly examined until the spot is found. In the event of the outward appearance of the cable showing nothing, the armour and juting should be taken off until the burn in the lead sheath is found, when it can be cut clear and a joint-box put over the spot as previously described. The few yards of cable that has had the armour taken off in the search cannot, of course, be properly rearmoured on the spot, and the best way to make up the deficieney would be to wrap the lead with waterproof tape and renew the continuity of the armour by means of copper ribbon wound over the tape and riveted at both ends. This laid in a 1in. wood trough, with 1in. clearance all round, filled in with bitumen and covered with tiles, would make a quite satisfactory reinstatement. Should the fault be a long-standing one, it is likely that the damp may have gone through to the inner insulation, and in time may give trouble. An insulation test will show if this is so, in which case (to avoid renewing the cable) a pit should be dug out under the place where the lead has been stripped, a tent put up, and a couple of fires kept burning on both sides of the damp place for a day or so to dry out the moisture. Care should be taken not to overheat the lead or burn the jute serving on the good portion of the cable. Before finally leaving the job it will be as well to find where the leakage current went to earth from the lead. More trouble is sometimes caused by the lead being eaten away at such points of departure than is caused by the faults themselves.—B. C. H. J.

Answer to No. 451 (*awarded* 5*s.*).—The enquirer should have stated how the concentric cable is laid, whether armoured and laid direct in ground, laid on solid system in troughing, or laid in conduits or pipes on a draw-in system. I consider each case in order.

(*a If Armoured Cable.*—The simplest and quickest way would be to take up the 10 yards of ground and examine the outside of the cable. A bad burn-out would probably show itself through the armour. Then strip off the armour, lead, and insulation at this point for, say, 12in., examine the conductors, and, if necessary, make good and continuous by sweating, bolt a split cast-iron box over joint, and fill solid with compound. The conductors need not then be reinsulated with tape, provided care is taken to see they are left far enough apart from each other and from the box. If the fault cannot be seen on the outside of the cable, it is best to take out the faulty 10 yards and joint in a new piece.

(*b*) *If Laid on Solid System.*—The cable would most probably be in this case plain lead covered. The trough should be broken away and the lead of cable examined, and where found burnt away there would be the fault. Proceed as in case (*a*), putting box on cable, or reinsulating joint with tapes and wiping lead sleeve over-all. The box method is, however, quickest.

(*c*) *If Cable is Drawn into Pipes.*—The faulty length should be cut at drawing-in boxes, drawn out, examined, and burnt place found. The distance from one end to the burn-out should be measured, then the ground taken up and conduit or pipe broken away (for, say, 18in.) at the correct distance from one end, as measured on the cable. The length can then be drawn in again, a box or tape-insulated and wiped joint made at faulty place as before, and conduits made good by building a small brick pit round break, covering same with a flag and cementing up, after which ground can be reinstated. The joints at draw-in boxes could be remade by another jointer while one repaired fault.

If in any of the above cases damp has run up the cable from the fault, a new length of, say, 10 yards is, of course, absolutely necessary. This can easily be judged by noting condition of cable and its surroundings.—J. A. M.

Question No. 452.—Given a cable such as the above, but with a fault between inner and outer conductors, such fault having a high resistance as compared to that of the conductor itself. How could the fault be located?

Best Answer to No. 452 (*awarded* 10*s.*).—A high resistance short is always more awkward to deal with than that of the "dead" variety, and the best preliminary would be to isolate this main, and to break it down by putting on double pressure. When this has been thoroughly done, the fault will be an easier matter to locate by either the drop of potential method, the bridge method, or the induction method. These, however, are by no means accurate without very delicate instruments are used and very considerable care is taken. Therefore, if a main is wanted in a hurry, better abandon the double-pressure operation and let the jointer's truck go forth with a simple insulation testing set (such as a Kelvin, Silvertown, or Evershed) to the nearest joint-boxes along the cable route, disconnecting at these and testing until the faulty length is reached between two joints. With a fault such as this, inner to outer, it is 10 to 1 that the trouble is in one of these boxes, and they should be entirely freed from their fittings and another test taken before proceeding further. If still faulty, however, the length should be cut in the middle and tested for the bad half. A second cut in the middle of this half should leave a sufficiently short length under suspicion to make it preferable to dig up the main and examine rather than cut it a third time. This will depend upon the kind of paving and the time to spare—wholesale cutting and testing being usually the quickest and cheapest (especially if the main is under a contractor's guarantee). If however, the fault has been broken down sufficiently, and there is in the works a sensitive galvanometer, a few heavy-current cells, a portable ammeter, and a resistance, together with a man used to them and some spare time, the test (see

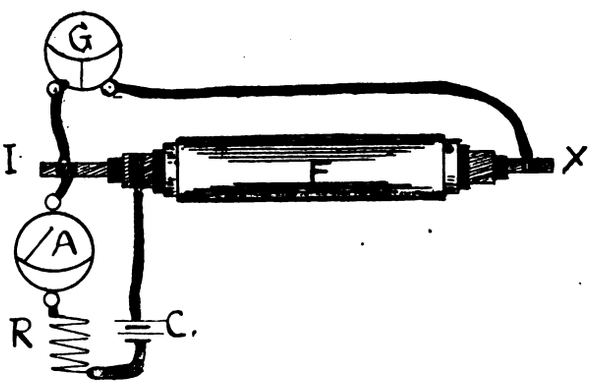

diagram) should give the position within a few yards. The diagram, perhaps, explains itself. The ammeter and resistance are to ensure that the same current passes when testing from either end. The wire shown from the galvanometer to far end of faulty length may be an adjoining cable temporarily used. With a certain current indicated on the ammeter, a deflection, vulgarly called d_1, will be obtained on the galvanometer. Then shift the ammeter, resistance, and cells to the other end of the main (leaving the galvanometer and its connections untouched) and couple up there. On obtaining the same current, another deflection will be obtained on the galvanometer. Call this d_2. Now, if the length of main is christened L, the distance from L to the fault equals $\frac{L\,d_1}{d_1+d_2}$.

Given the same conditions as last, the induction method may be tried, and this consists in passing an interrupted current through both conductors of the defective main (which current goes to earth at the fault and returns to the station earth-plate) and listening at a telephone receiver in the circuit of a coil wound on a triangular former, which is carried over the run of the defective main. An unfortunate property of the armour and lead covering is that they shield and sustain the sound effect, so that instead of it ceasing just after passing over the fault, it only diminishes it in an imperceptible degree, and renders an accurate localisation impossible. In fact, the writer's experience is that the man with the two C's—commonsense and cable-cutters—will sooner free a network from a fault than will the average dealer in algebra with a wagon-load of galvanometers and bridges.—B. C. H. J.

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Answer to No. 452 (*awarded* 5*s.*).—The only quick and practical way would be to pump current through the fault till it was burnt down to a dead short, and then use loop test. The text-books give instructions and formulæ for locating these kind of faults by testing, but I never heard of a hard-worked practical mainsman who had time to use these methods. The tests are intricate, and have to be made very carefully, and in case of mains with services tapped off, it is almost impossible to make use of them.—J. A. M.

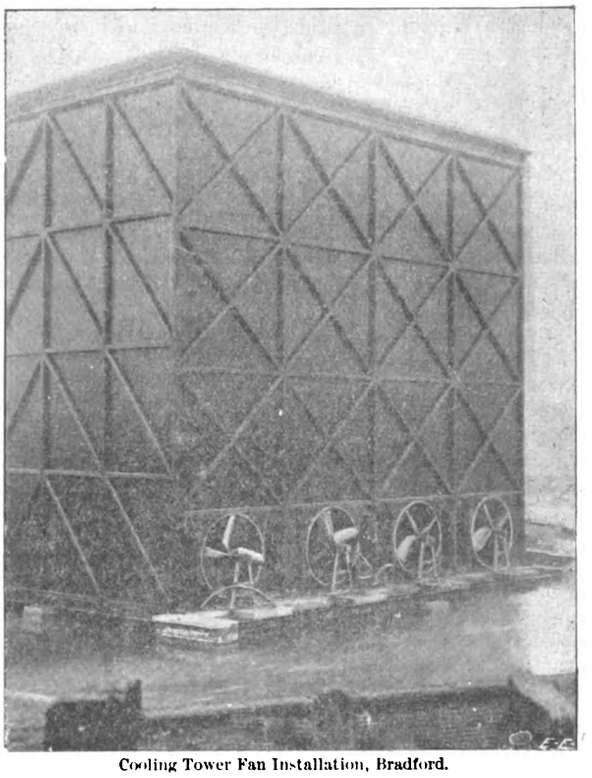
TRADE NOTICES AND NOVELTIES.

Doulton's Water-Softener.

We have just received from Messrs. Doulton and Co., Limited, of Lambeth, S.E., a well illustrated description of their patent water-softeners, which are finding extensive use in various parts of the country. These water-softeners, which work on the lime-and-soda principle, contain many points of interest. The actual design of the apparatus depends largely on the space and height available. The essentials, however, in each case are the same. They are a tank for the softening solution, which is capable of holding sufficient lime-water and soda to soften a full day's supply of water. The mixing of this solution is done by means of a revolving stirrer actuated by a small water-wheel over the incoming water passes. When the tank is full the water is automatically shut off, and the excess lime settles on the bottom of the tank. This softening solution is drawn off by means of a ball float, so that a clear solution is obtained for mixing with the incoming water which has been softened. This mixing is done in a trough containing a funnel which leads into a settling tank. The arrangements here again are automatic, so that when more water is required the requisite quantity of softening solution is admitted with it and mixes at the same time. The settling tank has a large capacity compared with the day's supply of water. In this way the greater proportion of the deposits is accumulated in the tank, and the filter, through which all the water has to pass in leaving it, has not a great deal to do. The various valves and fittings about the apparatus are so designed as not to become choked by the deposit which is obtained in the settling tank and elsewhere. At the back of the list some interesting results from water-softeners which have been at work for several years are given. These show that when the apparatus is properly looked after, it most effectively softens the water passed through it.

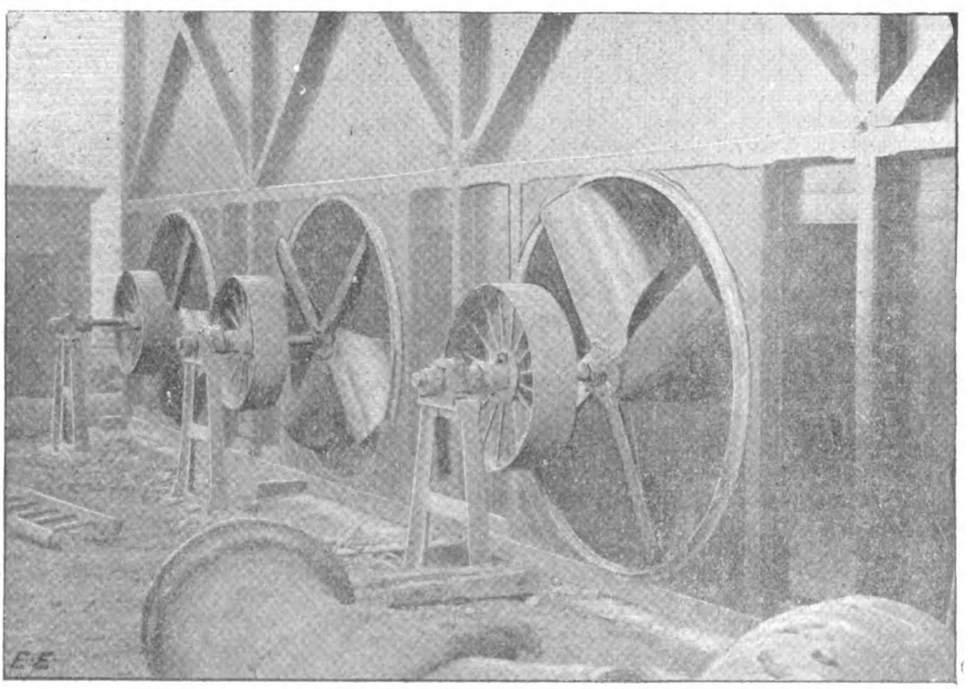
Forced Draught for Cooling Towers.

We reproduce herewith two photographs showing the application of motor-driven ventilating fans for water-cooling purposes. These fans have been installed by Messrs. John Gibbs and Son, 72-76, Duke-street, Liverpool, in connection with the cooling tower recently erected at the Bradford Corporation electricity works. The installation consists of eight of the above firm's patent air-propelling and ventilating fans, mounted on four shafts. Each shafts has a length corresponding to the width of the cooling tower at its base, and carries a fan at either end so that there are four fans per side blowing into the tower. From blade tip to blade tip each fan has a diameter of 8ft. The fans are belt-driven from electric motors at a speed of 250 revolutions per minute, there being a separate motor provided per pair of fans. At the speed in question each pair of fans is capable of delivering upwards of 120,000 cubic feet of air per minute, which corresponds to the large aggregate of 960,000 cubic feet for the eight fans, at a nominal expenditure of 30 h.p. per pair. A recent test gives every justification, we understand, for the expectation that a considerably less expenditure of energy will be required in actual practice due to the high efficiency of the type of fan adopted. The



Cooling Tower Fan Installation, Bradford.

blades, which are of steel, are secured to the shaft by a boss of ingenious form, the construction of which renders it impossible for the blades to become detached, while the method of staying makes ample provision for the strain to which they are likely to be subjected in working, and at the same time affords minimum obstruction to their effective action. Needless to say, this boss has been patented by Messrs. John Gibbs and Son, whose practical experience with work of the class under notice is well known. It may be added, in conclusion, that the fans described above are amongst the largest, if not actually the largest, which have been employed for a similar purpose in the United Kingdom.



Cooling Tower Fan Installation, Bradford.

Thomson-Houston Pamphlets.

We have recently received from the publishing department of the British Thomson-Houston Company, Limited, Rugby, copies of two descriptive pamphlets. The first of these—No. 116—which supersedes No. 90, issued March 25, 1901, describes the company's type O.K.

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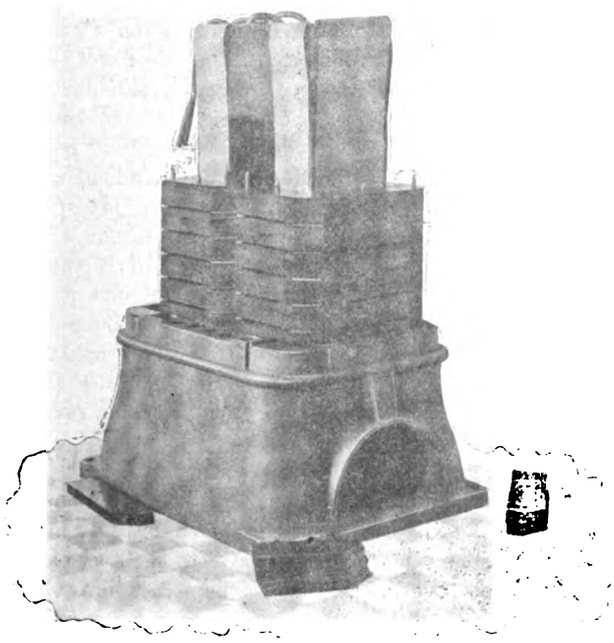
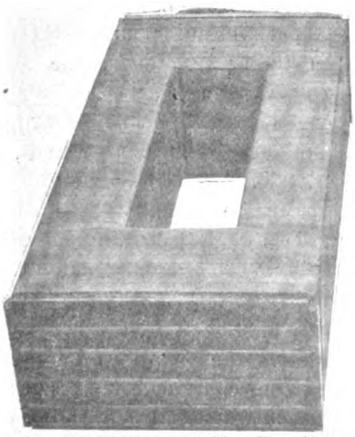
ampere-hour meter. This new type of meter is constructed, we are told, for use on two and three wire constant-potential, continuous-current circuits only, and for capacities of 15 amperes and under. The registering mechanism of the meter is adjusted so as to give the readings directly in kilowatt-hours on the usual dial, provided, of course, the volts on the circuit average the number stamped on the name-plate. There



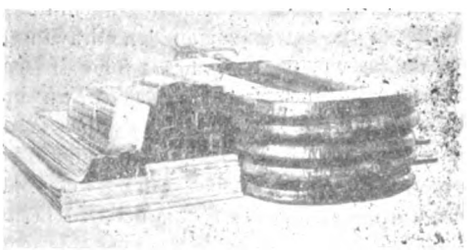
Air-Blast Transformer in process of Construction.

is approximately one-half a volt drop due to the instrument resistance with full load, so that the loss of energy from this source is negligible. The motor starts with 1 per cent. of the full load current or less, thereby ensuring a high degree of accuracy on the smallest loads which the instrument is expected to record.



Assembled Coils for Air-Blast Transformer.

The second pamphlet—No. 117—describes the company's air-blast transformers, type A B, specially designed for power transmission in cases where conditions permit the banking of transformers in groups of large output. They are claimed to be particularly suitable for all sub-station distribution. A few words as to the construction of this



Coils and Diaphragms for Air-Blast Transformers.

type of transformer and the method of cooling the same may not be out of place here. As regards the latter, the coils and core of the transformer are provided with numerous air-ducts, the coils being so proportioned that even in the largest sizes no portion of the electric conductor is more than ½in. from an air-duct, while the spacing strips which separate the coils from each other and from the core are on the narrow edges of the coils. Almost the entire surface of the coils is therefore exposed to a blast of cool air. Each bank of transformers is provided with one or more blowers to force the air through the windings. All parts of the transformer are designed to ensure a temperature rise not exceeding 40deg. C. above the temperature of the surrounding atmosphere when the transformer is working under normal conditions. The interior insulation is largely composed of mica, so that in case of overloads higher temperatures may be attained without damage. The first of the accompanying illustrations shows a British Thomson-Houston air-blast transformer in process of construction. It may be mentioned that the air-ducts in the core are formed by metal spacing blocks between the assembled laminations. The coils are flat and thin; they are wound with copper strips, having rectangular cross-sections, and with but one turn per layer. A continuous mica strip separates each turn from the next. The primary and secondary coils are assembled in small intermixed groups with air-spaces between them. In transformers designed for 5,000 volts and upwards, diaphragms of solid insulating material are placed between adjacent primary and secondary sections, as well as over the exterior of all the windings, except at the ends of the coils. The assembled coils are compressed under heavy pressure, and tightly bound together in order to prevent any possibility of vibration due to the magnetic repulsions between the primary and secondary windings. The second illustration herewith shows the compact nature of the assembled coils for an air-blast transformer, the component parts of this assemblage being shown in the third illustration. The air necessary for cooling the windings is admitted under control at the base of the transformer, and passes directly through the coils in a vertical direction. A damper on one side of the transformer admits air to the ventilating ducts in the core, the escape being through a perforated casing on the opposite side. The approximate dimensions and weights of air-blast transformers ranging in capacity from 100 kw. to 1,000 kw. are given in the pamphlet under notice, as also particulars of the blower sets required for various transformer capacities.

FORTHCOMING EVENTS.

FRIDAY, FEB. 21.

Royal Institution.—At 9 p.m., Mr. W. Duddell on "Musical and Talking Electric Arcs."

Institution of Mechanical Engineers.—At 8 p.m., annual general meeting, followed by special meeting.

SATURDAY, FEB. 22.

North-East Coast Institution of Engineers.—General meeting at Newcastle.

Royal Institution.—At 3 p.m., Lord Rayleigh on "Some Electrical Developments" (Lecture II.).

Manchester Association of Engineers.—Ordinary meeting. Paper: "Intensified Gas Lighting," by Mr. J. Nasmith.

Institution of Electrical Engineers.—At 12.15 p.m., students' visit to the Bankside station of the City of London Electric Lighting Company.

MONDAY, FEB. 24.

London School of Economics.—At 6.15 p.m., Mr. Lynden Macassey on "Electric Traction on Railways" (Lecture III.).

TUESDAY, FEB. 25.

Royal Institution.—At 3 p.m., Mr. Wm. N. Shaw on "The Temperature of the Atmosphere" (Lecture I.).

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be further discussed: "Electrical Traction on Railways," by Messrs. W. M. Mordey and B. M. Jenkin.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., ordinary meeting. Paper: "Electrolysis," by Mr. James Swinburne.

WEDNESDAY, FEB. 26.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., ordinary meeting. Paper: "High-Tension Distribution," by Mr. C. E. Newton.

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "Recent Inventions in Weaving Machinery," by Prof. R. Beaumont.

THURSDAY, FEB. 27.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Papers: "Electric Shock and Legislation thereon," by Major-General C. E. Webber; "Electric Shocks," by Mr. F. B. Aspinall; "Electric Shocks at 500 Volts," by Mr. A. P. Trotter (illustrated by a demonstration at 500 volts).

FRIDAY, FEB. 28.

Royal Institution. At 9 p.m., Prof. H. A. Miers on "Gold Mining in Klondyke."

Institution of Civil Engineers (Students' Section).—At 8 p.m., ordinary meeting. Paper: "Indicating High-Speed Steam-Engines," by Mr. A. M. Arter.

Electro-Harmonic Society.—Ladies' night concert at St. James's Hall, W.

Physical Society.—At 5 p.m., ordinary meeting. Papers: "On Focal Lines and Anchor-Ring Wave-Fronts," and "Contributions to the Theory of the Resolving Power of Objectives," by Prof. Everett; and "The Absorption, Dispersion, and Surface-Colour of Selenium," by Prof. R. W. Wood.

SATURDAY, MARCH 1.

Royal Institution.—At 3 p.m., Lord Rayleigh on "Some Electrical Developments."

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THE
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TO CORRESPONDENTS.

All Rights Reserved. *Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

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OUR TELEGRAPH COMMUNICATIONS.

This week has seen the publication of two important matters which at first sight seem somewhat contradictory. The first is an abstract in the *Times* of an interim report by the Inter-Departmental Committee on Cable Communications. This committee is comprised of the following gentlemen, who from their past experience may be relied upon to discuss the matters at issue broadly as affecting the British Empire at large: Lord Balfour of Burleigh (chairman), the Marquis of Londonderry, Mr. Hanbury, Lord Hardwicke, Lord Onslow, Major-General Sir J. C. Ardagh (Director of Military Intelligence), and Rear-Admiral R. N. Custance (Director of Naval Intelligence). The present report, although signed by all the committee, has under the Marquis of Londonderry's signature a note to the effect that his decision on all matters, save the rates for communication to India, is reserved. As it is this delay in the proposed revision of the rates to India that is the cause of the report, this reservation is not vital. The facts are these: "In May, 1900, a statement was made in the House of Commons, on behalf of the India Office, that it was practically arranged that there should be at once a reduction to two shillings and sixpence a word, and that if the two-shillings-and-sixpenny rate brought in a certain number of messages the rate would be shortly reduced to two shillings. In point of fact, it had been definitely agreed between the India Office, the Eastern Telegraph Company, and the Indo-European Telegraph Company that the rate should be reduced to two shillings and sixpence, and that if in any three consecutive years after that reduction the receipts of the joint purse reached an average of three hundred and sixty thousand pounds there should be a further reduction to two shillings, the Indian Government undertaking for ten years to pay one-third of the amount by which the yearly receipts fell below three hundred and sixty thousand pounds, subject to a maximum annual liability of forty-five thousand pounds.' This was agreed to in May, 1900, and in spite of the fact that the Eastern Telegraph Company has a complete and independent system of cables from London to Bombay, the reduction has not been obtained yet. The fault lay not with the company in question, but in the fact that the consent of Russia and Germany to this reduction could not be obtained. This consent is necessary under (*a*) the joint purse agreement between the Indo-European Telegraph Department, the Indo-European Telegraph Company, and the Eastern Telegraph Company; and (*b*) the International Convention and the service regulations attached thereto. The committee do not condemn the joint purse agreement *per se*, but point out the great need for a revision in the terms of the same, which at present make the period of agreement indefinite. They urge a revision of the agreement and the drawing of a new one for a definite term of years. The International Convention, on the other hand, was drawn up in common interests in the days when land lines running through many countries were the chief means of international communication. Now that direct communication by submarine cable has been obtained to many places, the great need for certain clauses in this convention has passed. It is obvious, therefore, as the committee state, that where this direct communication has been obtained, it is not right that foreign countries should still have a veto on tariff reductions. This veto, which may greatly hamper our commerce, may be used for political purposes, and it is not to the interest of England or her many colonies that a foreign nation should be able for political reasons to prevent the development of our commerce. As the com-

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mittee point out, there are not many specific cases where foreign cable companies are at present likely to under-bid the British companies except by means of heavy subsidies. In our opinion it would be better to risk the chance of such competition, and to grant, if need be, counter-subsidies rather than allow our commercial communication to be retarded. This question is really part and parcel of the larger one of independent all-British communication to our dependencies in time of war, which is most necessary. The committee, after alluding to the many advantages derived from the International Telegraph Convention regulations, conclude that "at the same time it is clearly possible that the substantial advantages of these regulations may be outweighed by the restrictions upon policy imposed by the others; and the arguments advanced in favour of the convention do not, in our opinion, disprove the desirability of withdrawing from it in certain contingencies." The report seems to be appreciated in the proper quarters, as the reductions in the rates to India are now promised by the Eastern Telegraph Company from the first day of March, and hence we may conclude that the requisite consents have been obtained.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE CRAWFORD-VOELKER LAMP.

SIR,—We have recently received numerous enquiries anent the Crawford-Voelker electric glow lamp. This lamp has, we believe, been recently tested by Colonel H. C. L. Holden, of Woolwich Arsenal, and most astonishing results have been obtained. It may interest your readers to know that three of these lamps were tested by us in July, 1900. The best of these three lamps gave the following result at 100 volts:

Hours.	Candle-power.	Amperes.	Watts per candle.
0	11·4	·310	2·72
50	7·8	·285	3·66
100	6·5	·278	4·27
150	5·8	·269	4·65
200	5·3	·260	4·90
220 (broken down).			

An examination of Colonel Holden's figures will show that the lamp has made great strides since it was brought to this laboratory. In January, 1901, we made the following test: a 100-volt 16-c.p. 3·6-watt lamp of the ordinary kind. The lamp was run on 110 volts (mains), and photometered at 110 volts.

Hours.	Candle-power.	Amperes.	Watts per candle.
0	30	·658	2·41
10	37	·683	2·02
100	30	·674	2·48
(Test discontinued.)			

We regret that we are unable to let your readers have any more recent figures of the Crawford-Voelker lamp, but samples appear to be very difficult to obtain.—Yours, etc.,

ELECTRIC TESTED LAMP COMPANY, LIMITED.
(A. W. Gattie.)

[In view of the great disparity between the above results for the Crawford-Voekler lamps and those obtained by Colonel Holden, it is to be regretted that more lamps cannot be obtained to test the improvements since July, 1900. This is the more to be regretted because of the unfair comparisons made in Colonel Holden's report between the new lamps and those with ordinary carbon filaments — ED. *E. E.*]

WHEN DOCTOR'S DISAGREE.

SIR,—My attention has been called to a letter in your last issue from Dr. Panton commenting on certain state ments alleged to have been made by me in the discussion on Mr. Earle's paper. In your article, entitled "When Doctors Disagree," you make me say that the rate charged by the Trafford Power Company to the Lancashire Dynamo Company was ¾d. per unit, which *would* come out at £1. 6s. per horse-power per annum. What I did say was that it *did* come out at the figure named. The Lancashire Dynamo Company's demand, as shown on a Wright's maximum demand indicator, is 230 h.p., and they paid the company £306 last year. In order to produce the power necessary to drive their works they would have to put down generating plant having a capacity of 230 h.p.: therefore their bill works out at approximately the figure I gave—viz., £1. 6s. per horse-power installed.

Dr. Panton has fallen into the popular error of assuming that the indicated horse-power of the engine installed multiplied by the number of hours per annum the engine is run, represents the actual horse-power hours which are used. Even with power generated by one prime mover, and distributed over the works by means of gearing, shafting, belting, etc., this is not the case, as in no trades are all the machines run without a stop during the whole working hours, nor are they always at full load when so running. The difference in power required, whether all the machines are running or not, is not, of course, so marked in the above-mentioned case, where frequently the gearing, etc., absorbs 50 per cent. of the total power required to drive the works. In the case, however, where each machine, or, at any rate, small groups of machines are driven electrically, the total horse-power hours employed are astonishingly few compared to the maximum horse-power required to drive the machine at full load multiplied by the number of working hours per annum; and I am sure if manufacturers would take the trouble to sometimes meter the units taken by certain machine tools, they would be able to very considerably increase the output of that particular machine.

The question of the value of a unit of electricity for driving purposes is apparently so little understood by the public, that, if not trespassing too much on your space, I should like to put it before you in a way I have found easily understood. Assume that 1 kw. applied direct to the machine to be driven is equivalent to 2 i.h.p. which has to be transmitted from the prime mover to the machine, and this is an assumption that even the most obstinate opponents must admit. Then at 1d. per unit even multiplying by the whole number of working hours per annum—say, 2,400—the equivalent cost per indicated horse-power per annum is £5. You then have the whole saving which is effected by the fact that when a machine is not actually working it is costing nothing for power, and when it is working it is only consuming energy in proportion to the work it is doing. This saving, of course, varies according to the manufacture dealt with, but in practically every trade, other than spinning and weaving, it is not less than 50 per cent.—Yours, etc.,

S. V. CLIREHUGH, M.I.C.E.

[This full explanation is most interesting, especially the fact that the 230 h.p. was obtained from a maximum demand indicator, and was not the rated power of the motors installed, as we supposed last week. It is to be noted from the above figures that at the works of the Lancashire Dynamo Company the maximum demand is used on the average only for about 11 hours per week. This is under two hours per working day. Presumably, however, the maximum is high because of the supply current being used occasionally for testing large generators.—ED. *E. E.*]

[ERRATUM.—In Dr. Panton's letter last week there was an obvious misprint in the calculation. It should have read:

$$\frac{\cdot 75 \times \cdot 75 \times \cdot 56 \times \cdot 52}{240} = £6 \cdot 8 = £6.\ 16s.$$

An "s" was inserted after the decimal figure.—ED. *E.E.*]

TUNBRIDGE WELLS TELEPHONES.

Through the courtesy of a friend at Tunbridge Wells we have received the following two official statements, one as to the present financial position of the municipal telephone undertaking, and the other an estimate of the

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same after the capital expenditure has been raised to £25,000. The figures are being strongly criticised by the opponents of the municipal scheme, because no provision is made for depreciation or reserve. The criticism is not fair, because if the estimates are realised a margin is shown of over 4 per cent. which can be so applied ; also the repayment of the loan over a comparatively short period—which we believe is about 25 years—allows another 4 per cent. for depreciation, as it will not be contended by anyone that the telephone equipment will be valueless at the expiration of the license. Putting aside, however, any detailed criticism, the broad fact remains that there is a trading competition going on at Tunbridge Wells between the Corporation and the National Telephone Company. This competition has been authorised by Government. The company are admittedly giving a telephone service under cost price in the honest endeavour to crush out the municipal undertaking. Until, therefore, this "honest endeavour" has been frustrated, the Corporation are well advised in working at practically cost price. The building of large reserve funds is never done when keen competition has to be faced.

Income and Expenditure in respect of Capital Outlay of £19,320.

Income.

Annual income now produced by 533 actual revenue-earning lines at £4. 11s. 5d. average per line		£2,437
Estimated receipts from 315 additional lines at £4. 11s. 5d.		1,440
		3,877

Expenditure.

Management and office salaries and wages	£507	
Operators	260	
		767
Rent, rates, etc., of central exchange and offices, etc.	125	
Rent of branch switchrooms	50	
		175
Printing and stationery		50
Wayleaves		50
Terminal fees		25
Contingencies		107
Establishment charges		77
Maintenance and inspection		386
Royalty		387
Interest and redemption of loan		1,198
		£3,222

Excess of income over expenditure, £655.

Income and Expenditure in respect of Capital Outlay of £25,000.

Income.

Annual income now produced by 533 actual revenue-earning lines at £4. 11s. 5d. average per line		£2,437
Estimated receipts from 615 additional lines (of whom 266 are already promised subscribers) at £4. 11s. 5d.		2,811
		£5,248

Expenditure.

Management and office salaries and wages	£507	
Operators	390	
		897
Rent, rates, etc., of central exchange and offices, etc.	200	
Rent of branch switchrooms	100	
		300
Printing and stationery		50
Wayleaves		75
Terminal fees		25
Contingencies		*135
Establishment charges		105
Maintenance and inspection		†500
Royalty		525
Interest and redemption of loan		1.550
		£4,162

Excess of income over expenditure, £1,086.

* = about ½ per cent., † = 2 per cent.

PHYSICAL SOCIETY.

At the annual general meeting held on Feb. 14, Mr. T. H. Blakesley, vice-president, in the chair, the officers and council for the following year were elected as follows: President: Prof. S. P. Thompson, D.Sc., F.R.S. Vice-presidents (who have filled the office of president): Dr. J. H. Gladstone, F.R.S. ; Prof. G. C. Foster, F.R.S. ; Prof. W. G. Adams, M.A., F.R.S. ; Lord Kelvin, D.C.L., LL.D., F.R.S. ; Prof. R. B. Clifton, M.A., F.R.S. ; Prof. A. W. Reinold, M.A., F.R.S. ; Prof. W. E. Ayrton, F.R.S. ; Prof. G. F. Fitzgerald, M.A., F.R.S. ; Prof. A. W. Rucker, M.A., F.R.S. ; Sir W. de W. Abney, R.E., K.C.B., D.C.L., F.R.S. ; Shelford Bidwell, M.A., LL.B., F.R.S. ; Principal Oliver J. Lodge, D.Sc., F.R.S. Vice-presidents: T. H. Blakesley, M.A. ; Prof. J. D. Everett, D.C.L., F.R.S. ; S. Lupton, M.A. ; J. Walker, M.A. Secretaries: H. M. Elder, M.A. ; W. Watson, B.Sc., F.R.S. Foreign secretary: R. T. Glazebrook, D.Sc., F.R.S. Treasurer: Prof. H. L. Callendar, M.A., F.R.S. Librarian: W. Watson, B.Sc., F.R.S. Other members of council: C. Chree, D.Sc., F.R.S. ; W. R. Cooper, M.A. ; G. Griffith, M.A. ; R. A. Lehfeldt, D.Sc. ; A. W. Porter, B.Sc. ; W. A. Price, M.A. ; W. N. Shaw, M.A., F.R.S. ; W. F. Stanley, F.G.S. ; J. Swinburne ; A. A. Campbell-Swinton, M.I.C.E. Prof. S. P. Langley and Prof. H. A. Lorentz were elected honorary fellows to fill the vacancies caused by the deaths of Prof. Rowland and Dr. Koenig. The president of the German Physical Society was elected an *ex-officio* fellow of the society.

The Secretary then read the president's address. It commenced by giving some particulars of the life and work of Rowland, Koenig, Langley, and Lorentz. On Jan. 11 a telegram was sent in the name of the society to Prof. Hittorf congratulating him upon the jubilee of his professoriate. The work of translation, revision, and production of an English version of Gilbert's "De Magnete" has been completed, and a copy of the book presented to the society by the president. The remainder of the address dealt with the refusal of the law of this country to recognise as valid matter for the granting of letters patent anything which may have been brought before any of the learned or scientific societies. In the United States a man may appeal to the fact of his having read such a paper in proof of his subsequent claim to receive a valid patent for his invention. The law in this country works very inequitably. As examples, the invention of the microphone by the late Prof. Hughes, the president's invention of the "astigometer," and the invention of wireless telegraphy by Prof. Lodge were given.

An ordinary meeting of the society was then held, at which Mr. Littlewood exhibited an Attwood's machine. The society then adjourned until Feb. 28.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution on Feb. 13 the following were the candidates balloted for :

Member.—H. Spengel, P.O. Box 3,498, Johannesburg.

Associate Members.—W. B. Hodgetts, 23, St. Simon's-street, Salford, Manchester ; A. H. Marshall, 33, Victoria-street, Blackburn ; S. D. Schofield, Electricity Works, Shipley, Yorks ; H. E. Smith, 2, Great Stuart-street, Edinburgh ; W. M. Stewart, Westfield, Dalmuir, N.B.; W. C. P. Tapper, 1, Gunton-road, Upper Clapton, N.E.; J. E. Taylor, Engineer-in-Chief's Office, G.P.O., E.C.; H. B. Whitmore, 5, Chatham-grove, Withington, Manchester ; R. O. Wright, Fine Cotton Spinners' and Doublers' Association, Limited, St. James-square, Manchester.

Associates.—J. Ainscough, Corporation Electricity Works, Doncaster ; C. M. Butler, secretary, Incorporated Municipal Electrical Association, St. James's Hall, Piccadilly, W. ; E. V. Clark, 27, Park-place, Greenwich, S.E. ; G. R. E. Crawley, 44, Castletown-road, W. ; F. H. Grace, Park House, Thornbury, Gloucestershire ; E. R. Grote, 7, Binden-road, Shepherd's Bush, W.; R. B. Hungerford, 43, Fairfax-road, Bedford Park, W. ; W. D. N. Morgan, Electricity Supply Station, Gateshead-on-Tyne ; R. Nance, 5, Plasturton-place, Cardiff ; W. E. Nicoll, Commercial-chambers, Powis-street, Woolwich ; R. W. Perry, 48, Westover-road, Wandsworth, S.W. ; C. C. Roberts-Wray, c/o Messrs. Dick, Kerr, and Co., 2, Bendish-road, East Ham ; G. R. Rosevere, 204, Alum Rock-road, Saltley, Birmingham ; W. E. Russell, North-crescent, St. Annes-on-Sea ; T. P. Shilston, 2, Albury Park-road, Tynemouth ; E. Taylor, Electricity Works, Craven-street, Birkenhead ; W. L. Winning, 13, Greenlaw-avenue, Paisley, N.B.

Students.—A. C. Anderson, Oaken, near Wolverhampton ; W. J. Bell, 15, Vanbrugh-park-road, Blackheath, S.E.; G. S. C. Bodkin, Vicarage, Ringwood, Hants ; J. H. Dowling, care of J. J. Dowling, Esq., Kensington, Terenure, co. Dublin ; A. B. Duncalf, High-street, Reigate ; C. B. Franklin, 8, Appian-way, Leeson Park, Dublin ; C. G. Friedeberg, St. John's Lodge, Spencer-hill, Wimbledon ; C. E. Gunner, Elmbank, Kemble-road, Croydon ; A. E. Laurie, 112, Edith-road, West Kensington, W.; W. J. Percy, Downside, Leatherhead ; H. W. Prance, 39, Westbourne-gardens, Bayswater, W.; D. H. Remfrey, 32, Oxford-road, Putney, S.W.; A. B. Scorer, Coombe Hurst, Lincoln ; J. H. T. Strong, 1, Merton-villas, Emmet-road, Inchicore, Dublin ; W. E. W. Vincent, 10, Pembridge-crescent, Kensington ; P. Wilson, Roseleigh-drive, Dennistown, N.B.

NEW COMPANIES REGISTERED.

P. and R. Storage Battery Company, Limited.—Capital, £6,000. Objects: to adopt an agreement with Allan and Adamson, Limited, and W. Peto, the liquidator thereof, and to carry on business as electricians, electrical engineers, etc.

Mayfair Garages, Limited.—Capital £7. Object: to carry on the businesses of, or connected with, the storage of motorcars ; as repairers, instructors, hirers, manufacturers, and generators of electricity for charging electric cars, etc.

Associated American Electrical Manufacturers, Limited.—Capital, £1,000. Object: to adopt an agreement with A. F. Woodley, of 90, Cannon-street, E.C., agent for England and Wales of the Goudey McLean Company (a corporation organised under the laws of the State

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of New York for the purposes of managing the foreign sales of the products of a syndicate of American electrical manufacturers), and to carry on the general business of electricians and electrical engineers.

Hong Kong Tramway Electric Company, Limited.—Capital, £300. Object: primarily as indicated by the title; also as electricians and electrical engineers at Hong Kong or elsewhere in Asia.

Lane-Fox and Co., Limited.—Capital, £20,300. Object: to carry on the business of mining, hydraulic, electric light, heat, motive power, water supply, mechanical, sanitary, and general engineers, etc.

Garages, Limited.—Capital, £10,000. Object: to acquire and carry on the business of the club Garages, Limited, connected with storage of motorcars, etc.

Market Drayton Electric Light and Power Company, Limited.—Capital, £1,500. Object: to carry on at Market Drayton, Salop, and elsewhere the businesses of electrical and general engineers, contractors, manufacturers of electrical apparatus of every description, producers and suppliers of electricity, etc.

J. Kriegsfeld and Co., Limited.—Capital, £5,000. Object: to acquire the business of J. Kriegsfeld and Co., at the Princess Rubber and Imperial Works, 112, Princess-street, Manchester; to manufacture electrical, commercial, scientific, or medical apparatus in which rubber is used, etc.

Kent Electric Power Syndicate, Limited.—Capital, £10,030. Object: to carry on in Kent or elsewhere the business of an electric power supply company in all or any of its branches, to erect and maintain generating stations, to lay down all necessary plant, machinery, and apparatus, and manufacturers of cables and wires of every description, etc.

APPOINTMENTS VACANT.

Chief Assistant Electrical Engineer, Council for the Foreign Community of Shanghai, 200 taels per month (equal at present rate to about £300 per annum), with quarters, fuel, and light. Agreement will be for three years. First-class passage out and liberal leave rules. Half salary while on voyage. Applications not later than March 5 to Messrs. John Pook and Co., 63, Leadenhall-street, London, E.C. Full particulars in our advertisement columns.

Electrical Engineer, Capetown, £650 per annum with residence free. The Corporation will supply the officer appointed with a first-class passage from London to Capetown. Applications must be deposited at the offices of Messrs. Davis and Soper, 54, St. Mary-axe, London, E.C., not later than 4 p.m. on Feb. 28. Candidates selected from the papers submitted will be interviewed personally during the week following, reasonable expenses being paid. Full particulars in our advertisement columns.

Borough Electrical Engineer, Croydon Corporation, £400 per annum, rising by annual increments of £25 to £600, Feb. 27. Full particulars in our advertisement columns.

Mains Superintendent, Oldham, £100 per annum, March 10. Particulars in our advertisement columns.

Battery Attendant, Gateshead, 25s., hours 53 per week. Full particulars in our advertisement columns.

Assistant Jointer, St. Annes-on-the-Sea Urban District Council, 30s. a week, Feb. 28. Full particulars in our advertisement columns.

General Clerk, Bradford, commencing at 25s. per week. Feb. 28. Full particulars in our advertisement columns.

Shorthand and Typewriter Clerk, Bradford, commencing at 32s. per week, Feb. 28. Full particulars in our advertisement columns.

LEGAL INTELLIGENCE.

TRAMWAYS AND GENERAL WORKS COMPANY.

In the High Court on Friday Mr. Justice Byrne heard an application by the Tramways and General Works Company for the sanction of the Court to return to the shareholders a sum of £6,000, and to write that amount off the capital of the company. Counsel axplained that the company had now a capital of £20,000, divided into 20,000 £1 shares. The object of the company was to promote tramways and similar undertakings. When the Burnley Tramway Company was taken over by the Corporation of that town they were paid the £6,000 which it was now proposed to pay to the shareholders by treating the capital as in future consisting of 20,000 shares of the value of 14s. each instead of 20s. All the necessary steps had been taken and proper affidavits filed.

Mr. Justice Byrne made an order, subject to the matter being properly advertised, for the money to be paid the shareholders in a month.

NEWCASTLE TRAMWAYS.

On Monday, in the Chancery Division of the High Court, Mr. Justice Joyce disposed of the case of Wilkinson and Marshall *v.* the Mayor and Corporation of Newcastle, which was an action brought to obtain an injunction restraining the defendants from permitting to remain outside plaintiffs' premises a certain double line of tramways, which they had laid down in alleged contravention of the statutory powers comprised in the Act of Parliament passed in 1899. The plaintiffs are a firm of solicitors in Newcastle, and are the owners of property situated at the corner of Pilgrim-street and Mosley-street, Newcastle, the site of which they purchased in 1898 for £20,000. Plaintiffs built offices on the site, the ground floor being occupied by the Norwich Union Fire Office, and the rest of the building by other tenants. It was incumbent, said counsel, that express notice should be served on the frontagers in regard to this tramway, which must not be less than 9ft. 6in. from the pavement. The defendants denied having contravened the Act, and traversed the other allegations in the statement of claim, and said that the construction of the tramlines was completed before this action was commenced.

At the conclusion of the evidence **His Lordship** gave judgment, ordering the Corporation to remove so much of the rails not shown on the deposited plans as was within 9ft. 6in. of the footway; but he suspended the operation of the injunction over Aug. 31, and gave liberty to the defendants to apply for an extension of the time. In the meantime defendants undertook not to use the piece of tramway in question. Defendants were ordered to pay the costs of the action.

A STRANGE CASE AT LIVERPOOL.

At the Liverpool Assizes on Tuesday, a young man named Tomkinson sued the Liverpool Corporation for assault and false imprisonment under somewhat remarkable circumstances. It appeared that the plaintiff was travelling on an electric tramcar when the conductor, claiming that he had passed the penny limit, asked him for another penny. Plaintiff disputed the conductor's assertion, and refused to pay, and was then given into custody and taken by the police to Bridewell. Here he was searched and all his money detained for some days. He was summoned for non-payment of the penny, and fined 5s. and the penny. The police then refunded his money, minus the 5s. 1d. In the course of the case **Mr. Justice Wills** said it was monstrous that the police in a paltry case of this kind should have acted as they had done. He had up to now spoken well of the Liverpool police, but the story he had heard was shocking. In the result the plaintiff obtained a verdict against the Liverpool Corporation for £150 damages.

COMPANIES' MEETINGS AND REPORTS

CHARING CROSS AND STRAND ELECTRICITY SUPPLY.

Directors: William Francis Fladgate, Esq., Craig's-court, S.W. (chairman); G. H. Brougham Glazier, Esq., St. James-street, S.W. (vice-chairman); Stefano Gatti, Esq. (A. and S. Gatti), Strand, W.C. (managing director); John M. Gatti, Esq. (A. and S. Gatti), Strand, W.C.; Richard Chadwick, Esq., St. Martin's-lane, W.C. Secretary: Edwd. Wilmot Seale, Esq. Engineer-in-chief: W. H. Patchell, M.I.C.E., M.I.E.E., M.I.Mech.E.

Report of the directors (with abstract of accounts), to be presented to the shareholders at the annual general meeting of the Company, to be held at the Savoy Hotel, W.C., on Feb. 26 at 12 noon:

In submitting the accounts for the year ending Dec. 31, 1901, the directors congratulate the shareholders on the satisfactory results of the year's trading in the whole of their areas of supply. These accounts, having regard to the provisions of the City provisional order, have now to be submitted in two parts, the first relating to the West-end undertakings and the second to the City undertaking. The progress of the business in the West-end areas is shown by the fact that the equivalent of 27,906 additional 8-c.p. lamps have been connected, and the units sold during the year 1901 show an increase of 31 per cent. over those sold during the year 1900. A portion of this increase is caused by the fact that the supply of the City undertaking has necessarily been given from the West-end generating stations, but apart from this supply the increase has been very satisfactory, the revenue from sales amounting to £99,715. 3s. 3d., an increase of 16 per cent. over the amount sold in 1900. The plant, machinery, and mains have been maintained in a high state of efficiency. Twenty-seven miles of mains have been added in these areas, and the trunk mains connecting these areas with Bow are being rapidly proceeded with. The new general offices of the Corporation, with the sub-station adjoining, at St. Martin's-lane is approaching completion, and the latter is being equipped with motor-generators and battery plant to enable the Company to deal with the constantly increasing demand for energy. The net earnings of the West-end undertakings, as shown in net revenue account No. 5, have amounted to £46,900. 10s. 3d. Ten thousand pounds was distributed as interim dividend at the rate of 8 per cent. per annum for the half-year ended June 30, 1901; there remains a sum of £36,900. 10s. 3d., which the directors propose to deal with as follows: dividend on 4½ per cent. preference shares to Dec. 31, 1901, £11,250; to pay a dividend at the rate of £12 per cent. for the half-year ended Dec. 31, 1901, on ordinary shares, making with the interim dividend paid in August, 1900, 10 per cent. for the whole year, £15,000; and to carry forward £10,650. 10s. 3d. The expenditure on capital account amounted at Dec. 31, 1901, to £504,257—viz., £234,257 expended by the City undertaking and £270,000 by the Charing Cross and City Electric Company, Limited, the contractors for the works. The progress of the business has been most gratifying to the directors, and the fact that, notwithstanding the difficulties in giving a supply, necessarily incident upon the impossibility of completing the City stations, current has been sold to the extent of £9,614 argues well for the success of this undertaking. The generating station at Bow, with machinery and plant of sufficient capacity to supply 225,000 8-c.p. lamps, is approaching completion. The trunk mains from this station to City area are completed, and the City will within the next few weeks be supplied from Bow. Distributing mains have been laid in the City to the extent of 114 miles. The sub-stations at Fenchurch-street, Upper Thames-street, and at Ludgate-hill have been equipped with the requisite permanent motor-generator and battery plant, and are ready for furnishing supply so soon as

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electric energy can be transmitted from Bow. A fourth sub-station in Beech-street, Barbican, to supply the northern portions of the City is contemplated, a freehold site having already been acquired and cleared. The capacity for supply from these stations will, with the machinery already in order, be increased before the end of the year to 375,000 lamps, and, if necessary, in the year 1903 to 600,000 lamps; 51,836 lamps are now being supplied, and the demand continues to be satisfactory. Contracts for 20,000 lamps would have been completed during the last month had it been possible to have supplied energy, and negotiations are pending for 100,000 further lamps. The revenue account for the City undertaking shows a deficit of only £756. 16s. 7d., which, having regard to the shortness of the time over which the business has been proceeding, appears to the directors to be satisfactory. This is carried to the balance-sheet of the City undertaking, and will have to be dealt with out of future earnings. Mr. G. H. Brougham Glasier and Mr. Stefano Gatti are the directors who retire by rotation, and, being eligible, offer themselves for re-election. The auditors, Messrs. O. R. Johnson and Son, also retire, and offer themselves for re-election. The whole of the recent issues of 20,000 preference shares and 20,000 ordinary shares have been taken up.

West-end Accounts.

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£	s.	d.
Coal or other fuel £23,172 6 6			
Oil, waste, water, and stores 1,631 0 2			
Proportion of salaries 1,004 3 8			
Wages and gratuities 6,260 8 6			
	32,067	18	10
Repairs, etc., of plant, etc.	4,371	13	5
	36,439	12	3
Distribution of Electricity.			
Proportion of salaries 719 8 8			
Wages and gratuities 163 7 4			
Repairs and renewals of mains 1,791 1 2			
Repairs and renewals of meters, etc. 731 9 7			
Wayleaves and licenses 814 7 11			
	4,219	14	8
Public lighting maintenance	610	18	5
Rents, rates, taxes, and insurances	5,675	14	7
Management Expenses.			
Directors' remuneration 1,050 0 0			
Proportion of salaries 3,033 11 10			
Stationery and printing 250 11 9			
General establishment charges 485 19 9			
Auditors of Company 75 0 0			
	4,895	3	8
Law and Parliamentary Charges and Other Expenses.			
Law expenses	172	2	11
Accident compensation claims	23	6	11
Auditor appointed under the order	85	0	0
Rate assessment appeals, surveyors' fees, etc.....	129	11	8
Depreciation.			
Depreciation of premises, plant, machinery, etc. ..	9,000	0	0
Total expenditure	61,251	4	9
Balance carried to net revenue	41,458	13	11
	£102,709	18	8

	£	s.	d.
Sales of current.....	99,715	3	3
Rentals of meters, generators, etc.	2,605	5	1
Transfer fees and sundry receipts.....	193	19	2
Rents receivable in respect of property	195	11	2
	£102,709	18	8

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	768,677	0	0
Sundry creditors	48,907	4	7
Balance at credit of net revenue account.....	25,650	10	3
Depreciation fund account	45,000	0	0
Leaseholds depreciation fund account	15,000	0	0
Share premium account	67,172	4	1
Reserve fund (capital) account	30,000	0	0
	£1,000,406	18	11

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	664,866	9	11
Payments on account of contracts...	19,400	0	0
Stores on hand	9,109	6	1
Freehold premises not used, at cost	3,550	11	6
Leasehold premises not used	400	0	0
Sundry debits	300,182	13	9
Cash at bankers and in hand	2,297	17	8
	£1,000,406	18	11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		9,037,995
Quantity sold { Public lamps	263,761	
{ By contract.....	861,125	6,553,792
{ Private consumers by meter...	5,428,906	
Quantity used on works		2,375,068
Total quantity accounted for.....		8,928,860
Quantity not accounted for.....		109,135
Number of public lamps.....		113

Total maximum supply demanded, 4,023 kw.

City Undertaking.

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£	s.	d.
Purchase of current in bulk £5,043 12 0			
Oil, waste, water, and stores 30 3 0			
Proportion of salaries 522 1 5			
Wages and gratuities 579 17 9			
	6,175	14	2
Repairs, etc., of plant, etc.	120	10	2
	6,296	4	4
Distribution of Electricity.			
Proportion of salaries 522 1 5			
Repairs and renewals of mains, etc.. 172 7 3			
Repairs and renewals of meters, etc.. 35 1 3			
Wayleaves and licenses 2 5 0			
	731	14	11
	7,027	19	3
Rents, rates, taxes, and insurance.....	349	19	5
Management expenses.....	3,022	17	3
Corporation of London statutory contribution	200	0	0
Total expenditure	£10,600	15	11

Cr.	£	s.	d.
Sales of current, less rebates	9,614	16	2
Rentals of meters and other apparatus.....	207	12	6
Transfer fees and sundry receipts	2	1	11
	9,824	10	7
Balance to net revenue account.....	776	5	4
	£10,600	15	11

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	209,400	0	0
Sundry creditors	4,965	9	10
Charing Cross and City Electric Company, Limited, for machinery, etc.	234,257	1	7
	£448,622	11	5

Cr. Assets.	£	s.	d.
Capital account—amount expended for works.....	234,257	1	7
Stores on hand	60	16	2
Expenses of debenture issue	1,579	12	5
Charing Cross and City Electric Company for loans	206,922	5	11
Sundry debtors.....	4,913	12	0
Balance of net revenue account.....	756	16	7
Cash at bankers and in hand.....	132	6	9
	£448,622	11	5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity bought in Board of Trade units		854,816
Sold { By contract	12,561	
{ Private consumers by meter	577,396	589,957
Quantity used on works		241,117
Total quantity accounted for.....		831,074
Quantity not accounted for		22,742
Total maximum supply demanded (kilowatts)		991

BRISTOL TRAMWAYS AND CARRIAGE.

The report of the directors for the year ending Dec. 31, 1901, states that the gross receipts for the year amount to £213,967. 8s. 2d., and the working and general expenses and renewals are £143,584. 8s. 8d., leaving a net revenue of £70,382. 19s. 6d. The following amounts have already been distributed—viz.: interest on 4 per cent. mortgage debenture stock and temporary loans, £9,943. 9s. 11d.; dividend on 4 per cent. preference shares and interest on calls paid in advance, £12,576. 14s. 10d.; interim dividend at the rate of 8 per cent. per annum (subject to income tax) for the half-year ending June 30, £18,916. 13s. 4d.; and it is proposed to appropriate the balance as follows: final dividend for half-year at the rate of 9 per cent. per annum (subject to income tax), £21,187. 10s.; to carry to reserve and renewals funds, £7,758. 11s. 5d.; the reserve funds will then amount to £99,261. 1s. 9d. The receipts from the tramways department show the important increase of £47,696, and those of the carriage department an increase of £185. The total number of passengers carried during the year on the Company's cars and omnibuses was 36,714,906, which is approximately 10 millions more than in the previous year. The accounts now presented cover the first complete year's operation of the Company's system since the general adoption of electric traction, and the great expansion in the traffic receipts and number of passengers carried affords an illustration of the vastly-improved service which the introduction of the new form of traction enables the Company to render to the public. The results of the initial period would have been even more favourable but for the one untoward episode that is common knowledge amongst local shareholders. During the height of the summer season designs were made upon the loyalty of the Company's staff, which involved about 450 of the employés, and culminated in a strike on the eve of the August Bank Holiday. Prompt and effective measures were taken, however, to replace the malcontents and minimise public inconvenience, though necessarily during the few weeks of public excitement the abnormal circumstances entailed some loss of traffic and special expenditure. Since the close of the year under review arrangements have been completed for discontinuing the use of the

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suburban generating station at St. George, so that the whole of the eastern lines formerly operated from that source are now worked with the main system from the central power station at Counterslip, the change being attended with many advantages in supervision, and effecting substantial economy.

BROMPTON AND KENSINGTON ELECTRICITY SUPPLY.

Directors: Henry Ramié Beeton (chairman), William Reginald Davies, Robert Arthur Germaine, William Francis Leese, William Page. Manager: Henry W. Bowden. Secretary: Thos. J. Owens.

Abstract of directors' report and accounts for the year ending Dec. 31, 1901:

The revenue account shows a credit balance of £24,249. 1s. 10d., which, with the balance of £487. 15s. brought forward, makes a total of £24,736. 16s. 10d. After deducting £1,183. 11s. 5d. for debenture and other interest, £2,100 for interim dividend on the 7 per cent. cumulative preference shares, and £3,493. 3s. 2d. interim dividend at the rate of 7 per cent. per annum for the half-year to June 30 on the ordinary shares, the directors recommend that the sum remaining—viz., £17,960. 2s. 3d.—be dealt with as follows: to credit of depreciation account, £7,000; to payment of dividend on the preference shares for half-year ended Dec. 31, £3,500; to payment of a dividend on the ordinary shares for the half-year ended Dec. 31 at the rate of 9 per cent. per annum, making 8 per cent. for the year, £4,498. 9s. 5d.; leaving a balance of £2,961. 12s. 10d. to be carried forward. The increase in the number of lamps connected during 1901 was equivalent to 12,234 35-watt (8-c.p.) lamps. As was proposed in the last report, the debenture stock has been repaid, and 8,000 preference shares and 339 ordinary shares have been issued. The premiums arising from these issues amount, after deducting expenses of issue and the premium payable on redemption of the debenture stock, to £20,551. 10s. 10d. The directors propose to apply £14,203. 14s. 4d. of this amount in extinguishing the renewals suspense account, and to place the balance of £6,347. 16s. 6d. to the credit of the depreciation fund, which will then stand at £30,847. 16s. 6d. Mr. H. R. Beeton and Mr. R. A. Germaine retire from the Board by rotation, and, being eligible, offer themselves for re-election. Messrs. Miall, Wilkins, Randall, and Co., the auditors of the Company, offer themselves for re-election.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£5,450	3	9			
Oil, waste, water, and stores	528	16	5			
Proportion of salaries	1,215	7	3			
Wages and gratuities	2,013	0	9			
Repairs and maintenance	666	3	7			
Cartage of ashes	26	6	6			
				9,899	18	3
Distribution of Electricity.						
Proportion of salaries	300	0	0			
Wages	214	7	5			
Repairs and maintenance of mains	42	9	3			
Repairs, etc., of transformers, etc.	70	19	1			
				627	15	9
Rents, Rates, and Taxes.						
Rents payable	530	2	2			
Rates and taxes	2,398	7	1			
				2,928	9	3
Management Expenses.						
Directors' remuneration	1,500	0	0			
Salaries of secretary and clerks	828	4	6			
Salaries of collectors	179	0	0			
Stationery and printing	155	6	11			
General establishment charges	332	6	9			
Auditors of Company	52	10	0			
Auditors of the Board of Trade	49	0	0			
				3,096	8	2
Law charges				19	16	1
Insurances				227	15	0
Remuneration to trustees and other charges				105	0	2
				16,905	2	8
Balance carried to net revenue account				24,249	1	10
				£41,154	4	6

Cr.	£	s.	d.
Sale of electricity per meter	33,291	13	8
Rental of meters	1,845	3	4
Transfer fees	17	7	6
	£41,154	4	6

Dr. GENERAL BALANCE-SHEET.	£	s.	d.
Capital account—amount received	200,000	0	0
Sundry creditors on open accounts	5,633	10	10
Balance at credit of net revenue account	10,960	2	3
	£216,593	13	1

Cr.	£	s.	d.
Capital account—amount expended for works less depreciation	186,530	10	10
Stores on hand	806	16	0
Sundry debtors for electricity supplied	15,690	1	1
Other debtors and prepaid and suspense charges	1,176	11	3
Cash at bankers	12,379	18	1
Cash at office	9	15	10
	£216,593	13	1

NATIONAL TELEPHONE.

The report of the directors of this Company for the half-year ended Dec. 31 last, to be presented to the meeting on 27th inst., states that the income accrued in respect of the business of the half-year amounts to £801,495, as compared with £732,093 for the corresponding period of 1900, being an increase of £69,402. The working expenses for the half-year amount to £444,391, as compared with £404,653 for the corresponding period of 1900, being an increase of £39,739. The net result for the half-year (after deducting the Post Office royalties, amounting to £73,423) is a profit balance of £283,680, as compared with £255,831 for the corresponding period of 1900, being an increase of £27,849. The rentals carried forward for unexpired terms of running contracts amount to £730,625, as compared with £696,568 at the corresponding period of 1900, or an increase of £34,056. Out of the available balance of £222,566 the Board recommends the payment for the half-year of a divident at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. per annum on the third preference shares, 6 per cent. per annum on the preferred shares and stock, and 4½ per cent. per annum on the deferred stock, being equivalent to 5 per cent. per annum on the ordinary shares now divided into preferred stock and deferred stock. The Board also proposes to transfer £100,000 to the reserve fund, and to carry forward the balance of £7,316. The sum of £233,097 has been expended on capital account during the half-year in the erection of 6,155 additional exchange and private lines and in the construction of underground works. The important and difficult negotiations with the Post Office relating to the London telephone service having resulted in a working agreement, Mr. Forbes, for domestic and other reasons, desiring to be relieved from the heavy care and anxiety of the position he so long held as president of the Company, determined to resign that office. Sir Henry Fowler, the vice-president, was elected president, and Mr. George Franklin was elected vice-president. These changes involved some reorganisation of the Board, and upon consideration Mr. Forbes decided that he would prefer to resign his seat as a director. The Board felt that it was desirable that Mr. Forbes's great knowledge and experience should be available to the Company, and that the shareholders would approve of the retention of Mr. Forbes's services in an advisory capacity. An arrangement has accordingly been made with him for a period of five years, under which he will receive a remuneration of £1,000 per annum, with power to commute.

GREAT NORTHERN RAILWAY.

Presiding over the half-yearly meeting of the proprietors of this Company at King's Cross Station on the 14th inst., **Mr. W. L. Jackson, M.P.**, said that for a considerable time the directors had been endeavouring to find increased facilities for their growing suburban traffic. In order to find a solution of the difficulty, agreements had been made first with the Great Northern and Strand, whereby an underground railway was to be made from Finsbury Park to Brompton. It was intended, and they expected, that the railway from Piccadilly to Brompton would be continued from the latter place to Earl's Court. Powers were being sought this session for a connecting line between the Strand line at Holborn and the Piccadilly line. It was further proposed to make a connection with the District Railway south of the Strand. The line from Finsbury Park to Brompton was to be erected as a continuous line, the Brompton and Piccadilly Company taking over the powers of the Great Northern and Strand from Finsbury Park southward. That afforded a route calculated to give a great traffic and to prove a great convenience to their passengers. They thought the solution was one of great value to their suburban district. In the second place, the Great Northern and City would go from Finsbury Park to Finsbury-pavement in the City—a short and direct connection from their suburban districts. An agreement had been made with the Great Northern and City, by the terms of which the Great Northern Company had to construct an underground station at Finsbury Park. He then referred to other matters respecting the business of the Company.

The report was adopted.

NATIONAL ELECTRIC LIGHT.

The ordinary general meeting of the shareholders in this Company was held at Preston on the 12th inst.

Mr. J. Booth, who presided, said they would no doubt notice a very pleasing monotony in the report of this Company, for each year had shown an increase of business and a larger income. The past year, however, had been the most successful one in the history of the Company, and the directors were recommending a dividend which he felt sure would be satisfactory to them all, and this in spite of the fact that at the beginning of the year they were handicapped with the high price of fuel, and that they had only for a small portion of the year been able to reap the benefit from the capital outlay on their new machinery. The most important change during the year had been the increasing of the pressure from 110 to 220 volts. This enabled the Company to supply more than double the number of lamps from the same mains. There was no doubt that further improvements in lamps would continue to be made which would materially reduce the cost of electric light to the consumers, and so increase its popularity and general use. This change of pressure had involved a very large amount of work upon the Company's engineers and staff, and he should like to mention that the directors fully appreciated their services and the satisfactory and inexpensive way the change had been carried out. The Company was in a stronger position than ever before. They had sold on exceptionally favourable terms their original small plant, and replaced it with a larger and more efficient one. The light was more appreciated than ever, and the demand for both light and

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power continued to increase. The new machinery was the finest obtainable, and it was being kept in the highest state of repair and efficiency. He concluded by moving the adoption of the report and accounts.

Mr. H. Curwen seconded, and the motion was carried *nem. con.*

A resolution was afterwards adopted declaring dividends of 4 per cent. per annum on the preference shares and 7s. per share on the ordinary shares.

METROPOLITAN DISTRICT RAILWAY.

The half-yearly meeting of this Company was held at the Westminster Palace Hotel at noon yesterday, Mr. R. W. Perks presiding.

The **Chairman,** in moving the adoption of the report, regretted that it was his misfortune to present the worst account ever submitted in the history of the Company. Dealing with electric traction, he said they thought they had succeeded in inducing the Board of Trade to accept their proposals for electrification, but Colonel Mellor, of the other line, objected to the terms in which it was referred to in this Company's report. They tried to work with their partners, and were satisfied that they had in their supporters and financial backers, and in Mr. Chapman, their engineer, some of the soundest advisers. The advantage of the site for a generating station at Lot-street was its nearness to the river and the command of a good coal supply either by rail or river. The power-house would be very much larger than at first intended, and would now have a capacity of 60,000 kw. The Metropolitan Company were not coming in with the other companies who were going to take current from that house, but if they found out that the rosy picture they presented to their proprietors was not correct they could come in and also obtain current. The District Company would only be responsible for the current they used. The Company was not dominated by an American syndicate. In conclusion, he expressed the hope that they would work quite amicably with the Metropolitan Board.

Major Isaacs seconded the motion, which was carried unanimously.

WESTMINSTER ELECTRIC SUPPLY.

Directors: The Right Hon. Lord Suffield, K.C.B., G.C.V.O. (chairman); Captain Edmund I. Bax; Edmund Boulnois, Esq., M.P.; W. Hayes Fisher, Esq., M.P.; the Right Hon. Lord Kinnaird; J. Browne Martin, Esq.; R. W. Wallace, Esq., K.C. Engineer-in-chief: Alex. B. W. Kennedy, LL.D., F.R.S., M.I.C.E. Manager: L. H. Hordern, Esq. Secretary: Frank Iago, Esq.

Report of the directors (with abstract of accounts) to be presented to the shareholders at the annual general meeting to be held at the offices of the Company, Eccleston-place, S.W., on Feb. 26 at 11 a.m.:

The supply of current, which on Dec. 31, 1900, was provided for the equivalent of 469,589 lamps of 8 c.p., had increased by Dec. 31, 1901, to the equivalent of 533,462 lamps, of which approximately 8,020 lamps are due to public lighting. At the present time there are on circuit the equivalent of 540,724, and applications have been received for a further 5,996 lamps of 8 c.p. The length of roadway in which continuous-current mains have been laid now exceeds 67 miles, making about 260 miles of ways, into which upwards of 209 miles of copper (strip and cable) have been drawn. In addition, during the past year three miles of trunk mains have been laid in the Company's area to connect the stations with the Central Electric Supply Company's station at St. John's Wood. These mains represent a total of 12 miles of ways, which is estimated to be sufficient to carry a supply of energy to meet the Westminster Company's requirements for a period of 10 years. The public lighting of the district undertaken by the Company has been proceeded with as rapidly as possible. There are now 599 lamps erected and in circuit, and it is expected that the whole system will be completed before the Coronation. Your directors are pleased to state that the public supply is considered to be extremely satisfactory. In accordance with resolutions passed at extraordinary general meetings held in December last, the directors have allotted the new issue of 30,000 cumulative preference shares of £5 each to the shareholders on the register on Dec. 4, 1901, and this capital will be expended in providing plant, mains, etc., necessary for the future development of the Company's business, which is increasing in the most satisfactory manner, a larger number of lamps having been added during the past 12 months than in any year since the Company commenced operations. An interim dividend at the rate of 10 per cent. per annum for the half-year ending June 30, 1901, has been distributed. After allowing for depreciation, sinking fund, etc., the net balance available for dividend is £31,003. 6s. 3d., out of which the Board recommend the payment of a dividend at the rate of 11 per cent. per annum, less income tax, for the past half-year, carrying forward a balance of £2,643. The continued high price of coal has again materially affected the profits of the year, and the very great increase in rates and taxes has also reduced the amount available for dividend. The directors therefore consider that they may congratulate the shareholders on the rate of dividend being maintained. To provide the necessary capital for the equipment of the Central Electric Company's works at St. John's Wood, your directors have, jointly with the directors of the St. James's and Pall Mall Company, guaranteed the payment of the principal and interest on an issue of £250,000 4 per cent. debenture stock of the Central Electric Supply Company, Limited. For the information of shareholders, particulars of the receipts and expenditure of that company to Dec. 31, 1901, are given on the enclosed statement. The works are being rapidly proceeded with, and it is expected that the Central Company will be ready to supply energy to the Westminster and St. James's Companies by the ensuing winter. In accordance with the articles of association two of the directors, Captain Bax and J. Browne Martin, Esq., retire, but, being eligible, offer themselves for re-election.

REVENUE ACCOUNT.

Dr.			£ s. d.
Generation of Electricity.			
Coal, carriage, etc.	£38,597 2 0		
Oil, waste, water, and stores	3,498 16 5		
Proportion of salaries	2,867 0 10		
Wages, etc., at generating stations	6,462 11 6		
Repairs and maintenance	7,454 14 1		
			58,880 4 10
Distribution of Electricity.			
Repairs and maintenance of mains	1,410 14 9		
Repairs and maintenance of meters	1,816 17 6		
			3,227 12 3
Public Lighting.			
Arc lamps—cleaning, recarboning, etc.			1,499 10 1
Rents, Rates, and Taxes.			
Rents	1,059 12 0		
Rates and taxes	10,661 2 11		
			11,720 14 11
Management Expenses.			
Directors' fees	3,000 0 0		
Salaries of manager, etc.	6,954 9 5		
Stationery and printing	464 18 8		
General charges and office expenses	774 14 7		
Wages of meter readers, etc.	1,011 11 8		
Depreciation on office furniture	88 0 0		
			12,293 14 4
Depreciation, etc.			
Sinking fund	2,500 0 0		
Depreciation account	23,679 0 0		
			26,179 0 0
Special Charges.			
Insurance	553 7 1		
Board of Trade audit	85 0 0		
Cost of supplying steam	1,568 11 11		
Testing high-tension plant	55 7 3		
Depreciation on coal stored	878 13 3		
			3,140 19 6
General law charges and parliamentary expenses			1,417 6 2
Total expenditure			118,359 2 1
Balance to net revenue account			57,892 16 10
			£176,251 18 11

Cr.	£ s. d.
Sale of current by meter	162,805 16 10
Public lighting	5,743 8 4
Rental of meters, etc., on consumers' premises	6,058 3 5
Transfer fees	60 7 6
Supply of steam	1,584 2 10
	£176,251 18 11

GENERAL BALANCE-SHEET.

Dr.	£ s. d.
Capital account	803,590 0 0
Amount received on founders' shares cancelled	500 0 0
Sundry creditors	43,032 13 10
Temporary loan from bankers	45,000 0 0
Deposits by consumers	74 10 0
Debenture interest accrued, less income tax	4,119 7 9
Depreciation account	85,258 14 6
Sinking fund	18,032 7 1
Reserve fund	10,539 15 10
Net revenue account	31,003 6 3
	£1,041,150 15 3

Cr.	£ s. d.
Capital account	855,792 12 4
Stores in hand	9,382 6 2
Sundry debtors for current supplied	58,721 12 6
Other debtors on open accounts	5,125 11 2
Cash at bankers (Messrs. Barclay and Co., Limited)	13,668 4 2
Cash in hand	65 19 2
Deposits with vestries, etc.	89 19 0
Central Electric Supply Company, Limited	76,020 18 0
Advances under house wiring agreements	342 0 2
Investments at cost	21,212 1 8
Expenses of new share issue to date	729 10 11
	£1,041,150 15 3

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Board of Trade units generated			10,244,421
Quantity utilised	Sold to consumers	8,927,883	9,015,793
	Used on works for lighting, meter testing, etc.	87,910	
Quantity expended in distribution	In batteries	18,166	891,265
	In feeders	873,099	
Total quantity accounted for			9,907,058
Quantity unaccounted for			337,363
Number of lamps on circuit			533,462

CAMBRIDGE ELECTRIC SUPPLY.

The annual general meeting of the shareholders in this Company was held at Cambridge on the 12th inst., Mr. D. Munsey presiding.

The directors' report stated that during the year 1901 there has been added to the Company's mains the equivalent of 3,737 8-c.p. lamps, making the total 34,723. The number of units supplied has been 382,224, an increase of 24,789 units. The Company, after paying all

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charges and placing £750 to depreciation account, has a balance of £5,019. 10s. 4d., which, added to £38. 10s. 10d. brought forward from last year, makes £5,058. 1s. 2d. An interim dividend of £1,518. 16s. 10d. and interest on temporary overdraft and loan (£340. 5s. 3d.) have already been paid, leaving a net balance of £3,198. 19s. 1d. Out of this the directors recommend the payment of a dividend of 4½ per cent., making, with 2½ per cent. already paid, 7 per cent. for the year. This will absorb £3,080. 0s. 7d., leaving a balance to carry forward subject to fractional adjustment of income tax of £118. 18s. 6d.

The **Chairman**, in moving the adoption of the above report, said that more land had been acquired at Chesterton. They would probably outgrow the present site, and they were looking forward to the future, when they would be obliged to secure a bigger place. The matter had been before them 12 or 18 months, and they had secured a site at Chesterton with a siding from the railway so that they could bring coal in the yard. They could also have the use of the river and the road. It was not likely to be used for the present, but they thought they ought to have it, because it was the only place where they could have the use of the river and the railroad. As regarded expenditure, he was glad to say during the last year they had made considerable savings on coal, not only in the matter of price, but also in the quantities used. They had produced many thousands of units extra, and had only purchased a few more tons of coal. He thought he might say that the Company's position last year was exceedingly good and sound, but that day it was better than ever before in its existence. Their last month was a very successful one, showing very satisfactory progress in the amount they were earning and in the business generally. He had much pleasure in moving the adoption of the report and of the accounts.

Mr. Mason seconded the motion, which was carried unanimously.

CARLISLE ELECTRIC TRAMWAYS.

The annual meeting of this Company was held at Carlisle on the 13th inst., Mr. T. D. Lingard presiding.

The **Chairman** moved the adoption of the report (which appeared in our last issue), and in doing so said the accounts were not so good that he wished to dwell upon them more than was necessary. The total expense per car mile had been 4·63d. This was rather less than the original estimate, and yet the net result, he was sorry to say, was anything but satisfactory, and as great a disappointment to the directors as to the shareholders. Roughly, the total amount of profits was £2,500. They had hoped for a much better return than this. The explanation was that they had not carried the number of passengers anticipated. The directors, however, hoped for better things this year, and they looked forward especially to the visit of the Royal Agricultural Show.

Mr. Barningham seconded the motion, which was carried.

ELECTRIC LIGHTING AND TRACTION OF AUSTRALIA.

Mr. J. B. Braithwaite presided over the ordinary general meeting of this Company, held at Winchester House on Monday.

In moving the adoption of the report and accounts (which appeared in our last issue), the **Chairman** said that at the formation of the Company and the amalgamation of the two electric lighting undertakings then supplying Melbourne, expectations were held out of considerable economies being effected, and these had been realised already, to some extent, under the management of Mr. Clements. The point had not yet been reached when one of the stations could be closed down altogether, but so soon as the new plant which had been shipped to Melbourne was erected and running—and any moment a cable might arrive announcing that it had commenced working—there would be further savings in wages, coal, and other items. Having referred to the state of the Company's business at Geelong and Adelaide, he mentioned that the capital expenditure at Melbourne and these two places aggregated about £100,000. To provide this money an issue of £75,000 of debentures was made in July, and the remaining £50,000 6 per cent. cumulative preference shares were also offered and fully subscribed for. Notwithstanding this fresh issue of capital, there was still owing to their bankers £69,870, and the shareholders would be asked to authorise the Board to avail themselves of the willingness of the bankers to finance the Company to a sufficient extent to enable the electric lighting of the Melbourne suburbs to be completed, and generally to place the whole undertaking in a sound position. This was a temporary expedient, rendered necessary until circumstances would permit of the issue of the balance of the ordinary shares. So far as the Board could see, there was nothing but probable success before the Company.

Mr. M. F. Armstrong seconded the motion, which was agreed to unanimously.

A resolution was afterwards passed authorising the Board to borrow from the Company's bankers a sum not exceeding £117,000 for the purposes mentioned above.

MARCONI'S WIRELESS TELEGRAPH.

The fifth ordinary general meeting of the shareholders in this Company was held at the offices, 18, Finch-lane, E.C., yesterday forenoon, Sir Charles Ewan-Smith presiding.

The **Chairman**, in moving the adoption of the report which will be found in our last issue, said the directors believed that nothing could now withstand Mr. Marconi's ultimate and complete success in wireless telegraphy. After some further remarks of a general character, in which he stated that the Company's business during the past year had been of an extremely satisfactory character, the chairman called on Mr. Marconi to address the meeting with reference to his recent experiments in wireless telegraphy.

Mr. Marconi first dealt with the experiments in the transmission of wireless signals between England and Newfoundland. The arrangements for these experiments were commenced some two years ago, but they were kept secret, as it was thought that the time was not ripe then for making a public announcement in connection with them. In consequence of the severe damage to the poles, which had been erected at the Newfoundland station, due to bad weather, the installation on that side of the Atlantic was only of a temporary character. The experiments were actually carried out last December, and it was a great pleasure to be able to say that they were successful. Arrangements had now been concluded under which these tests would be continued without loss of time both in Canada and in the United States. He mentioned that his next series of tests across the Atlantic would include the transmission of words and messages. The letter "S," being the easiest signal in the Morse code to transmit, had previously always been used by him in his initial experiments over long distances. The suggestion which had been made, that he was capable of mistaking atmospheric strays with the signals which he had prearranged to be sent at fixed intervals, he characterised as being ridiculous. With regard to the hostile attitude of the cable companies, it had been asked, since he was able to transmit signals over 2,000 miles, why the Company had not regular work in hand over short distances, say between England and Ireland. The sole reason for this was to be found in the monopoly of telegraphic communication in the United Kingdom claimed by the Post Office. He next referred to the expert opinions of Sir Wm. Preece and Principal Oliver Lodge on wireless telegraphy, cited by Sir J. Wolfe Barry in his address to the shareholders in the Eastern Telegraph Company the other day. These had been quoted as illustrative of the highest expert opinion, and he thought it was only right to say that both Sir Wm. Preece and Dr. Oliver Lodge were entirely ignorant of the conditions under which his system was now worked, so that neither was competent to pronounce an opinion on it. Mr. Marconi also referred to what he called the hostile attitude of the English electrical Press towards his system. This portion of the English Press seemed vowed to the exclusive support of the cable companies, while the technical Press in the United States and Canada had given him much appreciative encouragement, for which he was very grateful. With regard to the commercial working of the system, he mentioned that it was at the present time in permanent use on 70 ships and 25 land stations. On a basis of 8,050 words in 24 hours transmitted between two stations at 6d. a word, he estimated that the annual revenue from each pair of such stations would be £73,000. He also stated that with his latest apparatus he was able to transmit 22 words a minute. As to the question of secrecy, he admitted that in the earlier stages of the system's development this objection might have been advanced with some cause, but he was happy to state that with his latest apparatus that objection had been entirely overcome by adopting syntonic devices. While it was true that in some cases wireless messages might be interrupted, he denied that it was possible to intercept and read such messages. He was leaving England on Saturday for Canada to conclude arrangements between his Company and the Dominion Government. He expected to be back here about the end of March, and if after his return either Sir Wm. Preece or Dr. Lodge being of opinion that within the space of a week they could succeed in intercepting and reading messages sent between two of his stations, they were at liberty to try the experiment, and he would be happy to place at their disposal for the purpose any one of his adjacent stations. He was willing, also, if they preferred it, that the experiment should be made between ship and shore; but in either case he was sure the only result would be to convey to the shareholders of the Eastern Telegraph Company the exact competency of their technical advisers to pronounce an opinion upon his present system of wireless telegraphy.

The **Chairman** then formally moved the adoption of the report, and the motion having been seconded, was adopted unanimously.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Boston.—The Council require tenders for electric lighting.

Tulcea (Roumania).—The Municipality invite tenders for lighting the town. Tenders by Feb. 25.

Spezia (Italy).—The Arsenal Authorities invite tenders for bronze wire, tubes, etc. Tenders by Feb. 24.

Bacau (Roumania).—The Mayor invites tenders for electric lighting of the town by March 15. The estimate is £5,646.

Ghent.—The Municipality require tenders for the electric lighting of the town. Tenders must be posted before March 1, 1902.

Bucharest.—The Administration of Government Monopolies invite tenders for metals for the year 1902-3. Tenders by Feb. 27.

Cuellar (Spain).—The Municipality require tenders for an electric lighting installation and working of the same for 20 years, by Feb. 27.

Bucharest.—The Administration of Government Monopolies invite tenders for supply of electric carbons for the year 1902-3. Tenders by March 3.

Brussels.—Tenders are invited for material and apparatus for electric lighting by the Government Railways. Tenders by Feb. 28. Specification No. 802.

Bournemouth.—The Town Council invite tenders for traction and arc lighting switchboards. Tenders by March 8. Details in our advertisement columns.

Madrid.—The time for receiving tenders for the electric lighting of the Madrid prison for 15 years has been extended from Dec. 26, 1901, to March 7, 1902.

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Rockhampton (Queensland).—The contract for the municipal tramways, full particulars of which appeared in a former issue, will remain open until March 31.

Fulham.—The Borough Council invite tenders for the supply of electrical stores for the year ending March 31, 1903. Tenders by March 5. Details in our advertisement columns.

Burgess Hill.—The Urban District Council invite tenders for the construction of electricity supply works in the district. Tenders by March 12. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of electrical equipments for cars and tramcar trucks. Tenders by March 10. Details in our advertisement columns.

Doncaster.—The Corporation invite tenders for the supply, delivery, and fixing of a fuel economiser at the Corporation Electricity Works. Tenders by Feb. 28. Details in our advertisement columns.

Aldershot.—The Urban District Council invite tenders for the supply of electricity meters and for maximum demand indicators. Tenders by Feb. 24. Details in our advertisement columns.

Pontypridd.—The Urban District Council invite tenders for Section M, comprising the overhead equipment and bonding for their tramways. Tenders by March 7. Details in our advertisement columns.

Aberdeen.—The Tramways Department invite tenders for the supply of 12 double-deck single-truck cars, complete with motors, controllers, etc. Tenders by March 6. Details in our advertisement columns.

Madrid.—The Post and Telegraph Department invite tenders for supply of 3,000 telegraph poles of horse-chestnut wood. The estimate is 7 and 8 pesetas per pole of 7m. and 8m. length respectively. Tenders by Feb. 22.

Rochdale.—The Corporation invite tenders for the supply, delivery, and erection at Rochdale, Lancashire, of one complete traction switchboard and accessories. Tenders by Feb. 25. Details in our advertisement columns.

Madrid.—The Public Works Department invite tenders for extensions to the San Sebastian tramways and working the same for not more than 60 years. Particulars may be obtained from the Department. Tenders by April 5.

Paris.—The Post and Telegraph Department, Rue de Grenelle, 13, invite tenders for 10 tons galvanised iron wire of 1mm. diameter; 160 tons galvanised iron wire 3-4mm.; 340 tons galvanised iron wire 4-5mm. Tenders by Feb. 28.

London and South-Western Railway Company.—The Directors invite tenders for the supply and fixing of plant and fittings for the electric lighting of Salisbury Station. Tenders by March 4. Details in our advertisement columns.

Ilford.—The Ilford Urban District Council invite tenders for supply of motor and trailer cars, trucks, motors, and equipments. Specification may be obtained at the offices of Mr. John W. Benton, clerk, Public Offices. Tenders by March 24.

Sunderland.—The Corporation invite tenders for the supply of a 12in. lathe, radial drilling machine, shaping machine, and other workshop tools for their Hylton-road station. Tenders by Feb. 28. Details in our advertisement columns.

Edinburgh.—The Council invite tenders for the electric lighting installation, etc., of the third portion of the Colinton Mains Fever Hospital, the number of lighting points being about 600. Tenders by March 3. Details in our advertisement columns.

Blackpool.—The Corporation invite tenders for the supply and delivery of steel rails, points, points and crossings, etc., at their Rigby-road depot. Specifications, etc., can be obtained from Mr. John S. Brodie, A.M.I.C.E., borough engineer. Tenders by March 1.

Fulham.—The Guardians invite tenders for the supply, delivery, and erection on their premises of two 50-kw. steam dynamos and boosters, four dry-back marine boilers, storage battery, and wiring for about 2,000 lights. Tenders by Feb. 25. Details in our advertisement columns.

Great Central Railway Company.—The Company invite tenders for the supply of electric light and telegraph materials for 12 months ending April 30, 1903. Specifications, etc., can be obtained from Mr. Oliver S. Holt, secretary, London-road Station, Manchester Tenders by March 4.

Halifax.—The Tramways Committee invite tenders for the supply of various stores and materials during 12 months ending March 21, 1903. Specifications, etc., may be obtained on application to Mr. W. M. Rogerson, borough electrical engineer, Foundry-street, Halifax. Tenders by March 1.

Aberdeen.—The Tramways Committee invite tenders for the electrical equipment of their Rosemount circular route, comprising overhead equipment and bonding (poles and bonds supplied by Corporation), and supply and laying of cables. Tenders by March 6. Details in our advertisement columns.

Elland.—The Urban District Council invite tenders for the supply of quick-speed engines for direct coupling to dynamos, dynamos, booster, and balancers, storage battery, switchboard, travelling crane, supply and laying of cables, and condenser apparatus. Tenders by March 11. Details in our advertisement columns.

Stalybridge.—The Tramways Committee of the Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board invite tenders for the supply of rails, anchor plates, and fishplates, points, crossings, filling pieces, tie-bars, bolts, nuts, and rivets, and trolley wire (43 tons). Tenders by March 3. Details in our advertisement columns.

London, S.W.—The London County Council invite tenders for two lots of 50 double-decked double-bogie electric tramcars, equipped with a plough for working on a conduit system, and to be capable of seating about 68 persons. Specification and other particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by March 4.

Sale.—The Urban District Council invite tenders for conductors laid in bitumen, meters and demand indicators, switchboard and instruments, balancer, and altering buildings. Specification, etc., can be obtained from Messrs. Hopkinson and Talbot, 29, Princess-street, Manchester, and 26, Victoria-street, S.W. Tenders by Feb. 29.

Valetta (Malta).—Tenders will be received at the office of the Receiver-General and Director of Contracts, Valetta, until 11 a.m. on 21st inst., for the supply of 75,000 arc lamp carbons. Particulars, specifications, etc., may be obtained on application to the Superintendent of Public Works in Malta, or to the Crown Agents for the Colonies, Downing-street, London.

Oban (Scotland).—The Corporation invite tenders for the supply and erection of steam, exhaust, drain, and other pipes, pumps, condensing plant, etc., balancing transformers and motor-generators, storage batteries, switchboard, arc lamps, incandescent lamps, and fittings, cable work, and travelling crane. Specifications, etc., can be obtained at the offices of Messrs. Burstall and Monkhouse, consulting engineers to the Corporation, 14, Old Queen-street, Westminster, S.W. Tenders by March 7.

RESULTS OF TENDERS.

East Ham.—The tender of Dick, Kerr, and Co. has been accepted for the supply of 10 tramcars, at £590 each.

Leytonstone.—The Board of Guardians have accepted the tender of the Sir Hiram Maxim Electrical and Engineering Company, Limited, for steam pipes, etc., at £716.

Newcastle.—The tender of J. J. Robson, at £6,892, has been accepted for the laying of the tramway track from Barras Bridge along Hunter's-road to Spital Tongues.

Manchester.—The Corporation have accepted the tender of the Sir Hiram Maxim Electrical and Engineering Company, Limited, for steam, feed, and exhaust pipes, pumps, heaters, etc., at £12,727.

Newcastle-on-Tyne.—The Corporation have accepted the tender of the Electrical Power Storage Company, 4, Great Winchester-street, London, E.C., at £5,277. 18s., for a storage battery for their generating station.

Garston.—The Garston and District Electric Lighting Company have accepted the tender of the Electrical Power Storage Company, 4, Great Winchester-street, London, E.C., at £1,010, for a storage battery for their Gateacre station.

Hornsey.—The Council have accepted the following tenders for their electricity works: J. Spencer, Wednesbury (Section E), pipework, £2,147. 15s.; Temperley Transporter Company, 72, Bishopsgate-street Within, E.C. (N), mechanical coal-handling plant, £748.

Newcastle-on-Tyne.—The Corporation have received the following tenders for the laying down of about 1¼ miles of single-line tramway: J. J. Robson, Newcastle (accepted), £6,892. 5s.; J. Brunton, Hull; E. Nuttall, Manchester; Brebner and Smith, Gosforth; J. L. Miller, Tynemouth; J. Thompson, Gosforth; A. Stark and Sons, Glasgow; and R. Laycock, Walker.

Walsall.—The Town Council have accepted the tenders of T. Parker, Limited, for supplying and erecting a dynamo, spare armature, and an exciting dynamo, at £2,020; Bumsted and Chandler, for supplying and erecting the engines for the generating set and exciter, at £1,657. The tender of T. Parker, Limited, for supplying and fixing a new switchboard frame, at £68, has also been accepted.

Middlesbrough.—The Council have accepted the following tenders for the electricity works extensions: Witting Bros. (Section A), engine-house plant, £2,833; Nalder Bros. and Thompson (B), switchboard panels, £490. 13s. 4d.; Crompton and Co. (C), condensing apparatus and pipework, £314. 10s.; Mather and Platt (D), feed-pump and economiser, £375. 10s; British Insulated Wire Company, mains extension, £867. 8s. 4d.

Lancaster.—The Corporation have accepted the following tenders for generating plant: British Westinghouse Company (Section A) four high-speed continuous-current steam dynamos, motor-generator, and balancer, and (C) traction and lighting switchboard, £12,316; J. Foster and Sons, Preston, (B) Lancashire boilers, piping, valves, condensers, etc. £2,851. 12s., excavating, etc., £60; J. Carrick and Sons, Edinburgh (D) overhead travelling crane, £329. Power station: W. Harrison, masons' work, £2,104; E. Thompson, joiners' work, £546; H. P. Calvert, plumber and glazier's work, £129. 19s.; G. Stephenson, painter's work, £69. 8s. 1d.; R. Hall and Son, slater and plasterer's work, £235. 2s. 11d.

Aberdeen.—The Corporation have received the following tenders for tramway equipment: British Insulated Wire Company, Prescot, Lancs., overhead construction and bonding (accepted); Anchor Cable Company, Leigh, Lancs., cables (accepted); Lowden Bros., Temple Electric Works, Dundee; Macartney, McElroy, and Co., 53, Victoria-street, Westminster, S.W.; Robt. Blackwell and Co., 59, City-road, London, E.C.; Johnson and Phillips, Old Charlton, Kent; Western Electric Company, Bridge-chambers, 171, Queen Victoria-street, E.C.; W. T. Henley's Telegraph Works Company, 27, Martin's-lane, Cannon-street, E.C.; Siemens Bros. and Co., York-mansions, York-street, Westminster, S.W.; St. Helen's Cable Company, Warrington; W. T. Glover and Co., Trafford Park, Manchester; W. F. Dennis and Co., 23, Billiter-street, London, E.C.; Telegraph Manufacturing Company, Helsby, near Warrington; Allgemeine Electric Company, 25, Victoria-street, London, S.W.; tramway poles, bases, etc.: A. J. Stewart and Menzies, 50, Wellington-street, Glasgow, poles (accepted); W. McKinnon and Co., Spring-garden, Aberdeen, bases, trimmings, etc. (accepted); Wilson's Union Tube Company, 5, Wellington-street, Glasgow; Macartney, McElroy, and Co., 53, Victoria-street, Westminster, S.W.; J. Russell and Sons, Crown Tube Works, Wednesbury; R. W. Blackwell and Co.,

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59, City-road, London, E.C.; Lowden Bros., Temple Electric Works, Dundee; J. Spencer, Globe Tube Works, Wednesbury; British Mannesman Tube Company, Landore, S. Wales; W. H. Richards and Co., Darlaston; National Tube Company, 23, Dock-buildings, Billiter-street, E.C.

London County Council.—The Fire Brigade Committee have accepted the tenders of Jackson Bros. to execute the wiring and to supply the fittings for electric light installations at the Bishopsgate and Manchester-square stations for £159. 7s. and £177. 8s. 6d. The tender of Edison and Swan has been accepted for 2,000 lamps of 32-c.p., 200 volts, at £112. 10s. (at 1s. 1½d. each). Tenders for the supply of about 3,250 tons of track rails, 1,850 tons of slot rails, 670 tons of conductor rails, 125 tons of fishplates, 155 tons of soleplates, together with the bolts and nuts and other accessories, required in connection with the reconstruction for electrical traction of further portions of the London County Council Tramways, have been received as follows:

Name of firm tendering and place of manufacture.	Amount of tender.
P. and W. Maclellan, Limited, Glasgow; Société Anonyme des Acieries d'Angleur, Tilleur by Liège, Belgium	£41,709 10 10
Ditto (with special lock nuts)	41,742 4 4
Bolling and Low, London; Phœnix Works, Ruhrort, Belgium	42,897 10 0
E. Le Bas and Co., London; Ougree Works, Belgium	42,935 0 0
P. and W. Maclellan, Limited, Glasgow; Barrow Hematite Company's works	50,463 15 0
Bolckow, Vaughan, and Co., London; at the company's works	51,188 8 9
W. Scott, Limited, Leeds; Leeds Steelworks	52,587 10 0
J. F. J. Peeters and Son, London; at the firm's works (apparently)	58,381 5 0

West Ham.—The Council have received the following tenders for the supply of four sets of surface-condensing plant:

		A.
G. and J. Weir	£5,480	—
Mather and Platt	6,300	£6,065
W. H. Allen, Son, and Co. (accepted).	6,580	6,400
Ditto	6,220	6,040
G. Fletcher and Co.	6,650	6,507
Ditto	7,655	7,512
Klein Engineering Company	7,040	6,940
Ditto	7,700	7,600
Ditto	7,995	—
J. Abbott and Co.	7,250	7,035
Cole, Marchant, and Morley	7,650	8,054
Ditto	8,090	8,494
Pulsometer Engineering Company	7,876	7,708
Davey, Paxman, and Co.	7,896	7,688
D. Stewart and Co.	8,758	8,604
Worthington Pumping Engine Company	8,906	8,646
Ditto	7,704	7,456
Ditto	8,108	7,848
Ditto	6,908	—
Ditto	11,700	11,440
G. de Ritter	9,050	8,310
D. Adamson and Co.	9,205	8,935
Babcock and Wilcox, Limited	9,277	8,708
Ditto	8,293	7,724
Alley-Maclellan	9,500	9,300
Ditto	9,300	9,100
J. Cochrane	9,600	9,200
Ditto	9,000	8,800
Mirrlees-Watson Company	10,050	9,720
Ashton, Frost, and Co.	10,050	9,800
Couper, Schwarz, and Co.	11,552	11,260
Campbell and Calderwood	12,000	11,800

A. Alternative price if auxiliary pump and tank not required.

BUSINESS NOTES.

TRACTION.

Rhondda.—A petition is in circulation opposing the District Council's tramway scheme.

Hastings.—The Town Council have agreed to oppose the Hastings Tramways Bill in Parliament.

Sunderland.—The net profits of the new municipal electric tramways for the last six months were over £8,000.

Bursiem.—The Town Council have agreed to oppose the Bill being promoted in Parliament by the tramway company.

Twickenham.—The District Council have decided to present a petition against the Middlesex County Council's tramway proposals.

Ince.—A special meeting of the District Council is to be held in order to further discuss the question of the purchase of the tramways.

Camborne.—A start will shortly be made by the electric tramway company at this place with the work of laying the rails, which are now being delivered.

Berlin.—The Berlin overhead and underground railway was formally opened on the 15th inst. by a trial trip of the Imperial, State, and municipal authorities.

Chester.—The Town Council have received proposals from the British Electric Traction Company, Limited, for taking over and working the tramways.

Dewsbury.—The British Electric Traction Company have made all the preliminary arrangements for an early start in laying down the light railway in this district.

Lyndhurst.—The promoters of the proposed light railway order in this district are applying for a six months' extension of time in which to commence the work of construction.

Aberdeen.—A sub-committee has been appointed to arrange for the buying of tools required in connection with the electrical equipment of the system and the tramways workshop.

Manchester.—On Wednesday night the City Council gave their final sanction to the promotion of a Bill in Parliament to authorise the construction of several new lines of tramways.

Warwick.—The Tramways Committee have been requested to open up communications with the tramways company with regard to their plans for the conversion of the trams from horse to electric traction.

Surrey.—Formal opposition will be entered on behalf of the County Council against the scheme of the London United Tramways Company for the construction of nearly 16 miles of additional tramways in Surrey.

Portsmouth.—The Town Council have adopted a revised scale of 1d. fares on the tramcars. It was stated at their last meeting that the workmen's cars were not run at a profit, there being a loss at present.

Soothill.—The Light Railway Commissioners have arranged to open an enquiry at this place next Tuesday into an application for an order authorising the construction of the Wakefield and district light railways.

Exeter.—The Literary Society Debating Club have resolved that the ratepayers will derive the greatest benefit from the proposed electric tramways being carried out and worked by a company under the control of the Council.

Rome.—An electric railway from Rome to Naples is proposed by the American Westinghouse Company. At present the journey occupies six hours, and it is stated that with electric traction the distance could be covered in 2¼ hours.

Wigan.—The Town Council this week confirmed their resolution to promote a Bill in Parliament for the purchase of the undertaking of the tramways company, to construct new lines, and to run omnibuses in connection therewith.

Gateshead.—It is stated that it is contemplated to abolish the double-deck cars on the Coatsworth-road-Bensham-road tramway route at Gateshead, and with single-deckers to run from Saltwell Park to the terminus in Wellington-street.

Devonport.—Mr. Chadwell, C.E., has been engaged on behalf of the Town Council in preparing specifications for the proposed new tramways, and it is expected that tenders for the work will be brought forward at the next meeting of the Corporation.

Erdington.—The London and North-Western Railway Company have notified the authorities at the Private Bill Office of the House of Commons of their intention to oppose the Erdington Tramways Bill before the committee of that House to which it is to be referred.

Barnsley.—The borough surveyor has received a letter from the engineer for the Barnsley and District Light Railway stating that the contract for the construction of the light railway has been let, and that it is expected that the work of construction will be proceeded with very soon.

Hanley.—The town clerk has been instructed to call the attention of the Potteries Electric Traction Company to the danger in frosty weather arising from the washing of their rails in Lichfield-street, also to call the attention of the company to the occasional overcrowding of their cars.

Darlington.—A letter was read at the last meeting of the Town Council from the Electromagnetic Traction Company inviting the Tramway Committee to view an experimental length of surface traction tramways. It was decided to take no steps in the matter until the report of Prof. Kennedy on the efficiency of the system was received.

Failure on the Tube.—Passengers travelling westward on the Central London Railway soon after midnight on Friday had a curious experience. The current gave out about a quarter past twelve, and the passengers had to alight and seek another means of reaching their homes. At Marble Arch each passenger had his 2d. returned.

Dover.—With a view to checking the furious driving of motor carriages, the Corporation have resolved to station police officers at various points with stop watches in order to time the speed of the drivers. The Corporation hope to secure the co-operation of other authorities in advising by telephone of cars travelling furiously.

West Ham.—At their last meeting the Borough Council received two deputations from the "tradesmen and stall traders" in Green-street, Upton Park, objecting to the tramway scheme for that road on the ground that it would be detrimental to business. The Mayor promised the deputations that their representations would have due consideration.

Swadlincote.—It was reported at the last meeting of the Urban District Council that as a result of the opposition of the Council at the recent enquiry respecting the light railway scheme, the promoters, among other things, had agreed to insert a clause in the draft order empowering the Council to purchase the tramways in 25 years at market value.

Christchurch.—In regard to the tramway scheme at this place, the Road Committee recommended at the last meeting of the Town Council that wood block paving was not advisable on the macadamised road, and that tar macadam with granite setts be adopted; also that the tramway company be urged to extend the lines as far as the Royal Arms Hotel. The recommendations were adopted.

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Walsall.—At the next meeting of the Town Council the Tramway Committee hope to be in a position to present a report showing the complete equipment of the tramways, the total cost of the working, and the estimated receipts. The Board of Trade have approved the proposed mode of electrically equipping the tramways.

Spen Valley Trams.—The Liversedge District Council have been notified that the British Electric Traction Company are about to sell their interests under the Spen Valley light railways order to a company which has been formed under the name of the Yorkshire Woollen District Company, Limited. The agreements which have been entered into will therefore be taken over by the new company.

Metropolitan Railway Directorate.—The following are the gentlemen proposed by the shareholders' committee as new directors of the Metropolitan Railway Company, and their names have been officially communicated to the Board: Sir William Birt, director of the Great Eastern Railway and formerly general manager of that line, and Mr. Albert G. Kitching, chairman of the Metropolitan Surplus Lands Committee.

Whitehaven.—A circular has been sent out in the town asking the recipients whether they would require electrical energy for motive power or lighting purposes, and if so to what extent. At the last meeting of the Town Council a councillor asked if it was competent for any person, company, or body to enter into competition with the Corporation within the borough in regard to their electrical undertaking. The official reply was in the negative.

Nottingham.—The newly-completed St. Ann's Well-road section of the electric tramways was tested last week, when a car similar to those usually running on the Station-street to Sherwood route was sent a trial trip the whole length of the new section with very satisfactory results. The car had been specially fitted with a new kind of guard, or "catcher," constructed of wood and working automatically in the same manner as some of the metal guards already in use.

Hull.—The Corporation Works Committee have decided to pay £10,000 out of the profits of the electric tramways towards the relief of the rates. This works out at the rate of 2½d. in the £. A special meeting of the Tramways Committee has been urgently summoned to consider a letter from the Board of Trade calling for the substitution of a new life-saving guard for the present one. This action, it is understood, has arisen out of a fatality which took place on the Holderness-road the other day.

Clydebank.—An open-air meeting was held last week, when resolutions were adopted protesting against the action of the Town Council in attempting to hand over the right to run tramways within the burgh to a company, and in favour of confining negotiations between the Clydebank Council and Glasgow Corporation. Deputations afterwards waited on the Town Council and gave expression to the views of the public meeting. The Council appointed a committee with powers to do in the matter what they considered best for the burgh.

Chatham.—The question of municipal tramways was discussed at the last meeting of the Town Council on a motion to consider the practicability of approaching the Corporation of Rochester with a view to a joint tramway scheme for the two towns. The proposal was referred to the Highway and Works Committee for consideration. It may be stated that the British Thomson-Houston Company are now engaged in the construction of an electric tramway system in Chatham and Brompton, several sections of which have already been completed.

Scarborough.—The Parliamentary Bills Sub-Committee have received a deputation of owners and occupiers of property in Newborough and Westborough streets with reference to the Tramways Bill. The deputation urged that the part of Westborough lying between Aberdeen-walk and Bar-street, and the narrow part of Newborough from Bar-street to St. Nicholas-street, was not suitable for trams. The Tramways Bill has passed the Examiner of Private Bills on Standing Orders, and will be reported for first reading in the usual way.

Bournemouth.—A largely-attended public meeting was held on Monday night in connection with the tramway scheme, which, as originally outlined and accepted by the ratepayers, was to cost under £200,000, but which, according to new proposals, will cost considerably more than this figure. The meeting demanded a reduction in the cost by the omission of certain side routes, and the substitution of the overhead for the conduit system in the centre of the town. The general opinion was expressed that the scheme as now proposed would be a serious financial failure.

Bradford.—The tradesmen carrying on business between Cheapside and Westgate and between Kirkgate and John-street are opposing the decision of the Corporation not to reconstruct a tramway along North-parade to Rawson-square, and have held a meeting at which a resolution was passed expressing astonishment at the intention of the committee not to reconstruct the line, which is the oldest and one of the most used sections in the city. A committee of 27 members was appointed to bring the views of the meeting before the Tramways and Markets and Fairs Committees of the City Council.

Norwich.—The Tramways Committee recommend that all the powers and duties of the Council with respect to all matters relating to the tramway carriages and the drivers and conductors thereof be delegated to the Watch Committee for the time being, and all matters relating to the permanent way of the tramways company be delegated to the executive committee for the time being; provided that such committee shall in no case be authorised to borrow any money or to enter into any contract, and that the proceedings of such committees be submitted from time to time to the Council for approval.

Middleton.—At a special meeting of the Town Council on Monday a resolution was passed authorising the Manchester Corporation to proceed with the construction of the tramway from Middleton to Blackley at once. The terms of agreement are that Manchester shall erect the tramway at the expense of Middleton, the amount of interest and sinking fund to be repaid in 21 years. It is hoped to have the line complete in four months. The Manchester Corporation are not in a position to supply power as yet, but it is agreed that Middleton shall supply the current at 1½d. per unit until Manchester are in a position to run the cars.

Smethwick.—It was reported at the last meeting of the Town Council that the Birmingham and Midland Tramway Company had decided to strike the clause for the construction of the tramway leading from High-street, down Rolfe-street to Rabone-lane, in the direction of Handsworth, and also the tramway from Watery-lane to Waterloo-road, out of the Bill at present before Parliament. The company had definitely decided not to construct the latter tramway, the reason given being that the Council had insisted upon so much widening to the roads that it would not pay them to construct it. The company, therefore, only proposed to construct three sets of tramways in the borough.

Penge.—A special meeting of the Urban District Council was held on Saturday to consider the question of tramways for Penge. The question at issue was whether Penge should join issue with Beckenham in opposing the British Electric Traction Company's scheme and in promoting a local scheme, or whether they should endeavour to obtain more favourable terms direct from the company. As a result of a long discussion the Council decided to oppose the company's scheme if terms satisfactory to the Council could not be arranged. Pending these negotiations the Council agreed not to take joint action with Beckenham and other local authorities with a view to obtaining a Bill authorising a joint tramway.

North Down.—An Order in Council is gazetted authorising the construction of the North Down tramways. The promoters of the undertaking are the National Electric Traction Company, Limited. The principal line of tramways is that from Bangor to Donaghadee. Other lines provide specially for the Seacliffe-road and the new pier, Ballyholme Bay, Groomsport, Balloo Lower, and Orlock Lower. Full powers are given for equipping the lines with electric apparatus and working them with electric power, and ample powers of supervision are vested in the various local authorities through whose districts the proposed lines are to pass. The tramways are to be finished and ready for traffic by Jan. 1, 1904.

Northumberland.—Mr. Campion, private Bill examiner at the House of Commons, had the Northumberland Electric Tramways (Morpeth to Bedlington, Bebside to Blyth, and Ashington to Newbiggin) Bill before him on Friday last. The measure was opposed on the ground that consent had not been obtained to the scheme. It had been before the House of Commons from time to time and postponed for the purpose of the consent of local authorities being obtained. On Friday the agents reported that they had now obtained all the consent necessary, and Mr. Campion found that all the Standing Orders had been complied with. The Bill will accordingly be reported for first reading without opposition.

Dudley, Stourbridge, and District Electric Traction Co.—This Company have made a further issue of £60,000 4½ per cent. debenture stock at par, and redeemable at 105 in either of the following events: (1) the voluntary liquidation of the Company; (2) at the option of the Company at the expiration of seven years. The whole of the ordinary and preference shares have been subscribed and paid up. The tramways serve a district with a teeming population, and the net profits last year amounted to £6,900, while the interest on the debenture stock will only absorb £2,700. There is a steady growth of traffic, and the lines are connected with those of a number of other companies, which feed each other with passengers. The prospects of the Company are said to be excellent.

Newcastle.—The extension of the tramways to Heaton-road is now open for passenger traffic. The acquisition of additional slipper-brake cars enabled the management to open out fully the Central Station to Elswick-road (Bentinck) route on Saturday. The question of watering the streets by means of motorcars will shortly be considered. It is announced that certain impediments in the way of preventing the extension of the tramways into Benwell will be very shortly removed, and the extensions of the lines proceeded with. It is expected that the whole of the route to Gosforth proper will shortly be completed. A sub-committee has been appointed to enquire into financial matters appertaining to the tramways, particularly as to the great amount spent beyond the original estimate for construction.

Gosport.—Having considered the memorandum proposed by the Electric Traction Distribution Company, the Roads and Works Committee of the Urban District Council recommended at the last meeting that the following should be added: "That the Council might at any time during the agreement give the company six months' notice to conclude the purchase of the Provincial Tramway Company, failing which the agreement to terminate." Eventually the recommendation was referred back for further consideration, the committee to have power to deal with the matter. A letter from the tramway company stating that it was useless to keep on patching up the old tramway lines, and that it was proposed at once to commence the renewal of the whole system, was referred to the Roads and Works Committee.

Cardiff.—Notice has been served on the Cardiff and Penarth Harbour District Tramway Company to sell their undertaking to the Corporation. The Local Government Board have now communicated their sanction to the Corporation borrowing £15,644—repayable in 30 years—for the purchase of the rolling-stock. The new tramway route to Castle-road will probably be opened for traffic at the end of this week. The receipts from the tramways during January—the first month of working by the Corporation—amounted to a total of £2,583. 11s. 1d., whereas the total expenditure for the month amounted to £2,090. 16s. 1d., leaving a balance of £492. 15s. The total number of passengers carried during the month was 583,221. The average receipts per car per day works out at £2. 13s. 8d., and the revenue at £81 per day.

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Vale of Rheidol Light Railway.—The above railway is rapidly nearing completion. It was stated at the half-yearly meeting of the company on Tuesday that the main line was so far completed that the Board of Trade would be asked to inspect the line in the third week of April, and it was hoped to have the line opened on the Coronation day. As to the Aberayron extension, a meeting had been held of the Cardigan Town Council last week at which a resolution was passed asking the Light Railway Commissioners to sanction their subscribing £18,000 to that extension, but it must be clearly understood that the landowners and the public interested must help or the line would not be made. The company was prepared to make up any deficiency of subscription and to construct and work the line on terms which could not be obtained elsewhere.

Liverpool.—A remarkable electric car accident occurred on the morning of the 14th inst. in a dense fog. While a car was coming down a steep incline in Fitzclarence-street, Everton, the brake failed to act properly owing to the ice-bound condition of the rails, with the result that the car rushed down the slope at a great pace. On reaching the bottom of the incline, where there is a sharp curve, the car left the line and crashed into the front of a building in Eastbourne-street, demolishing the parlour window and a considerable portion of the surrounding brickwork, besides destroying some of the furniture. The car was greatly damaged, but the motorman had a miraculous escape, sustaining no more serious injury than a severe shaking. The passengers in the car were greatly alarmed, but escaped serious injury, only one young woman complaining of shock. Fortunately the inmates of the house were not in the room where the damage was done.

Kensington.—The Law and General Purposes Committee report that they have had before them the London County Council (Subways and Tramways) Bill, under which the Council seek powers to construct a subway and tramway between Theobald's-row and the Victoria-embankment, and also to make and maintain subways for lines or tramways in or under any such streets in the Metropolis as they may think fit, and to work the railways or tramways constructed in the said subways. The committee consider that the position of this and the other borough councils as the road authority for their respective districts is very seriously menaced by the roving powers which the Council are seeking by Part III. of this Bill, and they deem it expedient that the Council should, by presenting a petition against the Bill, secure their *locus standi* to be heard when the Bill comes before a committee of the House of Commons. The necessary steps in the matter have been taken.

London Underground Railways.—A great number of petitions has been lodged at the Private Bill Office of the House of Commons against the several new London underground railway schemes which will be enquired into during this session. The list shows 15 against the Brompton and Piccadilly-circus Railway (New Lines) Bill; 18 against the Central London Railway (New Lines) Bill; two against the Charing Cross, Euston, and Hampstead Railway (No. 3) Bill; nine against the Charing Cross, Hammersmith, and District Electric Railway (No. 2) Bill; 14 against the City and Crystal Palace Railway Bill; 24 against the City and North-East Suburban Electric Railway (No. 2) Bill; six against the Edgware and Hampstead Railway Bill; two against the Great Northern and Strand Railway; three against the King's-road Railway (Putney Extension); 44 against the London United Electric Railway Bill; 29 against the North-East London Railway (No. 2) Bill; and 34 against the Piccadilly and City Railway (No. 2) Bill.

The Peak District.—The local papers state that great interest is being manifested by the people in that part of the Peak district extending from Hathersage to Baslow, Eyam, and Bakewell in the scheme for an electric tramway from Sheffield to Bakewell. From plans prepared it appears that the intention of the promoters is to join the Sheffield tramways at Totley and proceed through Totley, over the moorland country through Baslow and Pilsley, to Bakewell. The overhead trolley system would be adopted, and the gauge of the line is to be 4ft. 8½in., similar to the gauge of the Sheffield Corporation line. The average speed would be 10 miles an hour, and although there would be no regular stations or stopping-places, there would be a regular passenger service. The local authorities of the districts through which the line would run are being approached for their sanction to the scheme before steps are taken to form a company, and in case the scheme meets with local support the Light Railway Commissioners will probably be approached in May next.

Huddersfield.—In connection with the acceptance of the tender of Messrs. E. Nuttall and Sons, of Trafford Park, Manchester, for the conversion of the 14 miles of line at present worked by steam power to electric traction, we understand that the work will be carried on day and night by 600 or 800 men, and it is expected that the lines will be ready for use by June. During the progress of the work the traffic will be stopped, with the view to getting the lines equipped with the utmost speed. The Fartown and Lockwood routes will be first dealt with, and in connection with the latter route the line to Berry Brow will be converted, and a new line laid from Berry Brow to Honley Bridge, partly within the area of the Honley Urban District Council. The Moldgreen and Waterloo section will be taken in hand as soon as possible, and the other sections afterwards. The total amount of the whole of the contract for this conversion is £109,977. 18s. 4d. Twenty-five new cars have been ordered, and about a third of them have been completed. They are much lighter than the cars at present in use on the routes already electrically equipped.

Tyneside.—On Friday the Tyneside Tramways and Tramroads Company's Bill for new lines and extensions was opposed before Mr. Campion, one of the examiners of Standing Orders in the House of Commons, on the ground that the promoters had not obtained the consent of the local authorities through whose areas the extension was to pass. The Bill provides for about 16 miles of tramways, and the expense of the construction is estimated by the engineers to amount to £112,000 or £113,000. The examiners have had the Bill before them on several occasions, and its consideration has been postponed from time to time in order that the promoters might have an opportunity of obtaining the consent of the local authorities. They have failed to do this, and so reported to Mr. Campion, the examiner, on Tuesday. Upon this Mr. Campion found that the promoters had not complied with the Standing Orders, and said he would so report to the Standing Orders Committee. Under the new rules of Parliament relating to private Bill legislation the Standing Orders Committee have power to dispense with the compliance with Standing Orders where the consent of the local authorities is proved to have been unreasonably withheld.

Motor Racing in France.—The *Daily Telegraph* says that starting places in the Paris-to-Vienna motor race have been balloted for at the Automobile Club of France. The list of inscriptions now published contains 119 entries. The Mors cars have secured the first four places, and the Panhards and Levassors the six following. Four more Mors vehicles are lower down on the list. Among other firms entered are Charron, Girardot, and Voigt, who have no fewer than 12 cars; Peugeot, three; Gardner-Serpollet, four; Georges Richard, eight; Diétrich, six; Clement, six; Darracq, six; Mercedes, the German makers, seven. The reason why the starting places have been balloted for is that departures for motor races are made singly at intervals of one or two minutes in the order of the list of entries. Competitors securing early numbers accordingly enjoy the distinct advantage of having a clear course ahead of them. Later starters driving for a win have to catch up the others, and every automobilist knows that passing another car at high speed is a ticklish performance. The last competitor on the list faces the unenviable prospect of having to make his way through one continuous cloud of dust from start to finish.

Liverpool Overhead Railway.—In the reconstruction of the Dingle Station, which, as reported in our last issue, has now been re-opened, special attention has been paid to the provision of appliances for detecting and extinguishing an outbreak of fire in the station and tunnel. In the booking offices and buildings in Park-road there have been fitted a standpipe and hose for working from the nearest street hydrant, and also hand chemical engines, whilst the platform is protected with two regulation hydrants, with hose, etc., one at each end of the island platform, and there are also a couple of powerful hand chemical fire-engines stationed on the platform. As a further precaution the company have had fitted the May-Oatway automatic fire-alarm system. The Overhead Company is the first railway concern that has adopted this system. Last week a number of representatives of the railway company and of the insurance company witnessed very satisfactory experiments with the system, consisting of lighting oil-saturated asbestos in one of the signal boxes, which in 40 seconds set the alarm gong going; and, secondly, causing a similar outbreak in the booking hall, which affected the detector and sounded the alarm in about a minute.

Nottingham-Derby Light Railway Schemes.—The Light Railway Commissioners, with Lord Jersey in the chair, have held an enquiry into the merits of two separate schemes for connecting Nottingham with Derby by a light railway, the chief promoter in one instance being Sir James Mackenzie and in the other Sir Bache Cunard. Mr. Balfour Browne, K.C., representing Sir James Mackenzie, said he had received an intimation that the Midland Railway Company objected to his scheme. He was bound to admit that his scheme would enter into competition with the Midland Railway, and as he understood that the Commissioners had recently rejected the scheme of the Ashby and Burton light railway on similar grounds, it might save time if the Commissioners would say whether they intended to take the same course now. After some discussion, Lord Jersey said that the Commissioners would reject any scheme on the grounds mentioned. Mr. Balfour Browne thereupon withdrew his application, stating that his clients would promote a Bill in Parliament for the achievement of their purpose. Sir Bache Cunard's scheme was then proceeded with. There was a formidable opposition, some of which, however, was formal in character. The strongest objectors were the Midland Railway. Eventually the Commissioners rejected this scheme also.

Windsor.—The Light Railway Commissioners, presided over by Lord Jersey, held an enquiry on Friday into the application of the Metropolitan Traction Company to establish an electric railway between Hounslow, Colnbrook, Slough, and Datchet, within about a mile of Windsor. Mr. Perks was solicitor for the promoters, the chief of whom was said to be Mr. Yerkes. In the course of the enquiry it was urged that the Metropolitan Traction Company were identical with the Metropolitan District Railway Company, which ran to Hounslow. The principal opponents of the scheme were the Great Western Railway Company, the Middlesex County Council, and the London United Tramways Company. It was stated that between the County Council and the United Tramways Company an agreement had been entered into, the former to develop the northern portion of Middlesex for electric traction and the latter the southern part. The London United Tramways Company had rights to Cranford beyond Hounslow, and intended to extend to Colnbrook. Early in the hearing the promoters relinquished their scheme beyond Colnbrook. Owing to the difficulty of passing through the narrow street in that town, a single line was proposed, and the Commissioners said that, after hearing the evidence of Sir Alexander Binnie, the engineer, they were not satisfied that sufficient provision would be made for widening the road under the order, and it would be useless to consider the other points in the scheme.

Mechanical Traction on London Streets.—It was stated by the chairman of the London Road Car Company at the half-yearly meeting on Tuesday that for a considerable time the subject of mechanical traction had been receiving the directors' attention, and they were making various experiments in connection with it. Such methods of traction required time to be brought to perfection, and the utmost prudence should be exercised. All sorts of underground schemes of locomotion were projected, many of which were visionary, and very

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few of them were likely to be remunerative, all, however, dealing with passenger traffic and regardless of the interests of the various existing carrying companies. The amount of capital invested in the omnibus industry was several millions sterling. Could all the passengers be taken from the streets and carried to and fro on underground railways the problem would yet be unsolved, for the streets would still be congested with the heavy vehicular traffic. He agreed that tunnels were necessary, but he contended that they should be for goods traffic only, which, if taken off the roads, would leave plenty of room for light vehicles, and passengers would then be carried in the open air. A solution of this matter ought not to be left to chance, but should be made the subject of enquiry by a Royal commission, which, after taking evidence, should submit to Parliament recommendations dealing with the question as a whole.

London-Brighton Electric Express.—The Bill being promoted in this session to authorise the construction of a high-speed electric railway between London and Brighton came before Mr. Campion at the House of Commons on Monday, there being several memorials alleging non-compliance with the Standing Orders. The principal memorialists were the London, Brighton, and South Coast Railway Company, in whose points of objection other memorialists concurred. They complained, amongst other things, of the omission of plans for buildings and misdescription; that a plan showing a station approach at Redhill was incorrect and misleading, and that the notices were not sufficient in regard to a bridge; that the Brighton and South Coast Company had power to take water from the River Mole; and that the promoters had not "referenced" in respect of their rights in regard to that river. They also alleged that certain subsidiary works relating to the diversion of roads and streams should be treated as separate works separately referenced, and with separate plans and books of reference deposited with the various local authorities, and that this had not been done. Furthermore, it was alleged that the statements as to a number of houses occupied by the working classes which will be taken in the course of the construction of the new line were incorrect in certain particulars. The enquiry into these points has been going on all this week, and a vast body of evidence has been given on both sides. The objections of the memorialists have been upheld by the examiner on several issues.

Wolverhampton.—We understand that the Corporation have appointed Mr. Henry N. Lea, of Birmingham, an electrical engineering expert, to inspect and report upon the Lorain system of electric traction which has been in use in the town now for over a fortnight. This action has been taken in accordance with a resolution passed by the Town Council at their meeting last week. The agreement between the Corporation and the Lorain Company was stated by the Chairman of the Tramways Committee at the last meeting of the Town Council to be as follows: The company have undertaken to equip about 11 miles of single track, and guaranteed to maintain it for a period of 12 months commencing from a date 10 weeks after the commencement of commercial operations—*i.e.*, till about the middle of April, 1903. If at any time up to that date their system shall not have proved a commercial success, or if it shall prove to be dangerous either to human beings or animals, etc., then upon receipt of notice to that effect from the Corporation the Lorain Steel Company shall take up their system and reinstate the track, and the Corporation shall not make any payment to or reimburse the contractors for any costs or expenses incurred by them in connection with the whole or any part of the work. On the other hand, if the system be proved to be safe, and a commercial success, the Corporation is to take over and accept the 11 miles of track, and payment shall be made for the work to the contractors. To put the matter concisely, the Corporation have the option of discarding the system should it not prove to be a success up to April, 1903, and they will not in any case pay any money until after that date.

London County Council Tenders.—The agenda paper of the London County Council for last Tuesday contained a report by the Highways Committee with reference to the acceptance of tenders for the supply of rails in connection with the reconstruction of the Council's southern tramways for electric traction. It will be seen from the report, which we append in full, that the committee, in recommending the acceptance of a Belgian tender, have been influenced by the fact that they will be able to get the rails from abroad at a very much lower cost than was offered by the English tenders submitted. The report, which owing to the pressure of business was not considered at the meeting of the Council on Tuesday, is as follows: "We have considered the tenders (referred by the Council on Jan. 28, 1902) for the supply of about 3,250 tons of track rails, 1,850 tons of slot rails, 670 tons of conductor rails, 125 tons of fishplates, 155 tons of soleplates, together with the bolts and nuts and other accessories, required in connection with the reconstruction for electrical traction of further portions of the London County Council tramways." Here follows the list of the tenders received, which will be found in our "Results of Tenders" column. The report proceeds: "Five other tenders were received, but as these were not for the whole of the materials to be included in the contract, they have not been considered by us. It will be observed that the first three tenders are for rails made in Belgium, while the others are for rails of English manufacture, and that the difference in price between the highest of the first three tenders and the lowest English tender is £7,500, while the difference between the lowest of the English and foreign tenders respectively amounts to £8,700, equal to about 18 per cent. We may state that the quantity of rails specified for in the tenders under consideration would, at the rate to be paid under the contract recently entered into for the supply of the rails required for the Tooting, etc., lines, cost about £59,000; but in that case it was decided only to accept tenders for rails of British manufacture. The tender of Messrs. P. and W. Maclellan is the lowest, and their proposals as regards times for delivery — namely, 615 tons within 14 weeks from receipt of order, and 225 tons per week afterwards—are satisfactory; and we think that their tender for the supply of the rails, etc., with special lock nuts, for the sum of £41,742. 4s. 4d. should be accepted. Should the Council concur with our opinion, it will be necessary for sanction to be given to the employment by Messrs. Maclellan and Co. of the Société Anonyme des Acieries d'Angleur as sub-contractors. Estimates, amounting in all to £644,350, to cover this and other expenditure on capital account in connection with the reconstruction of tramways for electrical traction, were approved by the Council on Jan. 28 last; and we recommend (*a*) that, subject to the result of the usual enquiries proving satisfactory, the tender of Messrs. P. and W. Maclellan, Limited, be accepted for the supply, for the sum of £41,742. 4s. 4d., of the track rails, slot rails, conductor rails, fishplates, soleplates, bolts, nuts, and other accessories, required in connection with the reconstruction, for electrical traction, of a further portion of the London County Council tramways; (*b*) that Messrs. P. and W. Maclellan, Limited, be allowed to sub-let to the Société Anonyme des Acieries d'Angleur the manufacture of the track rails, slot rails, and conductor rails, etc., to be supplied under the contract."

LIGHTING AND GENERAL.

Keighley.—Two extensions of electric cables are to be made at a cost of £90 and £60 respectively.

Surbiton.—The draft agreement with Messrs. Callenders, Limited, has been adopted by the Council.

Bridlington.—The Town Council have appointed Mr. Lomas electrical engineer to the Corporation.

Share Market.—During the week quotations were not changed much, although transactions were numerous.

Dover.—Dr. Astley, ex-mayor, has presented the town with a magnificent electric organ of the value of £3,000.

Partick.—It is expected that the electric light will be "turned on" in the streets of the burgh at the end of this week.

Hanley. — Mr. Stainer Hutchins has been appointed junior assistant engineer at the county borough electricity works.

Leamington.—The Town Council have decided to oppose the Leicestershire and Warwickshire Electric Power Company's Bill.

Shoeburyness.—Notice of motion has been tabled of a proposal to place Shoeburyness in telephonic communication with Southend.

Ramsgate.—The Electric Light Committee are debating the question of taking action under the Corporation electric lighting order.

Hythe.—Efforts are being made to execute the Council's electric light provisional order. A report from the Edmundson Company is expected daily.

Heckmondwike.—The District Council decided on Monday to apply for sanction to the borrowing of £6,500 for the extension of the electricity plant.

Worcester.—The accounts for the year's working of the Corporation electricity works show a profit of £1,385. 6s. 2d., by far the largest yet realised.

Heywood.—It is reported that the first quarter's working of the electric lighting works shows a revenue exceeding the cost of production and working expenses.

Whitwood.—The Urban District Council object to the West Riding Electric Lighting Bill on the grounds that Whitwood is not within the compulsory lighting area.

Dundee.—The electricity rental for the 11 months ending January amounted to £12,066, being an increase of £4,611 on the corresponding period of the previous year.

Alderley Edge.—The District Council have decided to support the Bill of the Manchester Telephone Board and to petition against the National Telephone Company's Bill.

Walsall.—The consideration of the question of reducing the charge for current to places of worship has been deferred until the annual statement of accounts has been prepared.

Tonbridge.—The Guardians have passed a resolution strongly supporting the proposal of the Tunbridge Wells Corporation to extend their system of municipal telephones, as proposed.

National Association of Electrical Manufacturers.—At a meeting on Tuesday night an association was formed under the above title. We understand that about 40 firms were represented.

Ashby-de-la-Zouch.—The Urban District Council intend to oppose the Leicestershire and Warwickshire Electric Supply Company's Bill with the idea of getting the best terms possible for the town.

Heywood.—The free library is to be lighted with electric light. Mr. W. S. Johnson, electrical engineer, has been asked to form a scheme and obtain estimates, submitting the same to the next ordinary meeting.

Edmonton.—At this week's meeting of the Edmonton Urban District Council, the clerk reported that the Council's petition against the North Metropolitan Electrical Power Supply Company's Bill had been lodged.

New Agency. — The Consolidated Telephone Construction and Manufacturing Company, Limited, have appointed Messrs. Moores, Farrell, and Co., of 26, Victoria-street, Manchester, their sole agents for the North of England.

Hastings Telephones.—A sub-committee of the Town Council on the question of municipal telephones has received a report from Mr. Bennett, a copy of which is to be sent to every member of the committee for thorough consideration.

Electrical Exhibition.—The Borough Council of Bermondsey intend holding an electrical exhibition on the 26th, 27th, and 28th inst. at the Town Hall, Spa-road, S.E., and are prepared to receive applications from firms wishing to exhibit.

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Earl's Court.—A boating exhibition is to be opened at Earl's Court on the 1st of next month, and to run fora fortnight. The exhibition will be held in the Ducal and Prince's Halls, while the lake will be utilised for trials of motor and electric launches, etc.

Appointments Vacant.—By some misadventure an obsolete paragraph referring to Croydon remained standing under this column in our last issue. The first note which appears again in the same place contains the correct figures relating to the appointment.

Aberdeen.—In order to supply the works of Harpers, Limited, at Craiginches, with electrical energy, a cable is to be laid in a 3in. malleable iron pipe under the carriageway of Wellington Suspension Bridge, and supported on the cross girders of the bridge.

Mundesley.—We understand that the Erpingham District Council are in communication with Messrs. Ridout and Co., electrical engineers, 124, Regent-street, London, W., with regard to a scheme for supplying electricity for lighting and other purposes to Mundesley-on-Sea.

Swansea Telephones.—The National Telephone Company has issued a circular giving reasons against the municipalisation of telephones, in which they allege that it is impossible for the Corporation to give a cheaper or more efficient service than that given by the company.

Bath.—The ratepayers have entered a protest against any large expenditure in regard to the electric lighting of the city in the shape of a resolution carried at a meeting held last week at the Old Sessions Court, Guildhall, under the auspices of the Bath Ratepayers' Protection Association.

Scarborough.—The Municipal Telephone Sub-Committee, after conferring with Mr. A. R. Bennett as to establishing municipal telephones at Scarborough, have instructed the engineer to prepare a plan showing the location of the present telephone subscribers as now suggested by Mr. Bennett.

Leeds.—The Sub-Lighting Committee have recommended that several streets in the centre—East-parade, Infirmary-street, Park-row, Cookridge-street, and Woodhouse-lane as far as the end of Blackman-lane—be lighted from the electric lighting works, special standards being erected to carry the arc lamps.

Buxton.—The Finance Committee, in a report submitted to the Urban District Council last week as to the National Telephone Company's underground wiring of the town, stated that they were determined to have the matter proceeded with at once, or that an end be put to the agreement. The report was adopted.

City Lighting.—At Thursday's meeting of the Court of Common Council, a letter was read from the City of London Electric Lighting Company to the effect that pending litigation the company will continue the public lighting for the Corporation on the same terms as heretofore, without prejudice to the rights of either party.

Hornsey.—The Highways and Lighting Committee at the last meeting recommended that 60 new arc lamps be provided for the lighting of various streets. The estimated annual cost of current and maintenance of the 60 lamps is £1,292. 17s. 6d. to replace 87 lamps now in lighting with gas. The proposition was not agreed to.

Eastbourne.—The new generating station at Rosclands is approaching completion. Two new combined engines and dynamos have been fixed, and two 800-h.p. boilers are in position. The lighting of the streets with arc lamps will be commenced shortly by the borough electrical engineer (Mr. J. K. Brydges), who is superintending the installation of the new machinery.

South-West Ham.—It is proposed that the arc lighting of the Victoria Dock-road should be extended from Hallsville-road to Hack-road. The Lighting and Tramways Committee have also been asked to have estimates prepared for extending the arc lighting to Custom House, and also for lighting High-street and Balaam-street, Plaistow, with arc lamps.

Schmidt System.—Messrs. Easton and Co., Limited, have granted a further sub-license to Messrs. Browett, Lindley, and Co. (1899), Limited, Sandon Works, Patricroft, near Manchester, to construct engines to work with highly superheated steam on the Schmidt system, at the same time retaining the sole right to manufacture the superheaters required in connection with such engines.

Penzance.—The Electric Lighting Committee have had an interview with Mr. Trentham on his report on the supply of electrical energy in the borough. The term of two years within which the compulsory works were required to be executed under the electric lighting order expires on May 25 next, and the Board of Trade have now been asked not to revoke the order at the end of such term.

Limerick.—Alderman Joyce, M.P., has written to the town clerk with reference to his question in the House of Commons on the want of better telegraphic facilities in Limerick. Alderman Joyce suggests that some representation should be made by the Borough Council and the legal profession to the postmaster in Limerick, as the Postmaster-General had promised to make enquiries on the subject.

Stockport.—With regard to the introduction of the electric light into certain wards in the workhouse hospitals, it has been resolved that consideration of the question be deferred for a period of three months, but that the master may, if he considers it advisable, give instructions for the laying of a cable sufficient both for electric lighting and for motor power for the ventilation of the house kitchen.

Luton.—The electrical engineer's last report states that since Jan. 1, 1902, 9,104 units have been generated; 309 8-c.p. lamps and one motor connected, making a total of 54 consumers, or 4,284 lamps and four motors; and that 156 lamps have now been wired. He also received 13 applications for the supply of current equal to 598 8-c.p. lamps. These premises will be supplied at an estimated cost of £900.

Twickenham.—The amended plans of the Twickenham and Teddington Electric Supply Company, showing the position of the mains to be fixed in the district, and also plans of the feeder pillars, brick chambers, and iron boxes required in connection therewith, have been approved, subject to the actual position of all feeder pillars and brick chambers being agreed with the Council's surveyor.

South Wales Electrical Power Bill.—Petitions on behalf of the following for leave to be heard against this Bill by counsel when the committee stage is reached have been deposited in the Private Bill Office: Newport Corporation, Great Western Railway Company, Swansea Corporation, Risca Urban District Council, and Abercarn, Abertillery, Ebbw Vale, Margam, Mountain Ash, and Tredegar Urban District Councils.

Darlington.—The Electricity and Tramways Committee of the Corporation have decided to extend the electric lighting mains along John-street, up Northgate and North-road, to North-rise, at a cost of £1,272. As Messrs. Brown, of the sawmills, are anxious to have a supply of current if it can be guaranteed by March, the electrical engineer was instructed to negotiate supplying them as part of the proposed extension.

Huddersfield.—The financial statement for the electricity works for the year ended Dec. 31 shows a balance of income over expenditure of £2,561. 16s. 3d. The income for the supply of electricity was £19,024. 7s. 6d., against £16,390. 7s. 1d. in the previous year. The surplus has been transferred to depreciation and contingencies account. About 100 electric motors are let out on hire, and these have been paid for out of the profits last year.

Worksop.—In consequence of the action of the Traders' Association, foreshadowed in our last issue, the Urban District Council have decided, as a matter of emergency, to rescind the resolution fixing the price at 5d. per unit, and to fix the same at 4d. per unit, with the usual discount. As a result of the Council's action Messrs. Wells-Smith and Garside have signified their intention of retiring from the Lighting Committee, whose recommendations have been reversed.

Kensington.—Notices from the undermentioned electric lighting companies relative to proposed extensions of their mains in the borough have been agreed to: Notting Hill Electric Lighting Company—Abbottsbury-road, Oakwood-court, St. Mark's-road, Bassett-road, Kelfield-gardens, Chesterton-road, Oxford-gardens, and Cambridge-gardens; and Brompton and Kensington Electricity Supply Company—Elm-place, Warwick-road, and Pembroke-road.

London Gazette.—The partnership existing between C. B. King, jun., and E. R. Smith, trading as C. B. King, jun., and Co., electrical engineers, 13A, Heath-street, Hampstead, Middlesex, has been dissolved by mutual consent. The first meeting in the estate of H. Cooke, electrical engineer, 12, George-street, The Parade, Birmingham, will be held on Feb. 26 at 11 a.m. at 174, Corporation-street, Birmingham, and the public examination on March 13 at 2 p.m. at County Court, Birmingham.

Hindley.—In reply to a letter *re* the suggested telephone call office, the Postmaster-General has informed the Council that if a Post Office call office were established at Hindley it would not be practicable for callers to communicate with the subscribers to the National Telephone Company at Wigan, which was in the same exchange area. In those circumstances the Postmaster-General was of the opinion that the establishment of a Post Office call office would not meet the public requirements.

Barnsley.—At the annual meeting of the Barnsley Gas Company recently, Mr. E. G. Lancaster, the chairman, in moving the adoption of the report and payment of the maximum dividends, said the company was still feeling the effects of the high price of coal. Had it not been for the electric light, the company would not have been able to meet the increased demand without additional plant, and they were therefore inclined to look upon the electric light from a very friendly point of view.

Ashton-under-Lyne.—A rough analysis has been made of the nine months' working of the financial year just completed by the electricity department showing works cost, 1·2d.; coal was estimated at £3,190, and up to the present £2,110 had been expended. The committee expect to be able to get through the year at £2,738, or a saving of £1,266 from last year. The wages were somewhat similar to last year. The output at the same rate is expected to be close upon a million units.

Barnstaple.—Mr. Trentham's estimate of the electric lighting scheme was £21,000, and borrowing powers have been obtained to that extent. The tenders received, however, for the work connected with the lighting of the compulsory area render it possible for the Council to carry out the scheme at considerably less than that sum, and leave a substantial margin, running into thousands of pounds, towards the cost of extending the electric lighting to Newport, Pilton, and Bear-street.

St. Annes.—An exhibition was held last week by Messrs. Gilchrist and Co. On the opening day the cooking of a dinner of several courses was demonstrated by Mr. R. R. Williamson, the representative of the firm in St. Annes. It was stated that the cost of cooking this dinner, large enough for nearly 40 persons, according to the charges for current made by the Council, was under 4s. The efficacy of the cooking was afterwards tested by an invited company, and greatly appreciated.

Wakefield.—At a meeting of the Wakefield Incorporated Chamber of Commerce and Shipping last week a communication was read from Edinburgh Chamber of Commerce, intimating that the Postmaster-General had consented to receive a deputation from chambers of commerce of the North of England on Tuesday, March 6, with regard to the question of an underground telegraph cable. The Wakefield Chamber's delegates to the meeting of the Associated Chambers were deputed to join the deputation.

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Ealing.—A return having been submitted of the number of consumers affected by a minimum charge being adopted, the Council agreed last week to adopt a minimum charge of 6s. 8d. per quarter, inclusive of meter rent, being made to all consumers occupying houses with a ratable value of £25 or under, and a minimum charge of 13s. 4d. being made to all houses of a ratable value of over £25, and to all shops and offices irrespective of rateable value, subject to the opinion of the town clerk as to legal power to differentiate.

Eton.—At the last Council meeting a letter was read from the Board of Trade, enclosing copy of a letter which they had received from the promoters of the Slough electric lighting provisional order, asking the Board to dispense with the consent of the Eton Rural District Council to the application for the order. The amount estimated by the promoters to be expended on the undertaking was £50,000. It was decided to reply that if the inhabitants of Datchet desire to have the electric light the District Council would not press their objection.

Liverpool.—The City Council on Wednesday discussed a recommendation of the Electric Power and Lighting Committee that from the end of the present quarter the prices of electric energy supplied for lighting to any consumer in any one establishment be as follows: up to 3,000 units per quarter, 3½d. per unit; beyond 3,000 units per quarter, 3d. per unit; and that the other prices charged for electrical energy remain as at present. The Council adjourned before a decision had been arrived at, and the matter will take precedence at the meeting on March 5.

Brierfield.—An enquiry is announced with reference to the application for a loan of £10,110 for the purposes of electric lighting. The Local Government Board having desired to know why the Council was asking for £130 less than the estimates the Council have replied that they expected to save the £130 by the employment of their own surveyor to supervise the work, and they had purchased the necessary land. The Tramways, Electricity, and Sewage Committee have received a letter from the Board of Trade approving of the system of electricity adopted.

Norwich.—At the next meeting of the Town Council the Law and Parliamentary Committee will recommend that consent be given in accordance with Clause 5 of the agreement between the Norwich Electricity Company, Limited, and the Corporation to the company expending a sum of £7,100 in the undermentioned works—viz., additional battery and changing existing battery from sub-station to central station, new feeder from Duke-street to St. Stephen's Gates to supply Newmarket-road district, £5,100; and extension of mains and free wiring of houses, £2,000.

Stock Exchange.—The Stock Exchange Committee have ordered to be quoted in the official list City of London Electric Lighting Company, Limited, £200,000 4½ per cent. second debenture stock, in lieu of the provisional certificates now quoted. Applications have been made to the Exchange Committee to appoint a special settling day in and to grant a quotation to Charing Cross and Strand Electricity Supply Corporation, Limited, further issue of 20,000 ordinary shares of £5 each fully paid, Nos. 50,001 to 70,000, and 20,000 4½ per cent. cumulative preference shares of £5 each fully paid, Nos. 50,001 to 70,000.

Blackpool.—The contract for the supply and erection of an artistic cast-iron structure to serve as a covered way and arcade for the Blackpool gigantic wheel has been obtained by Messrs. Rowland Carr and Co., electrical ironfounders, 6 and 8, Lime-street-square, E.C. The entrance will be lighted and ornamented by hundreds of electric incandescent and a large number of arc lamps, and will no doubt be a fine example showing how a handsome cast-iron structure can be made even more beautiful by the aid of electricity. The Corporation on Wednesday appointed Mr. Burgess, of Devonport, borough electrical engineer.

Flint.—At a recent meeting of the Council a letter was read from Mr. Herbert Lewis, M.P., stating what steps he had taken to bring to the notice of the Postmaster-General the desirability of having Holywell included in the telephone area of Chester instead of Rhyl. He enclosed a letter from Lord Londonderry stating that he could not see his way clear to alter the existing arrangements. On the suggestion of the Mayor, a vote of thanks was accorded to Mr. Lewis for the trouble he had taken in the matter, and also urging him to seize the first opportunity of again bringing the matter before the authorities concerned.

King's Lynn.—The electrical engineer's last report states that since the last meeting applications had been received for 396 additional lamps of 8 c.p. or equivalent, making a total of 10,242 from private consumers. He also reported that the working expenses for December as compared with the same month last year were: units generated, December, 1900, 36,993 (December, 1901, 42,701); units sold to private consumers, 8,424 (11,887); fuel, stores, repairs, and wages in the station (cost of), £253. 5s. 3d. (£141. 10s.); cost per unit generated, 1·64d. (0·79d.); wages of lamplighter and outside staff, £15. 16s. 9d. (£19. 14s. 7d.).

Oban.—The engineers have been instructed to prepare and issue the specifications for the remaining works connected with the electric light undertaking. Advertisements are to be issued for proposals from wiring contractors for easy wiring of consumers' premises, either on the hire or instalment principle; also for applications for the post of resident engineer, at £150 per annum, rising to £200, the duties to be taken up in the month of March. An order has been received from the Secretary for Scotland approving of the proposed site at Lochavullin for the purposes of a generating station and other works connected with the electric lighting scheme.

Upper Cabrach.—The inhabitants of Upper Cabrach are now anxious to have the telephone, which is at present erected between the Lower Cabrach post office and Huntly, extended to the post office situated in the centre of Upper Cabrach. It is said that the road between Lower and Upper Cabrach is often so badly blocked by snow during the winter months that it would be impossible for a person residing in Upper Cabrach to reach the post office of Lower Cabrach in less than three hours of a very arduous journey, or, on the other hand, it would be as difficult for a telegraph messenger to convey a telegram to a resident in Upper Cabrach.

Fulham.—At Wednesday's meeting of the Borough Council the borough electrical engineer reported that from Jan. 27 to Feb. 10, 1902, applications equivalent to 486 8-c.p. lamps had been received, making a total in all of 28,797 8-c.p. lamps, and that 349 services had been completed and connected to the mains, representing an equivalent of 14,050 8-c.p. lamps. It is proposed that deposits to be made by occupiers of flats before the connection of electric lighting services be adopted on the following scale: for lights not exceeding 12 8-c.p. lamps, £2; exceeding 12 but not exceeding 18 8-c.p. lamps, £2. 10s.; 18 to 24, £3; 24 to 30, £3. 10s.; 30 to 36, £4; 36 to 42, £4. 10s.; and exceeding 42 8-c.p. lamps, £5.

City of London Electric Lighting Co.—The directors have decided, subject to the completion of the audit of the accounts, to recommend to the shareholders the payment of the following dividends, after provision for reserve: on the Company's preference shares a final dividend of 6s. per share for the six months ended Dec. 31, 1901, making, with the dividend paid on account in July, 1901, a total distribution of 12s. per share, or at the full rate of 6 per cent. per annum; on the Company's ordinary shares a dividend of 10s. per share, being at the rate of 5 per cent. for the year ended Dec. 31, 1901, carrying forward a balance of about £13,000. Both the above dividends will be subject to the deduction of income tax.

Hove.—The Board of Trade have approved of the system for the supply of electricity under the Hove (Aldrington) Electric Lighting Order, 1898, thus revoking the approval given by the Board on Aug. 14 last except so far as it relates to an earth connection, the approval of which still remains in force. A dispute having arisen between the Council and the Hove Electric Lighting Company, Limited, in connection with the agreements relating to new buildings proposed to be erected on the company's land at Aldrington, the Lighting Committee have been authorised to take steps to protect the rights of the Council. The Council will also call upon the company to fulfil the conditions of their contract, especially with reference to providing four batteries of accumulators.

Sale of Plant.—The Bristol Tramways and Carriage Company, Limited, are offering for sale a practically new and complete electric tramway power station plant, in consequence of the opening of their new central power station for the operation of their entire tramway system. Full particulars of the machinery, etc., appear in a previous issue. The electrical equipment is by the General Electric Company, Schenectady, U.S.A., and supplied by the British Thomson-Houston Company, Limited. This station plant has been regularly operating a service of about 45 double-deck cars over 10 miles of heavily-graded lines (1 in 12 max.), with one unit always in reserve. For any company or corporation about to instal an electric car system of from 50 to 70 cars the opportunity is unique.

Soulcoates.—At a meeting of the Guardians on Tuesday a discussion took place on the recommendation of the Works Committee that the electric current required at the workhouse be produced by the Board's dynamo, and also on the master's report relating to the cost of production of electric light in comparison with the same when bought from the Hull Corporation. The master reported in favour of the Board making their own light, the cost being only 1·094d. per unit for a quarter. The architect will be requested to attend the next meeting of the committee in order to consider the question of the provision of accumulators. Mr. Rylatt has worked out a comparison for a month, which showed a net loss of £46. 8s. 9d. in buying from the Corporation as against home production.

Horsham.—On Wednesday the electric light was switched on by Mrs. Harrington, the wife of Mr. James Harrington, who has been the chairman of the Electric Light Committee. Mr. W. C. C. Hawtayne, M.I.E.E., was the consulting engineer for the undertaking. Sanction had been sought to borrow £15,506, including £1,500 for free wiring. This item was disallowed. The estimated cost of the works was, therefore, £14,006. The work of building the station and cables began in May, 1901, on a site in Stanley-street, in proximity to the waterworks and on the eastern side of the London, Brighton, and South Coast Railway. The buildings were erected by Messrs. Hull and Redford from the designs of Messrs. Gordon and Gunton. The supply is on the three-wire system with continuous current. The plant consists of two water-tube boilers, each capable of evaporating 3,500lb. of steam per hour at 160lb. pressure; two feed pumps for supplying 1,000 gallons per hour, one of which is electrically driven; a Green's economiser; and two steam dynamos, coupled to high-speed engines, capable of developing 80 kw. and 40 kw. respectively at 450 revolutions per minute, and of giving an emergency load 25 per cent. in excess of the normal load for one hour without injury. A set of four motor-generators and boosters has also been provided, as well as a storage battery with a capacity of 250 ampere-hours when discharged at the rate of 83 amperes for three hours.

Wireless Telegraphy.—Experiments were made a few days ago in wireless telegraphy between a cruiser steaming down channel and the Admiralty station at Dover at a point known as Spion Kop, near Shakespeare's Cliff. By the use of some special mechanism, which is stated to be a new invention, and tried for the first time, messages were successfully transmitted to a distance of about 40 miles further than had previously been obtained. The object of the authorities is to have wireless communication from Dover with Portsmouth on the west and Sheerness on the east. The Dominion Government are reported to have made an arrangement with Signor Marconi for the reduction of the present cable rates of 25 cents (about 1s.) to 10 cents

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(5d.) a word by wireless telegraphy in return for a contribution towards erecting stations.

Cardiff.—The electrical engineer's last report states that there has been an increase of 40 per cent. on the number of consumers since February of last year. During the past month 450 8-c.p. lamps were connected with the mains, and the total number of private consumers was 533. The Mount Stuart Dry Dock Company have decided to enter into a contract with the Council for the supply of current. The company will use the current for both lighting and power purposes. The Corporation will supply current on the following terms: at the rate of 1d. per unit with a guaranteed consumption of 50,000 units per annum for every 100 h.p. demanded; 1½d. for the same amount of power with a guaranteed minimum consumption of 35,000 units per annum; 1½d. per unit same power with guaranteed minimum consumption of 25,000 units per annum.

Louth.—The Highways Committee had offered to meet the directors of the gas company in conference *re* street-lighting, provided they withdrew their objections to the Council's application for a provisional order for electric lighting, and in that case the Council would be prepared not to make any use of the provisional order until after such conference. To this the gas company replied that they were willing to abandon their opposition, as large ratepayers, to the application by the Corporation for a provisional order under the Electric Lighting Acts provided the Town Council would enter into an agreement for seven years for the street-lighting. When these minutes came before the last meeting of the Town Council they were objected to on the ground that the ratepayers would best be served by the Council obtaining the provisional order before holding any conference with the directors of the gas company. The minutes were not confirmed.

London County Council.—At Tuesday's meeting of the Council it was agreed to lend the Battersea Borough Council £6,200 for electric light installation and meters, and the Shoreditch Borough Council £20,000 for electric light installation. Sanction was given to the Woolwich Borough Council to borrow £6,000 for the purchase of an electric light undertaking. The Bridges Committee reported that it would be necessary to obtain 2,000 electric lamps for use at the Blackwall Tunnel. A quotation was obtained from the Edison and Swan United Electric Light Company, Limited, who were willing to supply this number of 32-c.p. 200-volt clear incandescent lamps at 1s. 1½d. each, or £112. 10s. in all. Provision was made in the annual maintenance estimates for this expenditure. They recommended that an expenditure of £112. 10s. for 2,000 electric lamps for use at the Blackwall Tunnel be sanctioned, and that the offer of the Edison and Swan United Electric Light Company, Limited, to supply them at this price be accepted.

Shrewsbury.—The Lighting Committee in their last report state that the extension of the electric lighting cable in Belle Vue is well in hand, and the jointing up of the Coton Hill cable completed. The cable by the free library is to be extended down Castle Gates to the corner by the Welcome Hotel, at an estimated cost of £90. The committee had received several applications from residents on the Mount for electric light to be laid on to new houses about to be built. If they took the main along the Mount they would be enabled to take over a number of street gas lamps which would bring in a sum of £51 per annum. It would involve a cost of £500 per annum, and the committee would have to receive a return of 20 per cent. on that outlay if it were done. If they were guaranteed a sum of £50 a year from private consumers, that, with the £51 the Council would secure through not using the gas lamps, would make up the percentage. Preliminary steps to extend the main in that direction, providing they could get sufficient consumers to justify the expenditure, were sanctioned. A sub-committee is to be formed to consider the question of destructors.

Camberwell.—In January last the Council resolved to present a petition against the London County Council (Electric Supply) Bill in order that a clause might be inserted therein to enable the highways authorities of the Metropolis to exercise a power of veto over the opening and reinstating of highways in connection with the laying of bulk supply mains and apparatus. Subsequently it was further resolved to approve the general principles of the Bill, and to ask the members of Parliament for the borough to support the same. The town clerk having reported that it would be most inadvisable to present the petition against the Bill, the same has been withdrawn. The committee have approved of a resolution carried by representatives of metropolitan borough councils at a conference on Dec. 9 last at Stepney, in regard to the case of the Board of Works for the Whitechapel District *v.* Crow, to the effect "that united action be taken by the metropolitan borough councils for the transfer to them of the duties now exercised by the district surveyors under the London Building Act so far as those duties refer to electric lighting boxes and similar constructions under the public way."

Harrogate.—Mr. Norman has resigned his position as mains superintendent, and advertisements have been issued inviting applications for this position at a salary of £150 per annum. The switchboard attendant has also resigned, and advertisements have been issued inviting applications for this position at a salary of 30s. per week. With regard to the electrical engineer, the Lighting Committee consider it advisable from March next that the electrical engineer should discontinue outside consultation and devote his whole time to the work of the Corporation. The engineer has prepared designs and prices for a patent cable cart, and the offer of Callender's Cable and Construction Company to lend their patent cable cart at £1 a week has been accepted. If found to work satisfactorily, the same will be purchased for £37, the amount paid for the loan of the cart to merge in the purchase-money. The supply of electric current to radiators and stoves which are used for heating purposes only will be in future charged for at the uniform rate of 2d. per unit, and subject to a separate circuit being used and separate meter, or 1½d. per unit, subject to a minimum average use of three hours per day per stove or radiator during any quarter: provided the Corporation shall in no case demand for any electric current a greater sum of money than they would be entitled to demand if the consumption was just sufficient to bring it within the lower charge.

Radcliffe.—The Electricity Committee have considered a letter from the Lancashire Electric Power Company, stating terms upon which they were prepared to supply electric energy in bulk to the Council from Oct. 1, 1903. From reports to hand it appears that no action was taken. The company stated that they were prepared to supply electrical energy in bulk at the prices set forth in the second schedule of their Act, subject to a discount of 20 per cent. Thus the prices would work out as follows: hours per quarter of maximum demand, 100, price per unit 3·2d.; 200, 2·4d.; 300, 1·87d.; 400, 1·60d.; 500, 1·44d.; 600, 1·33d.; 1,400, 1·02d. This Council has joined the Incorporated Municipal Electrical Association for the present year. The Electricity Sub-Committee visited Farnworth on the 15th inst. and inspected the electricity works and tramways after the recent visit by the Local Government Board's inspector, in order that they might be better prepared to make any further suggestions or alterations in the plans of the Radcliffe Council's scheme should they consider it advisable; but they did not see anything that would necessitate an alteration in the details of the present plans.

St. Marylebone.—At the meeting of the Council on Thursday a report was submitted by the Lighting Committee upon a reply from the Board of Trade, stating that with regard to this Council approving of the principle of the Electric Lighting (London) Bill, subject to satisfactory provisions being made as to the financial effect of the scheme of adjustment, the Board are advised that any provision dealing further with the financial arrangements than Clause 5 of the Bill as introduced last session will require most careful consideration, but that the Board will be prepared to give the fullest consideration to any suggestion which the Borough Council may wish to make in the matter; that with regard to the public street-lighting of boundary thoroughfares, the Board will consider the question of inserting a clause in the Bill. Clause 5 of the Bill of last session with reference to financial arrangements has been approved by the committee. Notices of works from the Metropolitan Electric Supply Company, Limited, have been agreed to as under: (*a*) to lay 5in. cast-iron pipes along the east side of Carlisle-street, from the south side of Church-street to 62, Carlisle-street; (*b*) the west side of Seymour-place, from No. 57 to the north side of Upper Berkeley-street; and (*c*) the east side of Titchfield-road, and the north side of St. James's-mews, from 22, St. Edmund's-terrace to connect 1, Titchfield-road. The notice (*b*) was referred to the solicitor to consult the Council's expert with regard to the work therein mentioned, and provided he sees no objection thereto the same will be agreed to.

Islington.—At to-night's meeting a report will be submitted by the Lighting Committee as follows: "We have received a communication from the electrical engineer submitting information regarding the salaries, increments, and privileges attaching to the office of electrical engineer in the most important municipal electricity works, in which he points out that considering the extent of the Council's electric lighting undertaking, and the attendant responsibility, he is by comparison insufficiently remunerated. The information supplied shows that where the salary is £600 or less per annum, it is usual to permit either private practice or the taking of pupils. These privileges are no doubt the means of considerably augmenting the incomes of the engineers to whom they are accorded, but we think they also have the advantage of being beneficial to the undertakings, inasmuch as after the first 12 months' pupilage the services of young men thus trained are available for the discharge of certain routine duties. Your electrical engineer, moreover, holds the unique position of being the only resident electrical engineer of a London municipality who has had the entire responsibility of designing the works of which he has charge. Having regard to these facts, we are unanimously of opinion that the Council should recognise Mr. Gay's services and the high position which he holds in his profession by permitting him to take private pupils to a limited extent, subject to certain conditions to be hereafter settled by us and reported to the Council. We therefore recommend that, subject to certain conditions as aforesaid, the electrical engineer be allowed to receive and train in the electric lighting station not more than three premium pupils at any one time." The committee also recommended the laying of a length of low-tension distributing main at £82.

Gravesend.—Mr. Trentham has appointed Mr. McInnes as resident electrical engineer. Good progress is being made with the buildings at the electricity works, and the walls of the engine-room and boiler-house will be ready for the roof in about five weeks provided the weather is good. All the machinery is well in hand and is expected to be ready for delivery as soon as the buildings are sufficiently ready to receive it. The cable laying has not been hurried, as the engineer is anxious to lay spare ways at the same time to take the tramway feeders, and although the tramway company assented to the principle of having these spare ways laid at the same time as the Corporation cables in order to avoid disturbing the pavements twice over, they would not until the completion of the agreement give any indication of what their requirements might be. A small sub-committee has been appointed to settle the best positions for the arc lamp pillars. Fourteen of the traction pillars can be made use of on the main road, leaving 13 lamp pillars to be separately erected. In view of the adoption of the span wire system, the reconsideration of the type of bracket already decided upon has also been referred to the sub-committee. Circulars are being issued to householders in the compulsory area, in which it is stated that the Electric Committee are prepared to receive applications from intending consumers of electricity for lighting or power purposes. Mains are being laid or are about to be laid in the following streets: Milton-road (from Milton-place to Queen-street), King-street, New-

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road, Overcliffe, Harmer-street, Windmill-street, High-street, and Pelham-road, and the northern half of Darnley-road, and a supply will be available from July 1 next, if not earlier. It is, moreover, proposed, in order to encourage consumers to wire their premises ready for a supply from the commencement, that no charge be made for electricity supplied during the first calendar month of working. Afterwards it is proposed to charge on the maximum demand system for a period of 90 hours, or approximately one hour daily, at the rate of 7d. per unit, and all consumption over and above this amount at the rate of 3d. per unit. For consumers who use their lamps on an average of two hours or more daily, this charge works out at considerably less than an equivalent amount of light by gas at 3s. per 1,000 cubic feet.

Private Bills.—The following notices of opposition have been given to private Bills originating in the House of Lords: Baker-street and Waterloo Railway—Gordon Hotels, Limited; Brompton and Piccadilly-circus Railway (New Lines, etc.)—the President and Council of St. George's Hospital, the Borough Councils of Westminster, Holborn, and Kensington; West London Extension Railway Company—trustees of the late Sir C. J. Freake, Gordon Hotels, Limited, Baker-street and Waterloo Railway Company, the Governors of Brompton Hospital for Consumption, the Governors of Chelsea Hospital for Women, Central London Railway Company, National Telephone Company, and trustees of the late Gerald Noel Morrey and Henry Smith, and others; Central London Railway (New Lines.—the Duke of Devonshire, the Duke of Norfolk, the Duke of Wellington, Sir W. G. F. Phillimore, Westminster and Queenhithe Borough Councils, Kensington and Knightsbridge and Notting Hill Electric Lighting Companies, Great Western, Metropolitan, London and North-Western, North London, Metropolitan District, and Brompton and Piccadilly-circus Railway Companies; London United Tramways (1901), Limited—the President and Council of St. George's Hospital, Coutts and Co., Conservators of the River Thames, National Discount Company, St. James's Hall Company, and others; Charing Cross, Euston, and Hampstead Railnay (No. 3)—Westminster Borough Council and the Master and Scholars of Balliol College, Oxford; Charing Cross, Hammersmith, and District Electric Railway (No. 2)—the President, etc., of St. George's Hospital, the Duke of Devonshire, the Duke of Wellington, Gerard Augustus Lowther, Baker-street and Waterloo Railway Company, Conservators of the River Thames, Royal Dental Hospital, and Gordon Hotels, Limited; City and Crystal Palace Railway—Merchant Taylors' Company, London Corporation, Borough Councils of Southwark and Queenhithe, Conservators of the River Thames, Metropolitan, City and Brixton, South-Eastern, London, Chatham, and Dover, South-Eastern and Chatham Railway Companies, South Metropolitan Gas Company, Surrey Commercial Docks Company, and the London County Council; City and North-East Suburban Electric Railway (No. 2)—Great Eastern, London and Blackwall, Tottenham and Forest Gate, Metropolitan, London and North-Western, East London, Central London, Metropolitan, Whitechapel and Bow, South-Eastern and South-Eastern and Chatham Railway Companies, Trustees of Sir J. H. Warner, City of London Corporation, Tallow Chandlers' Company, London County Council, Hackney Borough Council, Regent's Canal and Dock Company, Master and Scholars of Balliol College, Oxford, and the promoters of North-East London Railway (No. 1 and No. 2) Bills; Edgware and Hampstead Railway—Provost, etc., of Eton College, the Midland and Great Northern Railway Companies, Hampstead Borough Council, Regent's Canal and Dock Company, New River Company, West Middlesex Water Company, Middlesex County Council, and Ecclesiastical Commissioners for England; Great Northern and City Railway—North London Railway Company, and Guest's Estates, Limited; Great Northern and Strand Railway, Borough Councils of Westminster and Holborn; King's-road Railway (Putney Extension)—Westminster Borough Council, Conservators of the Rivers Thames and Metropolitan District Railway Company; London United Electric Railways—Mercers' Company, President, etc., of St. George's Hospital, Duke of Wellington, Earl of Ilchester, Earl of Longford, Lord Kensington, Sir Owen Slacke, Sir W. Phillimore, Gerard A. Lowther, the Metropolitan, Great Western, Central London, London and South-Western, Great Western, London and North-Western, South-Eastern and Chatham Railway Companies, and others; North-East London Railway (No. 2)—Dean and Chapter of St. Paul's, Tallow Chandlers' and Ironmongers' Companies, Ecclesiastical Commissioners, London County Council, Great Eastern, Great Northern, Great Western, Metropolitan, South-Eastern and Chatham, and Central London Railway Companies, City of London Corporation, Middlesex County Council, and others; Piccadilly and City Railway (No. 2)—Duke of Wellington, Earl of Ilchester, Earl of Longford, Lord Kensington, Sir W. Phillimore, President, etc., of St. George's Hospital, Mercers' Company, Metropolitan, Central London, Great Western, London and North-Western Railway Companies, Thames Conservators, Cavalry Club, London County Council, Borough Councils of Kensington, Lambeth, and Westminster. In the House of Commons on Feb. 18 the Newcastle-on-Tyne Electric Supply and the Scarborough Tramways Bills were read a second time.

Village Lighting.—The village of Fladbury is situated between Evesham and Pershore. From Evesham to Fladbury Mill is a pleasant and popular river excursion, says the writer of a very interesting article in the *Birmingham Daily Post*, from which we quote the following: "Its antiquarian interest is not to be despised, for local tradition has it that there was a mill at Fladbury in the time of Harold the Saxon. Where formerly a creaking wheel turned laboriously, groaning as if in protest against its ceaseless round, two modern water-turbines have been laid down, and furnish not only the mill with power but drive a dynamo which supplies Fladbury with electric light. Leaving the station on a dark winter's night it is surprising to find the village street brilliantly lighted with electricity, and to note that even the little shops and the cottagers' humble abodes can boast of the incandescent lamps. The credit of the enterprise belongs to a few of the principal residents. A little more than two years ago the consent of the Pershore District Council having been obtained, they formed the Fladbury Electric Lighting and Power Company, Limited, with a capital of £2,000, but only about £900 has been subscribed, a sum which has been found sufficient to put down the plant necessary to meet the immediate requirements of the village. Tenders for the installation were invited, and that of Messrs. Young and Co., of Birmingham, for £860, was accepted. The contract was taken in hand towards the end of 1899, and by the middle of the following February Fladbury had its electric light, and save for about 48 hours at the end of 1900, when the floods rose in the Avon Valley to a phenomenal height, the village has been electrically lighted each evening and during early morning in winter. The floods of December, 1900, were higher than any registered for nearly a century, so that little apprehension is felt of the village being compelled to resort again to lamps and candles. Danger of a failure of supply could, of course, be greatly minimised by the introduction of accumulators, but the company cannot see their way clear, at any rate, at present, to indulge in this extra. The turbines are two water-engines capable of supplying much greater power than is needed for the village. They consist of two double horizontal 40in. British Empire turbines in self-contained cases, with vertical gates and gate-boxes built into a bulkhead wall. They are actuated by a fall of about 7ft. of water, and are capable, under ordinary conditions, of developing 20 h.p. each, whilst it is stated that they have worked fairly satisfactorily in flood times with only a fall of about 2ft. of water. The ends of the vertical turbine shafts are fitted with cast-iron mortised bevelled wheels, with hardwood cogs geared to pinions on a horizontal steel shaft, which pierces the mill wall, so that the power produced can be used by means of belting either for grinding the corn in the mill or for driving the dynamo. The turbines can be worked independently if necessary, and can be driven at varying speed as required. A single dynamo is at present employed, with a two-wire system, but a space has been left for a second dynamo in the dynamo-room, which is built on steel girders immediately above the turbines, and well out of reach of floods. The dynamo is constructed to give a normal output of 80 amperes at 220-250 volts and over, compounded to allow for a drop in voltage in the mains at full load. The mains, which are buried directly in the ground, are lead-covered and double-steel armoured, and, although they have been laid down for over two years, are still answering their purpose admirably. The total distance from the station to the farthest lamp is 630 yards, but the centre of distribution is about 450 yards from the generating station. Fladbury is a village of only 425 inhabitants, but there are seven lamps in the main street—two where the road branches of 30 c.p. each, and the other five of 16 c.p. For supplying the electricity for these lamps the company receive a yearly rent of £7 from the Parish Council, not an exorbitant amount. Electricity is supplied at a very reasonable rate. The original clients had their light laid on free of cost to themselves, and only pay a rent of 10s a lamp per year. The light is only supplied during certain hours—namely, from an hour before sunset until 11 o'clock, and from half-past six in the winter mornings until daylight. This is sufficiently long for all practical purposes in a place where most of the good folk are probably in bed before the light goes out. Should any of the residents require their light after 11 at night, they can secure the continuance of the current at the cost of 1s. an hour by giving notice to the company. On such occasions that resident indirectly confers a benefit on his fellows, for the latter can if they wish turn on their lights, the meter system not being in vogue. The working expenses of the little company are not very great, being only about £70 a year. So smoothly and well do the turbines and dynamo work that only one man is required to tend them. They supply light to about 280 lamps at a steady pressure of 220 volts at the centre of distribution, but if necessary the number can be increased to 320 lamps. When the demands of the village exceed that number the company will have to consider the advisability of putting down a second dynamo. The returns from rents are about £120 a year, and, though they have as yet paid no dividend, the directors hope that in time they will be able to make their installation a profit-earning concern, especially as new clients are now charged a little more per light than the original ones. In the meantime, however, the promoters, apart from the convenience which they themselves experience in having their own residences well lighted, have the satisfaction of knowing that they have conferred a boon on the village. It may seem a little incongruous for an old half-timbered cottage, dating back for some hundreds of years, to be lighted with incandescent electric lamps, but one has only to pay a visit to Fladbury at night to appreciate the innovation. There is no doubt that the enterprise is greatly valued. It is one that might well be copied by some of the residents in other Avonside villages, where the power is to be had for the asking. The time may yet come when the river will supply the power, or part of it, for the electric illumination of all the villages and towns along its course."

PROVISIONAL PATENTS, 1902.

FEB. 10.

3279. Improvements in conduits for electric cables and the like. Joseph Place and Sons, Limited, and William Henry Place, Commercial-street, Halifax.

3299. Improvements in brackets, pendants, and like fittings for gas and electrical illumination. Edmund Townshend, 11, Burlington-chambers, New-street, Birmingham.

3336. Improvements in electrical resistances. Robert Hopfelt, 53, Chancery-lane, London.

3350. Improvements in telephone clips. Charles William Wroe Oakes, Vaughan-road, Harrow.

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3374. An improved protective operating device for electric motors. James Yate Johnson, 47, Lincoln's-inn-fields, London. (The Electric Controller and Supply Company, United States.) (Complete specification.)

FEB. 11.

3390. Shallow conduit for electrical tramways and railroads. John Edward Parker, 107, Fearnlea-road, Balham, London.

3392. An electric lamp suspender adjusting device. Bernard Thomas Septimus Bagnall, 15, Water-street, Liverpool.

3411. Improvements in and relating to guards for electric tramcars and the like. Barry, Henry, and Co., Limited, and Robert Bowman Davidson, 96, Buchanan-street, Glasgow.

3416. Improvements in switches for electric light circuits and the like. James Jones and James Jones, jun., 33, Chancery-lane, London. (Complete specification.)

3428. Improvements in electric lamps and lamp-holders. Philip Johnstone Spencer Tiddeman, 70, Deansgate, Manchester.

3490. Improvements in lightning dischargers for electrical installations. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

3491. Improved brush-holder for electrical apparatus. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

3497. Improvements in machinery for generating electricity. Gordon Earl-Adams, 29, Lincoln's-inn-fields, London.

3533. Improvements in winding and circuit-closing devices for electrically wound clocks. Charles Madison Crook, 18, Buckingham-street, Strand, London. (Complete specification.)

FEB. 12.

3553. Improved adjustment for the telephone transmitter and combined receiver. Methuselah Brooks, Bridge End, Whalley, Lancs.

3556. An improved method of and electrical apparatus for fog signalling on railways. Humphrey Forster Clough, 11, Burlington-chambers, New-street, Birmingham.

3603. Improvements in means for conducting electricity from overhead cables to trams and other motors. George Henry Russell, Fife House, Kingston-on-Thames.

3608. Improved manufacture of strands for telegraph and telephone cables. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

3609. An improvement in governors for regulating speed, electricity, gas supply, and like apparatus. Charles Antoine Vigreux and Lucien Victor Brillie, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

3610. Improvement in electrically-propelled vehicles for single-rail elevated railways. Fritz Bernard Behr, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3617. Improvements in and relating to combined electrical piano playing and recording attachment. George Howlett Davis, 77, Chancery-lane, London. (Complete specification.)

3622. An improved device for cleaning and polishing electrical collectors. Wilhelm Kuppers, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3624. Method for perfecting the fabrication of electric sparking candle. Charles Edward Osborn and the British Motor Traction Company, Limited, Broad-street House, London.

3629. Improvements in electric arc lamps. Luis Wirtz, 4, South-street, Finsbury, London.

3631. Combined portable table stand and wall bracket for electric light. Lewis Alexander Richard Wallace, 53, Chancery-lane, London.

3647. Improvements in or connected with open-slot electric traction systems. John Charles Jackson, Norfolk House, Norfolk-street, Strand, London.

3652. An improvement in or relating to current collectors of tramway and railway cars run on the overhead system. Patrick Robertson Monro and Joseph Matthews Bowman, 70, Chancery-lane, London.

3657. Improvements relating to insulated electrical conductors. James Fulton Cummings, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3658. Improvements in and relating to the fixing and carrying of electric cables, wires, and such like connections. Arthur Ford-Lloyd and Charles Stirling, 11, Great Coram-street, Russell-square, London.

FEB. 13.

3704. Improvements in shade carriers for electric incandescent lamp shades. Albert Edward Kearsley and Thomas Sparrow, Albert-road, St. Annes-on-the-Sea.

3748. Improvements in alternate-current distribution. William Morris Mordey, 46, Lincoln's-inn-fields, London.

3737. Improvements in electrical and magnetic apparatus, such as transformers, dynamos, and other appliances, and alloys for use therein. Robert Abbott Hadfield, 46, Lincoln's-inn-fields, London.

3746. Improvements in and connected with electric ignition devices for internal-combustion engines. Arthur Freemore Spooner, 323, High Holborn, London. (Jules Guenet, France.)

3751. Improvements in and relating to electric arc projecting lanterns. Frederick Henry Loring, 18, Southampton-buildings, Chancery-lane, London.

FEB. 14.

3788. A point-shifting appliance for electric tramways fitted with overhead equipment. Patrick Graham, 6, Bronze-street, Rochdale-road, Manchester.

3811. Improvements in electrical signalling apparatus for railways William John Mildon, 9, Regent-street, London. (Complete specification.)

3819. Improvements in and relating to storage batteries. Job Thomas Niblett, 139, Queen Victoria-street, London.

3858. A new or improved method and means for reflecting, increasing, and intensifying light from electric and other lamps or the like. Richard Holmes Hammond and Julia Taylor, 165, Queen Victoria-street, London.

3859. Improvements in and relating to electric switches, switch-bases, and means for connecting the circuits to be controlled with the same. Leo Sunderland, 322, High Holborn, London.

FEB. 15.

3894. Improvements connected with the use of electric glow lamps for occasional illumination. Frederick Brown, 11, Burlington-chambers, New-street, Birmingham.

3907. Improved means of supplying energy to electric tramcars. Alexander Montague Davis and Matthew George Waggott, 36, Temple-street, Birmingham.

3912. Improvements in electric furnaces. Paul Louis Toussaint Héroult, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

3913. Improvements in coherers for wireless telegraphy. John Horace Reeves, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

3921. Improvements in elevated electric railways and trains. Arthur Petzenbürger, 15, Took's-court, Cursitor-street, Chancery-lane, London.

3932. Improvements in dynamo-electric machines and motors. Henry Francis Joel, sen., 1, Queen Victoria-street, London.

3938. Improvements in and relating to the storage and distribution of electricity by means of accumulators. Carl Wrede and Hermann Jungbluth, 72, Cannon-street, London.

3942. Improvements in or connected with casings for electric conductors. Henri Beau, 70, Chancery-lane, London.

3953. Improvements relating to telegraphic and telephonic apparatus. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Aktieselskabet "Progress," Norway.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published March 6.

1900.

22508. Electrical resistance switch. Cusworth

1901.

3030. Method of, and means for, holding and securing the wires of telephone receivers and the like. Bell and Byng.

3234. Electric ignition devices for explosion engines. Maybach.

3291. Anti-vibration base-frame for explosion and other motors, dynamos, and other mechanism, appliances, or apparatus. Middleton.

3481. Apparatus for wireless telegraphy. Fleming and Marconi's Wireless Telegraph Company, Limited.

4777. Electric switch mechanism for surface-contact electric railways and the like. Barker. (Murphy Safety Third-Rail Electric Company.)

4822. Arc lamps. Scott.

5039. Preparation of Nernst conductors for electric lamps. Garrard and Nernst Electric Light, Limited.

7368. Means for connecting electric wires and cables. Wilkes.

8956. Construction of dynamo-electric machines and electromotors. Rees.

15391. Carbon brushes for electric generators or motors. Parsons.

19702. Electrical switches. Gibbings.

21715. Electricity meters. White.

24628. Lanterns for electric incandescent lamps. Fleming.

25174. Electric apparatus for illuminating the mouth or throat. Schumacher.

25427. Supports for trolley and track wires for suspended cable roads. Henry McLellan Harding.

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26380. Telegraph and like poles. Crossland.

26472. Single-phase alternating-current motors. Burke.

26678. Electro-mechanical controlling mechanism for looms for weaving. Edwards.

26695. Dynamo-electric machines. British Thomson-Houston Company, Limited. (Geisenhoner.)

26731. Controlling attachments for the trolley poles of electric tramways. Barry.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	Feb. 8	566	528	+ 38	26,924	24,819
Birmingham Tramways	—	—	—	—	—	—
Blackburn Corporation	,, 14	517	534	− 17	3,877	3,393
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 15	138	136	+ 2	1,021	950
Bolton Corporation	,, 2	1,360	1,242	+ 118	7,465	6,654
Bradford Corporation	,, 16	2,260	771	+ 1,489	9,731	5,121
Bristol Tramways Company	,, 14	3,680	3,374	+ 305	—	—
Carlisle Tramways Company	,, 15	105	91	+ 14	803	722
Central London Railway	,, 15	6,732	6,131	+ 601	46,145	42,838
City and South London Railway	,, 16	3,144	2,047	+ 1,097	21,312	14,084
Cork E. T. and L. Company	,, 13	295	328	− 33	2,148	2,171
Darwen Corporation	,, 14	150	154	− 4	1,096	1,007
Darwen-Hoddlesden	,, 14	22	—	—	—	—
Dover Corporation	,, 15	149	131	+ 18	1,123	1,058
Dublin & Lucan Electric Railway	,, 16	86	72	+ 14	586	495
Dublin U. T., electric cars	,, 14	3,016	3,102	− 114	—	—
Dublin S. District, Electric	,, 14	609	672	− 63	—	—
Dundee Tramways Company	,, 12	635	439	+ 196	—	—
Glasgow Corporation	,, 15	9,854	7,800	+ 2,054	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 15	1,551	1,428	+ 123	77,658	63,747
Liverpool Corporation	,, 8	8,167	7,537	+ 630	52 ,820	46,867
Liverpool Overhead Railway	,, 16	1,118	1,208	− 90	9,446	10,337
Newcastle-on-Tyne Corporation	,, 15	1,562	—	—	—	—
Portsmouth Corporation	,, 15	918	—	+ 425	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 16	3,522	—	—	—	—
Southampton Corporation	,, 13	717	531	+ 185	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £153 decrease.
Barcelona Ensanche y Gracia, £5 decrease. Barcelona, £331 increase.
Brisbane, £259 increase (month of Jan., £28 increase).
Buenos Ayres and Belgrano Electric, £308 increase.
Calcutta, £20 decrease.
Cape Town (month of Jan.), receipts, £17,064; expenditure, £6,802.
La Capital Traction and Electric, Buenos Ayres (month of Dec.), £1,394 increase.
Mexico Electric (month of Jan.), receipts, £17,000; expenditure, £10,600.
Perth Electric, £132 increase.
Port Elizabeth (month of Jan.), receipts, £3,898; expenditure, £1,898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Tramways.—	£	£
Anglo-Argentine, 1-260,007	5 ..	4¼-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	124-127
Blackpool and Fleetwood Tramroad	10 ..	12½-13½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2⅜-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4⅜-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6¾-7¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9⅛-9⅜
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	14-15
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12¼-12⅜ xd
—— 5 per cent. Perpetual Debenture Stock	100 ..	126-129
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅜-2
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5⅛-5⅜
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5⅛
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11-12 xd
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14½-15½ xd
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¾-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	102-104
New General Traction, Ordinary	5 ..	2⅜-3⅛
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10¾
—— 5 per cent. Cum. Pref.	10 ..	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	98-101
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11 xd
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	10s. ..	½
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	50 p.c. ..	50 p.c.
Commercial and Industrial.—		
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅜-½ xd
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅛-⅜
—— Ordinary, 1-125,000	1 ..	⅛-⅜
British Insulated Wire, Ord., 1-70,000	5 ..	9¼-10¼
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5⅜-6¼
—— 5 per cent. Mortgage Debentures	100 ..	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5¼-6
Brush Electrical Engineering, Ordinary	2 ..	1⅜-1⅝
—— Nos. 90,001-105,731	2 ..	1⅜-1⅝
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	97-100
Callender's Cable, Debentures	100 ..	111-115
—— Ordinary	5 ..	16¼-17½
—— 5 per cent. Pref.	5 ..	5¼-6
Crompton and Co.	3 ..	3-3¼
—— 5 per cent. Debentures	— ..	99-104 p.c.
Edison and Swan United, Ordinary	3 ..	⅛-⅜
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	78-83
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	83-88
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1½-2
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9⅜-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	17½-18½
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	112-116
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15¼-16½
Telegraph Construction and Maintenance	12 ..	37-40
—— 5 per cent. Bonds	100 ..	102-104
Telegraph Manufacturing, Ordinary	5 ..	10¼-11½
—— 5 per cent. Cum. Pref.	5 ..	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	9¼-10½
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6⅜
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	100-105
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9¼-10¼ xd
—— Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	9⅛-9⅜
—— 7 per cent. Preference	5 ..	9-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	8-9
—— Nos. 20,001-30,000	5 ..	7½-8¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10¾ xd
Charing Cross and Strand	5 ..	8¼-9½
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜ xd
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	103-105
Chelsea Electricity Supply	5 ..	5-5¼ xd
—— 40,501-50,936	5 ..	4⅜-5¼
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	9¼-10¼
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	106-109
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6-6¼
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-6
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1⅛-1⅜
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	95-100
Metropolitan, Ordinary	10 ..	15¼-16¼
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1⅛-1⅜
—— £5 Shares	5 ..	7⅛-8
—— £4½ Shares, New	4½ ..	6¾-7⅛
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	98-101 xd
River Plate Electric Light and Traction, Deb.	100 ..	60-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1⅛-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-2½
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15-16 xd
—— 7 per cent. Pref.	5 ..	8-9 xd
—— 3½ per cent. Deb.	100 ..	98-101
Westminster, Ordinary	5 ..	12-13
Electric Railways.—		
Central London, Ordinary	100 ..	104-107 xd
—— 4 per cent. Pref.	100 ..	104-107 xd
—— ,, deferred	100 ..	102-105 xd
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-118
City and South London, Consolidated Ordinary	100 ..	65-68
—— Ordinary	10 ..	—
—— Nos. 60,001-70,000	10 ..	—
—— 4 per cent. Debenture Stock	100 ..	112-116
—— 5 per cent. Pref. Stock '91	100 ..	127-132
—— ,, ,, '96	100 ..	122-126
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-9 4
Telephones.—		
National Telephone, Ordinary	5 ..	—
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4⅜-5
—— 4 per cent. Deb. Stock, Red.	100 ..	93-96
—— 3½ per cent. Deb. Stock, Red.	100 ..	101-105
Oriental Telephone and Electric Company	1 ..	⅞-1

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NOTES.

Sludge-Hole Packing.—The verdict of a Board of Trade enquiry recently held at Sunderland into an explosion on a steamship, which resulted in two firemen being scalded to death, has just been issued. The verdict was that the accident had been caused by the blowing out of some round packing used to make a joint for the sludge-hole door of the boiler. Three-quarter inch round packing had been used for the joint where flat packing ought to have been employed. As it is not an uncommon thing for this to be done, the Court stated that they would blame superintendent engineers in future if similar accidents occurred.

Melbourne University.—We learn that electrical engineering is shortly to be included in the course of study at the Melbourne University. This is a result of the deliberations of a committee of enquiry of the university council, set up with a view to introducing fresh courses of study, and the initiation of a course of electrical engineering at Melbourne is to be commenced next month, subject to the consent of the senate to the proposal. The curriculum adopted by the council of the university comprises a four years' course of study with a sound training in engineering, followed by two years' "specialisation" in electrical engineering.

Telephones on Railways.—The use of telephones as means of communication between signal cabins instead of single-needle instruments is obtaining great favour on many lines in this country, although, we believe, in few cases does it entirely replace the same. We gather that the Illinois Central Railway in the United States is now experimenting with a telephone as the sole means of train dispatching, and that it finds the same advantageous in that fewer mistakes are made than with the telegraph. What seems to be wanted for this work is some form of recording instrument which would give written messages to the various signal stations.

Municipal and County Engineers.—We have to acknowledge the receipt of vol. xxvii. of the *Proceedings* of this association, together with volume of proceedings of Section 7 of the International Engineering Congress held at Glasgow in September, 1901. It contains a very large number of diagrams and designs, and is edited by the secretary of the association, Mr. Thomas Cole, A.M.I.C.E. Messrs. E. and F. N. Spon, Limited, are the publishers in London, and Messrs. Spon and Chamberlain in New York. We note that the council offer annually two premiums of £10 and £5 respectively for the two best papers contained in the volume of *Proceedings*.

Electrolysis of Gas and Water Pipes.—Messrs. Larsen and Faber have recently been making some measurements in Copenhagen with regard to the electrolysis of gas and water mains by tramway return currents. On the line which was tested, and which had a length of about 1,310 yards, with the rail joints in good condition, the stray current for cars in the centre of the line was found to be about 10 per cent., and for cars at the terminal of the line about 15 per cent. of the supply current. The sum of the currents passing through gas and water pipes was in both cases about one-half the total stray currents. The total stray currents, as well as the currents in the pipes, were proportional to the supply current.

Wireless Telegraphy in Canada.—A Reuter's message received in London yesterday states that the agreement between Mr. Marconi and the Canadian Government was laid on the table in the Dominion House of Commons on Wednesday. It provides that the Government shall grant a sum of 80,000dol., that a wireless telegraphy station shall be erected at Cape Breton, and that the company which is to work the new system shall transmit messages at a maximum rate of 10 cents per word for commercial messages and of 5 cents for Press messages. The Government is also to have the use of the system for coast signalling. If Lloyd's declines to agree to this use of the system, then the grant is to be reduced to 50,000dol.

Electrolytic Works in Italy.—A company with a capital of about £44,000 has just been formed at Milan for the electrolytic manufacture of caustic soda and of calcium chloride. These two products have up to the present been imported into Italy. The works of the new company will be situated at Varallo, where some 600 h.p. will be obtained from the River Sesia. The company expect with 350 working days of 24 hours to produce some 2,359 tons of calcium chloride solution and 2,880 tons of caustic soda solution. This will require about 1,806 tons of sodium chloride and 1,216 tons of quicklime. The estimate of the income and cost show an annual profit of 14 per cent. We are not told if the water power is subject to an annual rental.

Wireless Telegraphy on the Baltic.—At Kiel last week trials were commenced with two systems of wireless telegraphy. One—that of Profs. Slaby and Arco—has been bought by the Allgemeine Electricitäts-Gesellschaft; the other—the Braun system—by Siemens and Halske. The trials are being attended by representatives of the Naval Department, the Post Office, the War Office, and of the steamship companies. It will depend on the result of these experiments which of the two firms will get the order for the erection of stations for wireless telegraphy along the German coast. It is stated that the German Government is preparing a Bill to regulate the service of wireless telegraphy, which, presumably, will come under State control in the same way as it does in this country.

Lord Rayleigh's Lectures.—The second lecture of a course of six at the Royal Institution on "Some Electrical Developments" was delivered by Lord Rayleigh on Saturday afternoon last. A number of interesting alternate-current experiments were performed, and the effects of these were made clear to the audience by means of sensitive flames acted on by telephones. Lord Rayleigh incidentally referred in his lecture to the advantage of working with simple home-made apparatus, as he termed it, of the sealing-wax and match-box order. The lecture concluded by experiments on high-voltage discharges through gases, and Lord Rayleigh suggested that some such method might be used for the production of artificial nitrates. It will be remembered that Sir Wm. Crookes devoted a large proportion of his presidential address before the British Association at Bristol to this interesting problem, the solution of which would make us more independent of the nitrate deposits of South America.

Tunbridge Wells Telephones. It is encouraging to know that the municipal telephone system at Tunbridge Wells has the full support of such a strong and representative body as the tradesmen's association of that town. A discussion on the recent telephone enquiry regarding an application by the Corporation for more money to extend the system was introduced at the usual monthly meeting of this association last week. The enquiry, it may be remembered, was held by the officials of the Local Government Board at rather short notice, and thus the responsibility of deciding whether or no the association should support the Corporation at the enquiry devolved on the committee. Acting on an old resolution passed by the

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association some months ago, the committee readily agreed on the invitation of the town clerk to send a communication expressing the opinion that the municipal telephone scheme should go through, and this was done. We are pleased to see that this action of the committee has now been unanimously endorsed by the association, and this endorsement will be in ample time to come before the inspector at the adjourned enquiry.

Wireless Telegraphy in Africa.—It is announced that the Marconi Wireless Telegraphy Company have undertaken to instal the Marconi apparatus at certain places in the Congo Free State. The district particularly in view at the present time is that around the Upper Congo River, and the first installations will be made at Banana, the post of the north side of the Congo estuary, and St Paul de Loanda, in Portuguese West Africa. It is intended later to connect up Boma, the capital of the Congo State, with Banana in the same way. The apparatus for the first two places mentioned is now on its way to Congo Free State on board the Belgian liner "Albertville." It is said that the intended exploitation of wireless telegraphy in this part of Africa is the result of the success achieved in the experiments which have been going on between Frinton (near Walton-on-the-Naze), in Essex, and Withernsea with the Marconi system. The distance between these two stations is 158 miles, 85 over land and 73 over sea. Banana and St. Paul de Loanda in Africa are two similarly separated points, and are, therefore, expected to give equally satisfactory results with wireless communication.

Mr. Marconi's Statement.—In the report of the ordinary general meeting of the shareholders of the Marconi Wireless Telegraph Company, which appeared in our last week's issue, will be found a fighting speech of Mr. Marconi in replying to his critics. In it he alludes to what he calls the hostile attitude of the English electrical Press towards his system. We disclaim any such hostile attitude, as we have always wished the system success. Any hostility we have had to express has been directed against the commercial management of the company. This management has boomed wireless telegraphy in the daily Press to an extravagant extent, and in a way which has been, and is, misleading to the general public. At the same time all information which would enable the electrical Press to give an opinion on progress made has been withheld. It will be interesting to see, as promised, a successful Transatlantic system at work on the Marconi system, and it will be of commercial value if the secrecy promised by Mr. Marconi is obtained. From what we remember of previous experiments with syntonic wireless telegraphy, it does not follow that, in spite of this secrecy, the working of the system may not be seriously interfered with by other systems of etheric waves transmitted from apparatus which do not give a definite period.

The Post Office Telephones.—On Monday last the Post Office telephone service was commenced in London without any inaugural ceremony. We understand that Mr. J. Gavey, the assistant engineer-in-chief and electrician to the Post Office, was at Carter-lane with a few of his colleagues when the main switch throwing the central battery into operation were closed. In spite of this, no one is allowed to say who closed the switch, or which subscriber had the honour of recording a penny call against himself. Only between 100 and 200 subscribers were on Monday connected up to the Carter-lane exchange, and they were able to obtain connection to any subscribers on the following exchanges of the National Telephone Company: "Holborn," "Gerrard," "King's Cross," "Avenue," "Westminster," "Bank," "London-wall," "Hop," and "Kensington." They also had the use of trunk wires to various parts of the kingdom, and to the Continent as far as Paris. We understand that each subscriber has been presented with the National Telephone Company's directory, but it remains to be seen how the National Telephone Company's subscribers will be informed of the numbers of the subscribers to the Post Office system. We have already described the central exchange at Carter-lane and the instruments in use. There is no doubt that subscribers to this system will soon become accustomed to the greater ease in obtaining connections, and will learn not to miss the ring-up and ring-off signals. We trust, at any rate, that the reply of the operators will be so prompt that the outlet to one's feelings which many turns of the magnetos of the National Company gives will not be required.

Municipal Electrical Association.—At the special general meeting of the above association held at Westminster Palace Hotel on Friday last, the following resolutions were passed. The president, Mr. J. H. Rider, was in the chair, and there were about 80 members present. "(1) With reference to the resolution passed by this association at the Glasgow convention, 1901, authorising the council to approach the President of the Local Government Board and the Secretary of State for Scotland, with the object of obtaining leave to suspend the operation of sinking fund during the first three years of the loan, and to take such further steps as may be necessary to accomplish this object, this meeting approves the action of the council in approaching the Borough Treasurers' Association in order to ensure their co-operation, and unanimously agrees that the operation of sinking fund should be suspended for three years from the date of loan without, however, increasing the period allowed for repayment, and that this suspension should apply also to moneys borrowed for the purpose of extensions from time to time." Carried unanimously. "(2) That in the opinion of this association, electricity supply undertakings having to be maintained in a thorough state of efficiency out of revenue, no depreciation or further writing off of capital is necessary when the period allowed for repayment of loans is not greater than 30 years, as the equated life of the plant exceeds this period." Carried, with three dissentients. "(3) That with regard to the formation of a reserve fund, this association is strongly of the opinion that such should be formed, up to the limit allowed by the provisional order, before any contribution is made in relief of the rates." Carried unanimously. While there are some instances in which exception may be taken as to the second resolution, the objections so raised are met if due regard is paid to the third resolution.

Royal Institution.—The Duke of Northumberland presided last Friday at the lecture of Mr. W. Duddell on "Musical and Talking Electric Arcs." Mr. Duddell divided his subject into the talking and the musical arc, and showed how an alternating current of high frequency can be obtained by the combination of self-induction coils and paper condensers with an ordinary direct-current arc lamp. Having shown by means of a tuning-fork how the smallest variation in the oscillations of the arc is accompanied by a variation in tone corresponding to the same variation in light, and having explained that the success of these operations depends upon the minuteness of these variations, he connected an arc lamp first with a microphone and then with a telephone circuit. Talking through the former could not be well heard in the room. A subsequent whistling performance was, however, perfectly audible, the sound emanating from the arc which was placed on the table, while the microphone was some distance away in the

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gallery. For the talking arc experiment four arc lamps were connected in series, which greatly increased the volume of the sound. By varying the number of active turns in induction coils in series with the arcs, a gamut of two octaves was obtained, upon which Miss Duddell performed "Comin' Thro' the Rye," to the great delectation of the audience. With additional condensers and more induction coils a very low note was obtained. Some Tesla discharge experiments with very high voltages were shown, and also Preece's experiment of lighting a lamp at a distance without wires. The lecturer showed how a certain arc lamp could be made to respond only to a certain note; thus, in the case of wireless telegraphy, enabling the operator by means of this synchronising to connect with different stations which would not be interfered with by other signals. In conclusion, he thanked the City and Guilds Institute for the great assistance which they had given him in his experiments, and for lending him the exhibits which he had used during the evening.

Institution of Mechanical Engineers. — The annual report of the council of the above institution was presented to the members at the general meeting held last Friday, and unanimously adopted. The report showed a very gratifying progress in the work of the institution during the past year, and a large increase in the membership roll. Thus, at the end of 1901 the number of members of the institution of all classes was 3,491, as compared with 3,165 at the end of the previous year—a net gain of 326. The new names added to the list in the 12 months under review were 426, there being a total of 100 deductions, made up of 36 deceases during 1900, 40 resignations (which took effect on Jan. 1, 1901), and 24 removals. The announcement was made in the first part of the report that, in recognition of his distinguished services to science, Lord Kelvin, who acted as president of the International Engineering Congress in Glasgow, has been elected an honorary life member of the institution. Another interesting announcement was that the papers, together with reports of the discussions, read before the Mechanical Section of the Glasgow Congress will be published as a special part of the *Proceedings* of the Institution, and that members of other sections of the congress will be allowed to purchase copies. The attendance at the graduates' monthly meetings and monthly visits to works during the session has been of a satisfactory character. The council have awarded a first prize to Mr. W. H. Tregoning for his paper on "Tinplate Manufacture," which will be published in the *Proceedings*, and two second prizes to Messrs. H. H. Johnson and A. Marsden for their papers on "Gold Extraction from Free Milling Ore" and "Motorcar Transmission Mechanism" respectively. Another matter of importance mentioned in the report is that the council have joined with the councils of the Institution of Civil Engineers, the Iron and Steel Institute, and the Institution of Naval Architects in forming a committee to be called "the Engineering Standards Committee," for the purpose of recommending standard sizes for rolled sections, and other matters. The summer meeting of the institution this year will be held in Newcastle-on-Tyne.

Internal Resistance of Batteries.—The ascertaining of the true internal resistance of primary cells has occupied the attention of scientists for the last 50 years. The difficulty of obtaining accurate results which are not influenced by making the method of testing, is evidenced by the discrepancy between the conclusions of various experts. Mr. C. H. Ayres, jun., contributes to the *Physical Review* of January an article on a new method of measuring this internal resistance, using alternating currents. In his introductory remarks he reviews the results of other experimenters who also used alternating currents, and who found that the variations in the internal resistance were considerably less than when ascertained by means of steady currents. For instance, Prof. Kohlrausch found a value for the internal resistance which remained practically constant, while the value of the alternating current sent through was varied within wide limits. The author uses a modification of Kohlrausch's method, working with a metre bridge, and using a telephone as the indicator balance. He then inserts two condensers, one in the arm of the bridge containing the cell, and the other in the variable resistance arm. Under ordinary conditions, the cell would be prevented from sending any current by the condenser in series with it. When, therefore, it is desired to measure the resistance while the cell is sending current, it is necessary to shunt the same with a known resistance having no self-induction. With the arrangement as described, silence is obtained when

$$\frac{r_i}{r_2} = \frac{a}{b} = \frac{C_2}{C_1},$$

where r_i equals the internal resistance of the cell, r_2 the variable resistance; a and b are the lengths of each side of the metre wire from the slider, and C_1 and C_2 are the capacity of the two condensers. The author uses mica condensers of about 30 microfarads each. The operation in ascertaining the above conditions of silence was as follows: first, the slider was moved along the bridge wire until minimum noise in the telephone was heard; r_2 was then varied to improve the minimum, and then the slider again moved until silence was obtained. The author uses a small induction coil to give the alternating current. The full details of the apparatus are described in the article in question, in which also the theory of the arrangement is gone into. The results obtained on three different types of primary batteries with widely different values of internal resistance showed that this resistance was for each cell the same whether that cell was in open or closed circuit. It is, however, to be noted that the condition of the cell depends upon its previous history, amongst other things, upon any prolonged current that may have been flowing in so far as this actually alters the cells. The experiments show that the resistance of a cell is not a function of the current strength at the time, a result which is contrary to the conclusions of most other observers.

A New Coherer (?)—The Paris correspondent of the *Daily Telegraph* quotes Mr. E. Gautier to the effect that Prof. Edouard Branly has just patented a new "radio-conductor" or coherer for wireless telegraphy, which is a great improvement on the similar instrument bearing his name, which consists of metallic filings in a tube. "Prof. Branly has now discovered that by placing in contact two pieces of metal—steel, aluminium, silver, nickel, copper, zinc, etc.—one of which has been oxidised, a combination is obtained possessing exactly the same properties as the tube of filings, but in a higher degree. The new instrument consists of a plate of steel, for example, connected with one terminal of an electric circuit, and placed in contact with the oxidised extremities of a tripod of the same metal, which communicate with the other terminal. The superiority of the apparatus over the tube of filings is said to lie in the fact that after it has been rendered conducting by the Hertzian wave it is convertible into a non-conductor again by a shock much slighter and of far shorter duration than that required for the same purpose in the case of the instrument hitherto used. The new coherer will, it is said, accordingly permit of an immense increase of speed in wireless telegraphy, which, it is said, will thus be rendered as rapid as the ordinary telegraph by wires. Prof. Branly is stated to be receiving

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active support from the French Government in particular as regards two big undertakings projected by him. These are the establishment of a continuous system of wireless telegraph stations all round the French coast, and, secondly, the installation of a line of similar permanent posts from Southern Tunisia to the Lake Tshad, *vid* Ghadames and Ghat." We are always pleased to hear of experiments on a commercial scale in wireless telegraphy, but think that the above claims for novelty are rather late. On Jan. 21, 1898, Dr. Oliver Lodge read a paper before the Physical Society on "Electric Signalling without Connecting Wires," in which the following statement on coherers was made (*Electrical Engineer*, vol. xxi., p. 148): "The sensitiveness of a coherer depends upon the number of loose contacts; it is a maximum for a single contact—*i.e.*, for a needle point lightly touching a steel spring. With this sensitive coherer hardly any 'tapping back' is required for decoherence, but it wants delicate treatment when properly adjusted, and the greatest current through it should not approach a milliampere." In the discussion which followed Prof. Threlfall agreed with Dr. Lodge on the advisability of reducing the number of contact points in a coherer. In the face of the above publication, the patenting of a single-contact coherer would seem to be somewhat late.

Balloons in Wartime.—A very interesting paper on "The Use of Balloons in War," was read before the Society of Arts last week by Mr. Eric H. Stuart Bruce. After some prefatory remarks as to the earlier use of balloons in wartime, the author turned his attention to the material out of which the balloon should be constructed. For this purpose he favoured goldbeaters' skin. The reduction in the size of the war balloons was a very important matter. By the use of goldbeaters' skin, not only was the size of the balloon reduced, but also the weight of the equipment, when cylinders of compressed gas were taken out to the field of operations, for filling the balloons. At first sight the material might seem too fragile, but the desideratum of strength was obtained by combining layers on layers of the substance to any desired thickness. The author then gave an example of the extreme value of balloons in war, taking the siege of Ladysmith for an illustration. From its elevated position the captive balloon used at that time could locate the Boer guns, and by dispatching telephonic messages to earth ensure the accuracy of the artillery fire from the British force. The translucent South African atmosphere peculiarly lent itself to balloon observations; thus, in manœuvres in England the range of a balloon's effective vision at a height of 1,000ft. was not more than seven or eight miles, whereas in South Africa it was 10 or 12 miles. Mr. Bruce next related how some few years ago he applied electric flash signalling to a captive balloon so that the operator might remain on the ground. In this system which is too well known to call for a detailed description here since the weight of the car and operator was abolished, the balloon could be of such a size as to be portable, quickly inflated, and easily manipulated. A specially portable form of signalling balloon was the emergency balloon. To obtain lightness in this balloon the author employed goldbeaters' skin instead of varnished cambric, with the material of which only larger signalling balloons were made. Mobility was also secured by improvements in the electric storage batteries used, which were thereby rendered very portable. He estimated that the smallest possible size for an emergency electric signalling balloon to be useful, would be 7ft. in diameter. This would lift a light cable and the lamps a few hundred feet, and only require one gas cylinder of 120 cubic feet capacity for its inflation. In referring to the question of wind forces, the author stated that in the Santos Dumont experiments the wind forces overcome amounted to about 4½m. to 5m. per second, an advance of 1½m. per second on the experiments of Captains Krebs and Renard in 1885. To further the solution of the problem of a navigable balloon capable of being useful in war, he thought careful quantitative experiments would be more useful than any number of the more sensational journeys under the conditions of money prizes, in which the scientific desiderata were not sufficiently taken into account. A discussion followed the reading of the paper, in his reply to which Mr. Bruce admitted that linseed oil was almost useless for treating balloons; a good varnish was the great thing needed.

The Tube Vibrations.—The full report of the committee appointed by the Board of Trade to investigate the vibration caused by the trains on the Central London Railway has at last been issued. It will be remembered that this committee consisted of Lord Rayleigh, Sir John Wolfe Barry, and Prof. J. A. Ewing. A perusal of the report shows how incomplete were the preliminary extracts from the same which have filtered through to the Press. The committee employed Mr. A. Mallock to carry out a number of investigations on these vibrations in various houses along the route. The analysed results show (*a*) that it was a matter of chance whether a given train caused a slight or a severe vibration; (*b*) that trains causing a severe vibration in one house were as likely as not to cause only slight vibration in the others; (*c*) that different rooms in the same house were not similarly affected by the same train. Following up the investigation it was found that the want of rigidity in the rails could not be overcome by the employment of stiffer rails without encroaching too much upon the already narrow margin between the tunnel and the top of the carriages. The committee expressed the opinion that the extra cost of more clearance would have been more than repaid by the less power required to propel the trains. They deduced this from the observations made by Mr. Mallock on the air pressure in the front of the train. It was found that the rail joints, which, in fact, caused a good deal of noise, were not, as expected, an important source of vibration. From the measurements made, the committee see reason to believe that the principal source of disturbance lies in the unevenness of the surface of the rails. As they leave the rolls the rails are usually curved, and the process of straightening by local bending beyond the elastic limit, however skilfully carried out, inevitably leaves a certain waviness. As the unspring-borne part of the load follows the rail over the crests and hollows of the waves it is subject to vertical accelerations, which cause the pressure on the support to become variable. When there are no springs and the speed is high, a state of things is soon reached in which the pressure on the rail momentarily disappears, and the load is on the point of jumping across the hollows. Such part of the load as is carried by suitable springs moves nearly in a horizontal line without following the waviness of the rails, and the pressure on the rails corresponding to it remains nearly uniform and accordingly innocuous. When very high speeds are contemplated, it may become a question whether a higher standard in respect of straightness should not be aimed at. It appears that the irregular impulses given by uneven rail surfaces have the effect of establishing and maintaining an oscillation of the rails and road bed, the whole being regarded as an elastic support loaded with those masses which are not carried by springs. This view is borne out by the observed fact that the chief oscillations, as recorded in the tunnels, were found to have about the same frequency when the train producing them was run at various speeds. The conclusions of the committee as far as the influence of

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the type of locomotive affect the vibration have been fairly accurately given in previous issues. The report shows that the vibration is practically proportional to the unspring-borne weight per axle. The following figures in weight per ton per axle for the various types of rolling-stock are of interest: The gearless locomotives of the original type have a total weight of 44 tons. Of this, 11 tons is carried by each axle, eight tons being unspring-borne. With the geared locomotive with a total weight of 33 tons there are 2·5 tons of unspring-borne weight per axle, and 5·75 tons of spring-borne weight. Each motor carriage of the multiple-unit system weighs 20 tons, and gives an unspring-borne load of 1·75 tons per motor axle, as against 4·75 of spring-borne weight. The other axles on the motor carriages and on the passenger coaches carry 3·5 tons, of which 1·1 tons are unspring-borne. The committee conclude that as far as the Central London Railway is concerned, by adopting motorcars in place of the original locomotive, the vibrations produced by the running of trains can be reduced so as to cause no serious annoyance, although it is possible that the sound of the trains may still be detected, especially in the night; in fact, any method which reduces the unspring-borne load about 1·75 tons per axle will give satisfactory results.

Glasgow Local Section Dinner.—The first annual dinner of this flourishing branch of the Institution of Electrical Engineers was held at the Windsor Hotel, Glasgow, on Tuesday, Feb. 18, under the chairmanship of Prof. Magnus Maclean, the croupiers being Henry A. Mavor, Esq. (vice-chairman of the section), and W. A. Chamen, Esq. (electrical engineer to the Glasgow Corporation). Covers were laid for over 100 guests, and among those who sat down were the Lord Provost of Glasgow, Prof. Archibald Barr (president of the Royal Philosophical Society), Bailie Maclay (convener of the Glasgow Corporation Electricity Committee), Bailie Alexander and Mr. A. R. Bennett (convener and engineer respectively of the Glasgow Corporation telephone department), Colonel A. Denny, Mr. Kaye Gray (vice-president of the Institution of the Electrical Engineers), W. B. Sayers, Esq., and E. George Tidd, Esq. (hon. secretary of local section of the Institution of Electrical Engineers). During the dinner an interesting novelty was introduced, which caused a considerable amount of curiosity and speculation. Attached to the lighting brackets round the room, and hidden by greenery, were arranged a number of loud-speaking telephones, each of which was connected to a transmitter in a room of the Corporation telephone exchange in Renfield-street, a distance of about half a mile, where a small band of wind instruments with a piano were stationed, and rendered a selection of combined numbers and solos as well as the accompaniments to the music of the songs sung in connection with the Royal toasts, all of which were transmitted over the wires and heard in the dining-hall with a clearness and distinctness which was the subject of general comment. After the loyal toasts had been proposed from the chair and duly honoured, Mr. E. George Tidd (the hon. secretary) read letters of regret from Lord Kelvin, who wrote that he had to be in London; from Mr. W. E. Langdon, president of the Institution of Electrical Engineers; and from Mr. W. G. McMillan. Bailie Maclay proposed "The Imperial Forces," which was responded to by Colonel Archibald Denny. He took up the question of who should bear the blame for blunders in the army and navy departments. He thought that they frankly realised that Government business cannot be conducted upon modern business lines, because no one could take a position in a Government department as is done by the head of a large mercantile business, nor could the subordinates take up positions corresponding to managers and foremen in the factory. Let them take the case of an Admiralty surveyor posted to a mercantile yard watching the carrying out of a contract to a detailed specification. Innumerable points must arise during construction which had not been anticipated in the specification, or which arose from modifications considered to be improvements which the builder desired to introduce. In mercantile business the inspector appointed by the shipowner would in all probability, on his own responsibility, immediately settle the point; but the Admiralty surveyor would not, as a rule, do so, because if everything went right he would get no thanks for his zeal, while if anything went wrong he ran a serious risk of losing his appointment; and so it was right through the whole of the Government departments. Each man tried to shuffle the responsibility on to the man above him. Mistakes made in commercial firms were borne by the partners, but mistakes which could be traced to subordinates in Government departments were apt to lead to dismissals. Coming to the navy, they had just seen an important change in the *personnel* by the retirement of Sir William White. To him this country owed a great debt of gratitude, as he had been responsible for the design of all their naval vessels for many years, and his ships had formed models for those of foreign navies. The next toast, "The Lord Provost and Corporation of Glasgow," was proposed by Mr. H. A. Mavor. He said their Corporation had, above all, recognised electrical engineering as a force and factor in the development of their civilisation. They had swept from the streets the dirty old tramcars, with their mules and horses, and they had given them in their stead what might be described as fairy illuminated palaces, flying along at any speed up to 30 miles an hour. They had recognised the electrical engineer to the extent of spending three millions of money in acquiring his products. He could remember when there were only three electrical engineers in Glasgow; now there was one on the front of every tramcar. He would remind them, however, that the electrical industry was only just beginning in Glasgow, and he advocated a cheaper power distribution. Lord Provost Chisholm, in reply, expressed his pleasure in meeting the local section of the Institution of Electrical Engineers. He was proud to be associated in any way with such a body of gentlemen. He recognised the electrical engineers as a body of men who were engaged in studying and investigating for the purpose of guiding and controlling one of those occult forces of nature the mysteries and marvels of which are only beginning to be opened up. They were endeavouring to harness this force to the chariot of human progress and advancement, and the imagination itself failed to realise into what further regions of progress it might lead them. Prof. Archibald Barr proposed the toast of "The Institution of Electrical Engineers," to which Mr. R. Kaye Gray replied in the absence of Mr. Langdon. He then proposed the toast of "The Local Section." Prof. Magnus Maclean, replying to this, alluded to the rapid growth of the membership of the section, which now had reached 170, but they reckoned their strength rather by the quality of their members. He advocated an examination for associates as likely to raise the status of the Institution. The last toast was that of "The Hon. Secretary." He said that Mr. Tidd had done his arduous work in a pleasant and happy way. The reply of Mr. G. Tidd completed the formal toasts, and brought the first dinner of the Glasgow Local Section to a successful close. During the evening an interesting programme of songs and recitations was gone through, the following gentlemen taking part: Messrs. R. H. Young, J. Lowson, R. Webster, W. McCallum, and W. R. Carstairs.

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THE CITY OF LONDON ELECTRIC LIGHTING COMPANY'S WORKS.

When in March, 1899, we visited the Bankside works of the City of London Electric Lighting Company, the whole of the supply was practically being given by means of alternating currents. It had, however, then been decided that extensions should be made with direct-current machinery, and the foundations of buildings to contain the same were being laid down. At that time we were informed that the aggregate output of the plant in the station was 11,660 kw. This is all contained in the main station, seen in block plan in Fig. 1. The new plant has been placed in the west station, which is also seen in the same illustration, and which now contains generators able to deal with at least a load of 7,000 kw.

We believe we are right in saying that it was the demand for power for printing purposes in the Fleet-street district which first encouraged the company to provide special power mains with 400-volt continuous current, but these special mains have since been rendered unnecessary by the complete changing over of the supply in practically all the areas south of Cheapside, Newgate-street, and Holborn, to the direct-current system. This change over has been made on the grounds of economy. A reference to the description of the works, which appeared on pp. 262, 305, and 346 of vol. xxiii., will remind our readers of the details of the older plant in the stations. In this description a typical load curve was also given, which showed that the financial success of the undertaking was hampered by the tall and thin peak in the curve of daily demand; in other words, the load factor of the supply is exceedingly low owing to to the large number of offices which are lighted, and it involves a large capital outlay for a small average return per lamp. With the supply on the alternate-current system, the transformer losses, which are continuous for the 24 hours, formed a very considerable proportion of the

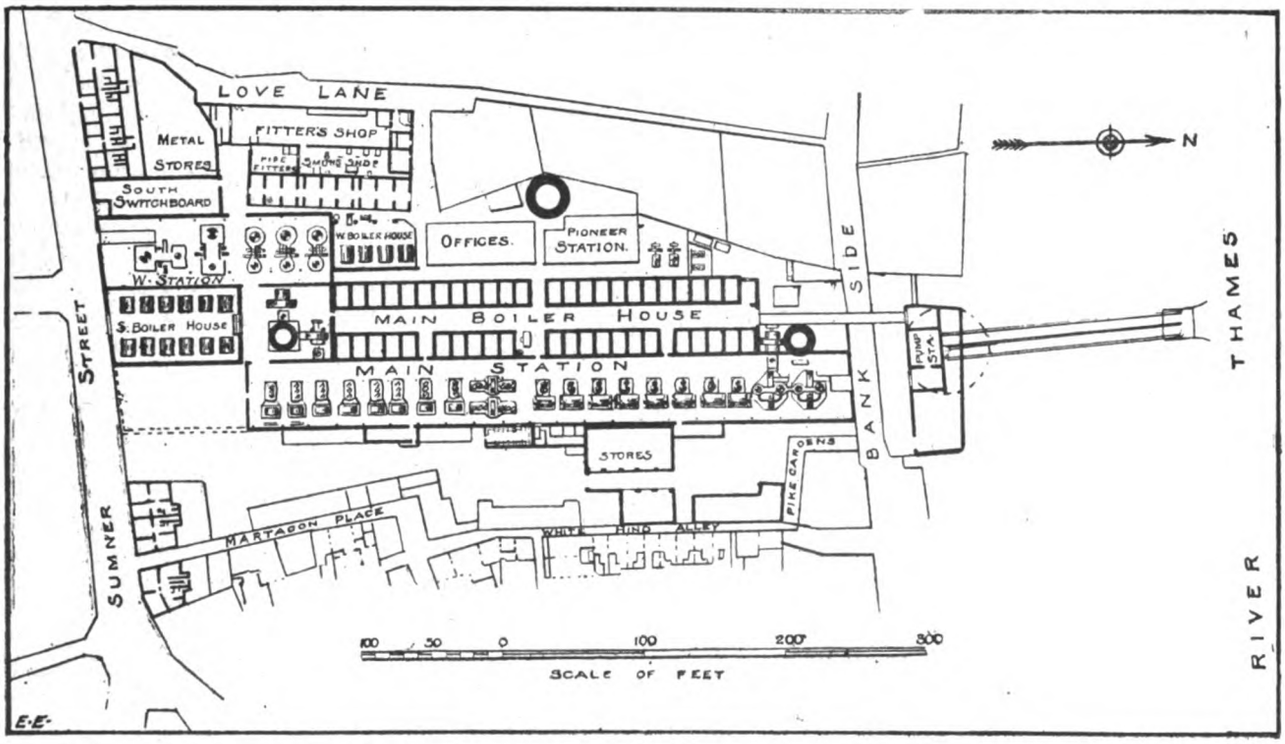

FIG. 1.—Block Plan of the whole of the City of London Electric Lighting Company's Works at Bankside.

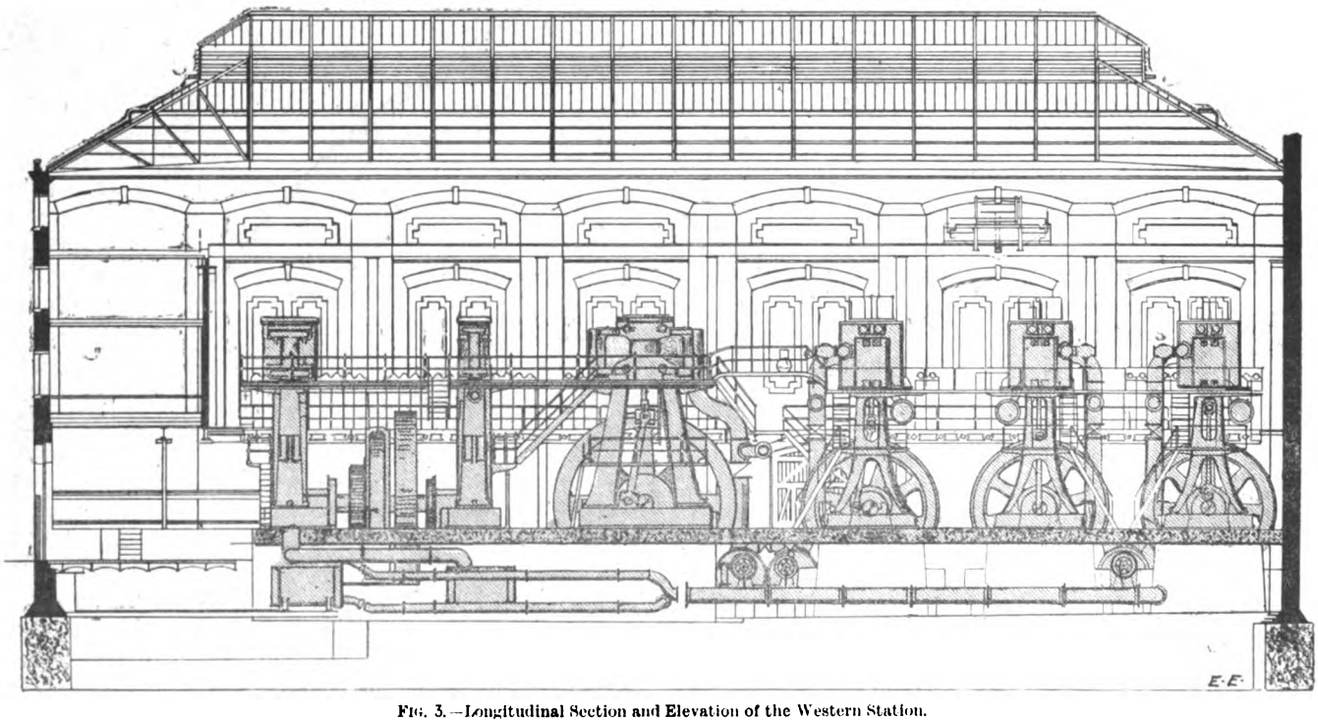

FIG. 3.—Longitudinal Section and Elevation of the Western Station.

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total output. In consequence, although the direct-current transmission at 400 to 460 volts may not be quite so efficient at full load, the total losses are very much less, and the chances of breakdown also much smaller. These advantages have been found so great, that the company have ordered motor-generators to enable the alternating-current plant to assist in the supply of the continuous-current extensions, and it is probable that the company may eventually use their alternators simply to transmit energy to the areas farthest away at times of heavy load, while the supply to these areas will be given by the continuous-current low-tension feeders during nine months of the year. This would result in there being no transformation losses except during three months in the winter, and then only at heavy loads. We presume that the motor-generators would be placed in sub-stations in the districts supplied.

The direct-current plant is placed in the western station, of which an enlarged block plan can be seen in Fig 2.

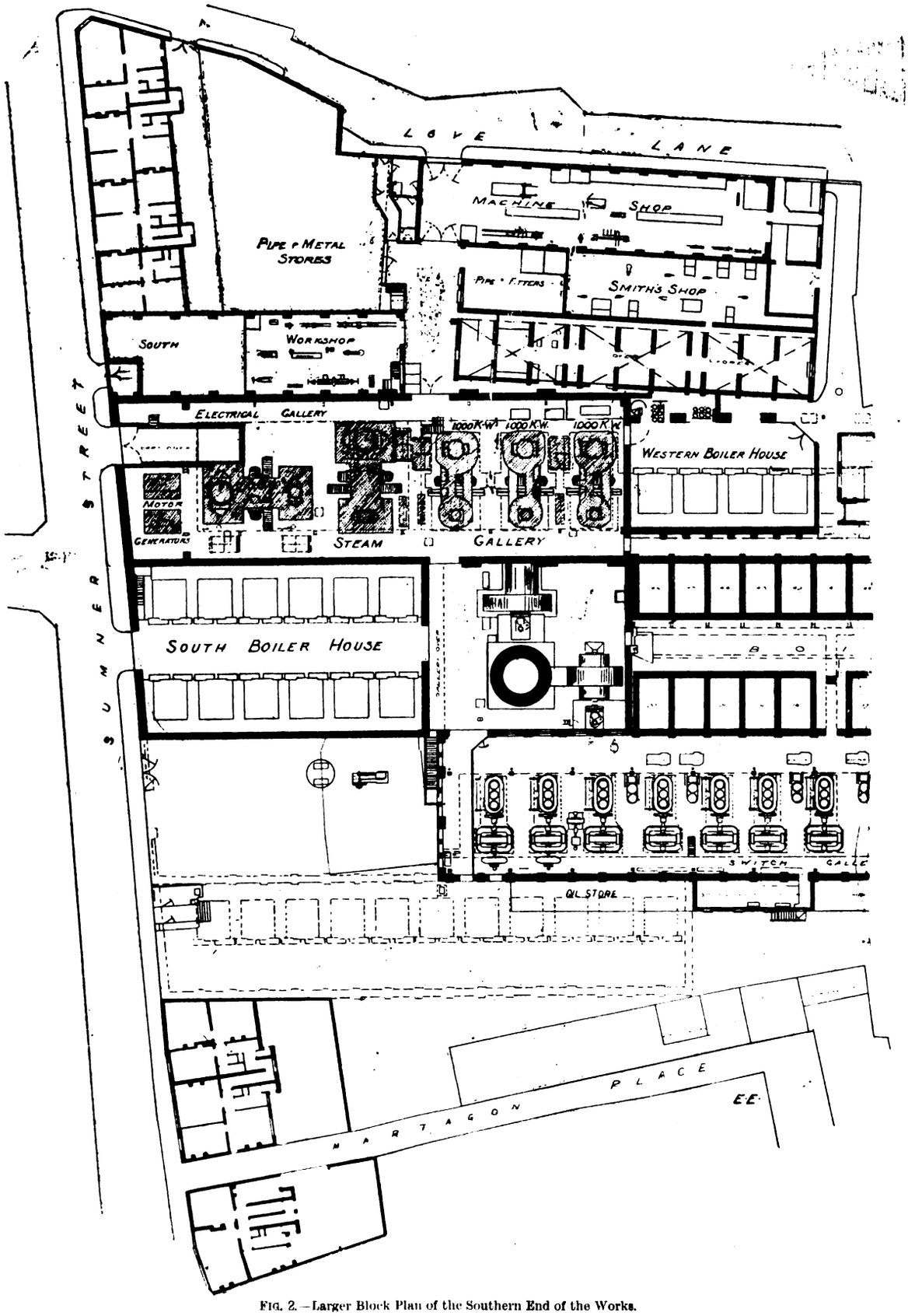

FIG. 2.—Larger Block Plan of the Southern End of the Works.

This figure also shows that ground has been cleared and is now available at the end of the main engine-room for further extensions. These, with the new boiler-house, are indicated by dotted lines. The plant in the western station consists of five units—two of 2,000 kw. each, with Westinghouse dynamos coupled to Musgrave engines, and three Allis-Westinghouse sets of 1,000 kw. capacity. It will be seen

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from the block plan that the last Musgrave set is turned round so as to allow of a cart dock and landing stage on the ground floor, from which spare parts of the engines can be picked up by the electric overhead crane, or which can be used to receive portions of the engine when they are being overhauled. The need for this will be seen from Figs. 3 and 4, which give respectively longitudinal and transverse sectional elevations of the station. The space otherwise available round these sets is exceedingly limited, there being 7,000 kw. of plant in an engine-room 138ft. long by 50ft. wide. Dealing first with the two large sets, we are able to give photographs which show some-

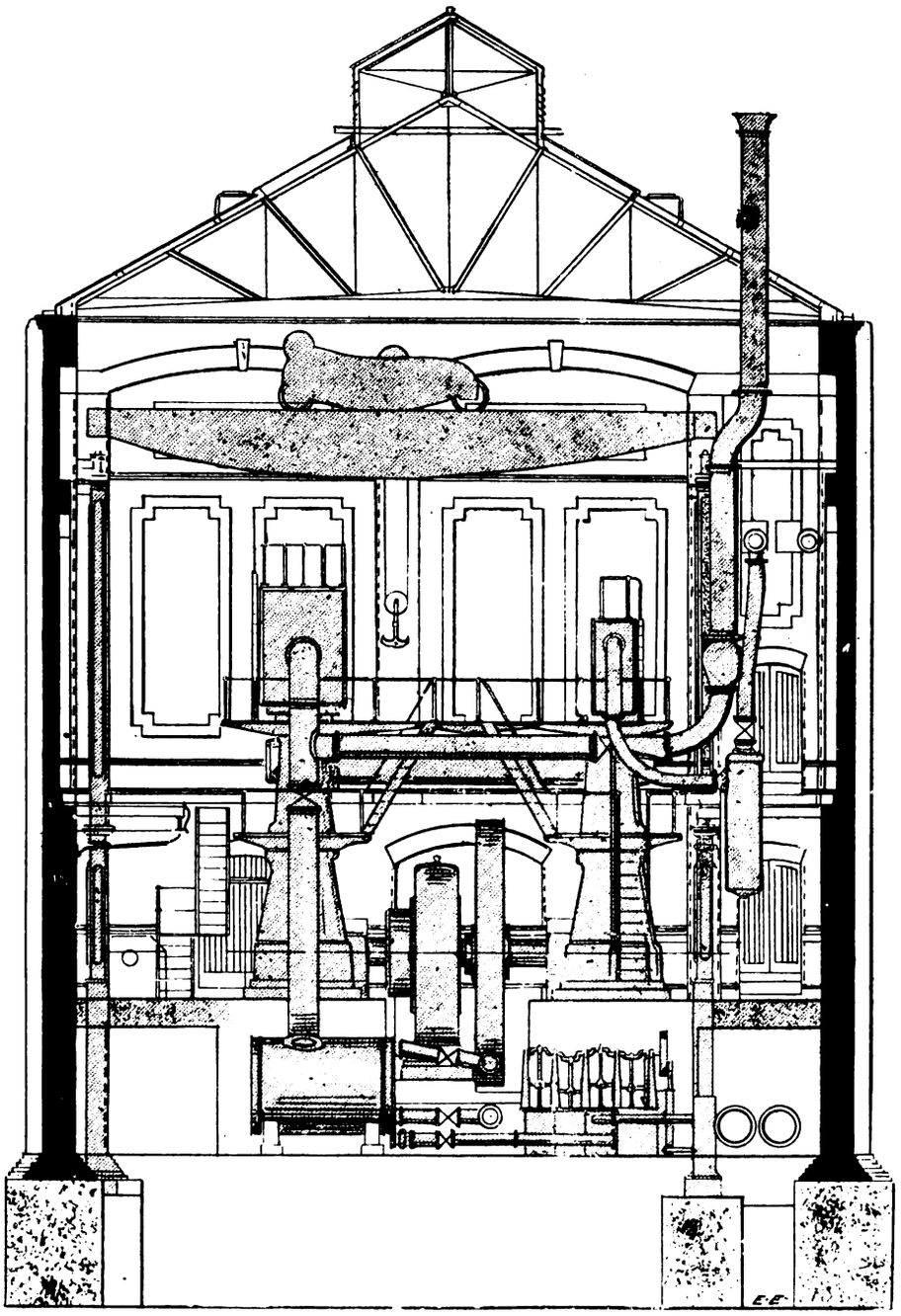

FIG. 4.—Cross-Section and Elevation of one of the Allis-Westinghouse Sets.

what their construction, but the space round the Allis engines is so limited that a photograph of them as a whole cannot be obtained. Figs. 5 and 6 show two views of these Musgrave-Westinghouse 2,000-kw. generators. The first was taken from the floor level, and Fig. 6 from the gallery at the end of the engine-room. These two generators give a normal output of 2,000 kw., the engines being capable of producing a maximum of 4,100 i.h.p. At this load the generator shows no signs of heating or sparking. The leading dimensions are as follows: diameter of high-pressure cylinder, 38½in.; diameter of low-pressure cylinder, 76in.; stroke, 4ft. 6in.; revolutions per minute, 75; diameter of crankshaft at main journals, 21in. by 42in.; diameter of crankshaft at dynamo centre, 28in.; diameter of flywheel, 24in.; weight of flywheel, about 80 tons. The valve gear of these compound engines is of the "Musgrave's Patent" type, which is very simple and specially suitable for engines driving dynamos. This valve gear has been found to give most satisfactory results when running engines in parallel. It is also arranged for carrying on the steam in the high-pressure cylinder, if necessary, to five-eighths of the stroke, cutting off earlier for the light loads automatically, thereby effecting a considerable economy in steam consumption for loads varying over a wide range. Fig. 7 shows this valve gear on the high-pressure cylinders. The governor rod is seen on the left, and the details of the trip gear in the centre of the photograph. There is an automatic gear in connection with the governors, which shut down the engine if a predetermined speed is exceeded. All the parts of these engines are strong enough for carrying 30 per cent. overload in case of necessity, and this necessity is frequently a London fog. The efficiency of these generators is 95 per cent. from three-quarters to full load, and the engines work with a steam water consumption of about 14lb. per indicated horse-power per hour when condensing.

The three Allis engines are of the ordinary vertical cross-compound condensing type, with high-pressure and low-pressure cylinders 28in. × 60in. diameter respectively, with

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48in. stroke, and they run at 90 revolutions per minute. The engines are rated for an economical output of 1,600 i.h.p., though it has been found that the economy is not limited to this rating, but covers a wide range from light load. These engines frequently run with an overload of 25 per cent. without showing signs of distress. The details of these engines are as follows: The crankshaft is of wrought iron, and 24in. in diameter. The flywheel is 18ft. in diameter, and weighs nearly 50 tons; this wheel is of the ordinary Allis standard type, having solid oval arms cast solid with the segments of the wheel. The armature of the dynamo is keyed direct on the shaft, and forced into place by hydraulic pressure. The valve gear of this engine is of the standard Allis type. The gear on the high pressure cylinder is shown in Fig. 8, but the governor seen in this illustration is only the emergency one for shutting off steam if the speed increases to more than 10 per cent. above the normal. The real governor is placed by the low-pressure cylinder, and the control to the high-pressure cylinder is transmitted by the horizontal shaft seen to the right of the illustration.

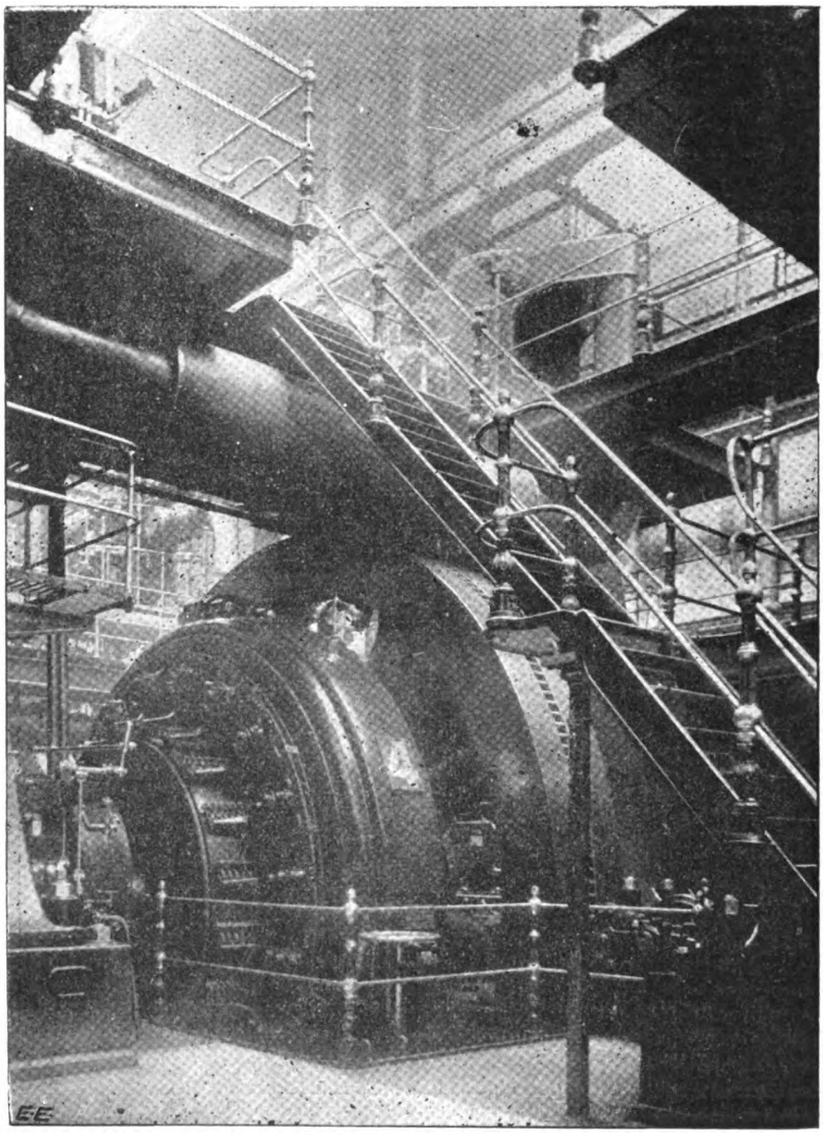

FIG. 5.—The 2,000-kw. Westinghouse Dynamo.

As regards the dynamos, which are all of the Westinghouse type and manufacture, the following details of the 2,000-kw. machines will be of interest. The field magnets are built up of steel stampings cast in to the yoke rings. The magnets are shunt wound, and all the machines are run self-exciting. The total height of this dynamo is about 21ft., its length along the shaft 5ft. 3in., and its extreme width about 26ft. The height of the machine above the floor line is about 9ft. 6in. The generator is built direct on the engine shaft, between the high-pressure and low-pressure sides, and close alongside the massive flywheel.

The armature and the commutator are both built on the same cast-iron spider, which is cast in four sections, with two spokes or legs to each section. The hub is 37½in. deep, accurately bored to fit the shaft, on to which it is pressed over the key. Two rings are afterwards shrunk over each side of the hub, the diameters outside the shrink rings being 47in. and 57½in. respectively. The flywheel is afterwards pressed into its position on the largest part of the shaft. On the inner side of the flywheel the hub is extended by a flange, which projects over the hub of the spider, and takes up its position against machined faces on the inner side of the spider arms. The flywheel flange is drilled in position to correspond with holes through the spider arms. The holes are reamed, and the spider and the flywheel are rigidly fixed together by eight 2½in. diameter tightly fitted bolts between the spider arms and the flywheel hub. The armature core is built up of sheets of carefully annealed steel clamped between cast-steel end plates. The core and the spider on which it is built are traversed by air passages, so arranged that when the machine is running a constant cooling stream of air circulates through the core and round the windings The armature conductors are carried in slots cut in the periphery of the core. They are of copper bar, forged to shape, and insulated before being placed in the core slots, where they are simply laid in position without any forcing, bending, or hammering being necessary, and secured by hard fibre wedges driven lengthwise into notches in the slots above the conductors. This form of construction ensures a most permanent insulation for the windings, places all parts of the same within easy access, and renders all inspection, repairs, or renewals of any portion of the conductors possible without difficulty, with rapidity, and without disturbing any other

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coil or portion of the winding except that at fault. In order to ensure an equal distribution of the magnetic flux with these large multipolar dynamos, and that each portion of the armature gives its equal share of the total output, the Westinghouse Company use equalising rings. These rings are respectively connected to a series of what should be equipotential points in the armature circuits, and the currents through these equalising rings have been found to balance any small errors in magnetic distribution, and to give sparkless running at all loads. That this is obtained is proved by an inspection of the commutators at Bankside. The commutator is constructed of the best hard-drawn copper segments insulated by specially prepared mica sheets of such corresponding hardness that an even wearing surface is exposed to the brushes. Carbon brushes are used; they are tightly secured in spring brush-holders, and clattering and vibration are quite prevented. The brush-holders are arranged in sets of eight, carried on rigid brackets supported in turn from a continuous ring which is concentric with the field ring. The brush or rocker ring is held by brackets close to the field ring, thus leaving the outer end of the commutator free and open for attention or cleaning. The lead of all the brushes is adjusted simultaneously by a hand-wheel, which connects through rods and bevel gearing to the brush ring. The finished armature of the machine is some 12ft. in diameter and 3ft. deep, the commutator being about 10ft. in diameter by 22in. wide at the collecting face. The total approximate weight of the complete armature and commutator is 85,000lb.

These engines are worked condensing in the same way as are the other engines driving the alternate-current plant. Surface condensers are used in conjunction with air-pumps of the Edwards type. The general arrangements of these parts can be seen in Fig. 4. In the right-hand lower corner of this illustration are shown the two large circulating water-mains which supply the circulating water to all these sets. This water is taken from the River Thames, and, as mentioned in our previous description of the works, is strained by being passed through a revolving screen. This screen is so arranged that as it revolves the incoming circulating water is forced through it in one direction, and after a certain angular motion of the screen, the outcoming water passes through the same part of it in an opposite direction, thus preventing any accumulation of detritus. This apparatus is so successful that a new one of similar type is now being constructed in the company's workshop. Most of the auxiliary plant in connection with the condensers is independently driven, but Messrs. Musgrave supplied one set of large air-pumps for direct connection to one of their engines. To provide against any trouble due to failure of the condensing plant while the engines are running, independent exhaust pipes to atmosphere are provided for each engine. This can be seen in Fig. 4. The automatic valve for discharge to atmosphere contains some novel features which are absolutely necessary when such large relief valves are employed. In Fig. 9 a section of this automatic relief to atmosphere is shown. The valve, A, which is normally closed on the seat, B, is partly balanced by the weight, W, connected to the valve spindle by the flexible wire rope, R. Above the valve is fixed a shield, S; this effectually prevents any clattering of the valve on its seat by deflecting backward pulsations of steam, which under certain conditions of running may be unavoidable. This backward pulsation is particularly felt on slow-running engines working into an independent exhaust pipe to atmosphere, and the hammering of the valve on its seat which would result would, but for the ingenious shield, S, soon destroy the valve.

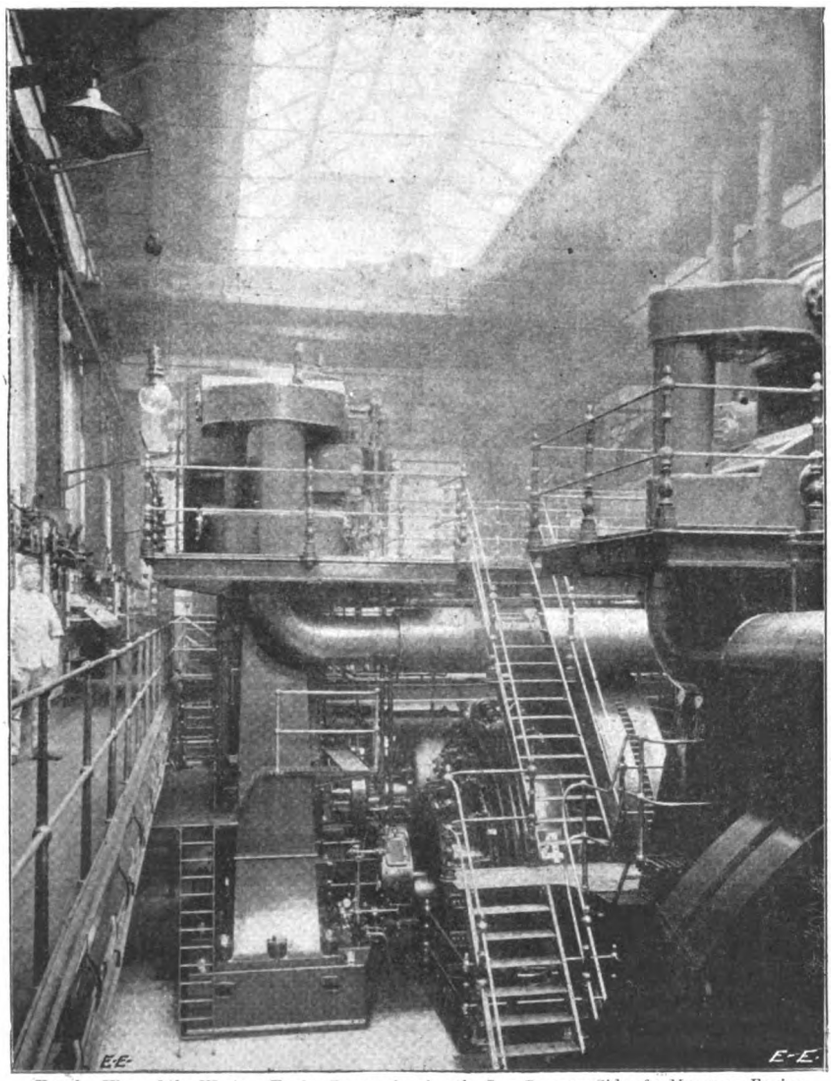

FIG. 6.—View of the Western Engine Room, showing the Low-Pressure Side of a Musgrave Engine.

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Coming now to the distribution of the continuous current, this is done on a switchboard, or rather switchboards, which occupy the full length of the engine-room. Only five generator switch panels are required, and the type of instruments on these can be seen from Fig. 10. These main switches, which also act as non-return cut-outs, are of the well-known Westinghouse type. In this instance the switches are remarkable for the large current (approximately 4,000 amperes) with which they have to deal The main connection is made by means of a springy laminated contact of copper against a flat copper surface. The break, however, takes place between two carbon blocks. In Fig. 11 are shown the five rheostats for regulating the voltage of the five machines, and the voltmeters placed over them show the omnibus supply volts. For bringing two of the machines into parallel a double-needle voltmeter of the Weston type is provided near each main switch (Fig. 10). The movement of one needle indicates the supply voltage, while the other shows the voltage on the incoming machine. In dealing with the exceedingly sudden demands for more power which fogs in London are apt to cause, the ease of switching in more dynamos on the direct-current system

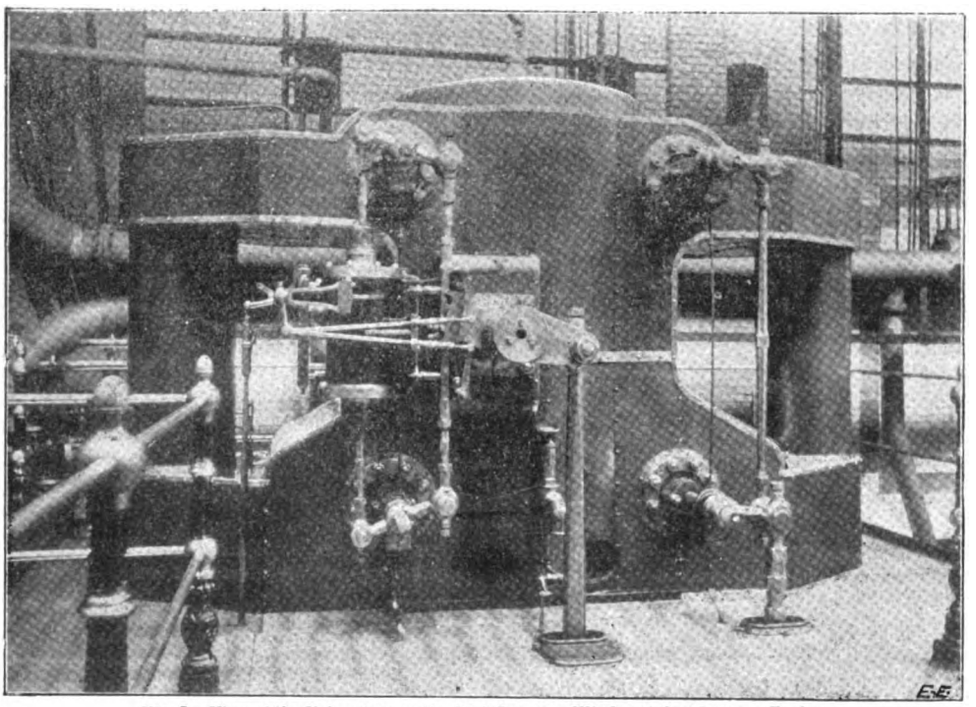

FIG. 7.—View of the Valve Gear on the High-Pressure Cilinder of the Musgrave Engine.

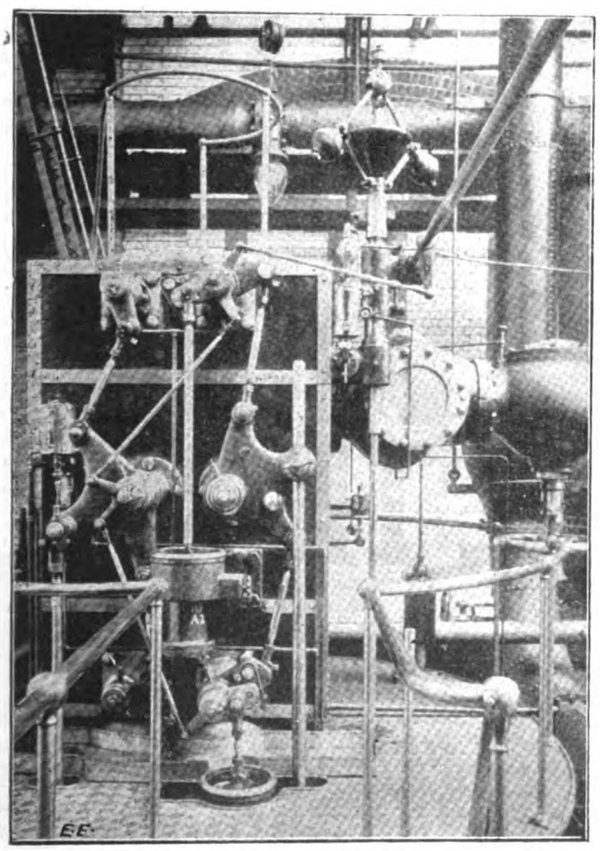

FIG. 8.—The Valve Gear on the High-Pressure Cylinder of the Allis Engine.

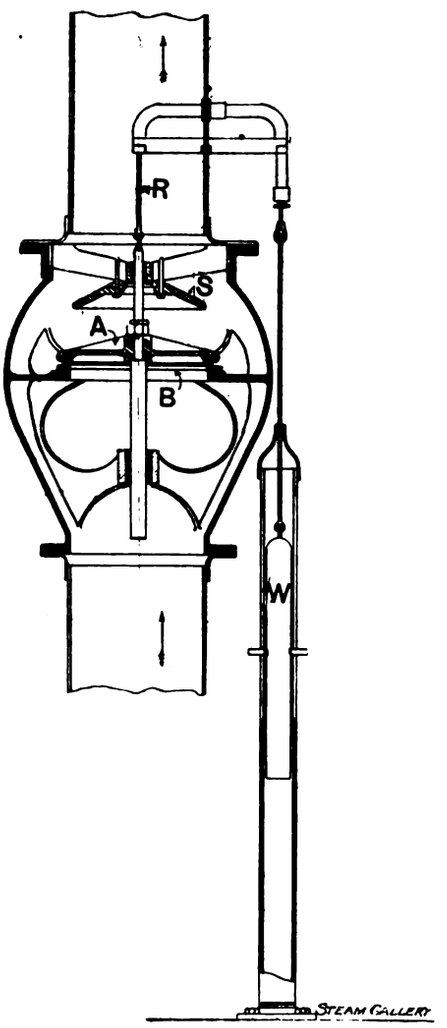

FIG. 9.—Section of the Automatic Relief Valve to Atmosphere.

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is greatly appreciated by the company's engineers, as compared with the time which it takes to synchronise alternators and to bring them into parallel. In Fig. 11 can also be seen the two large omnibus bars which distribute the current to the various feeder circuits. These omnibus bars are built up of broad copper strips placed one behind the other, and carried in stoneware insulators carried from supports which are built into the wall. These omnibus bars were designed and erected by the staff of the company.

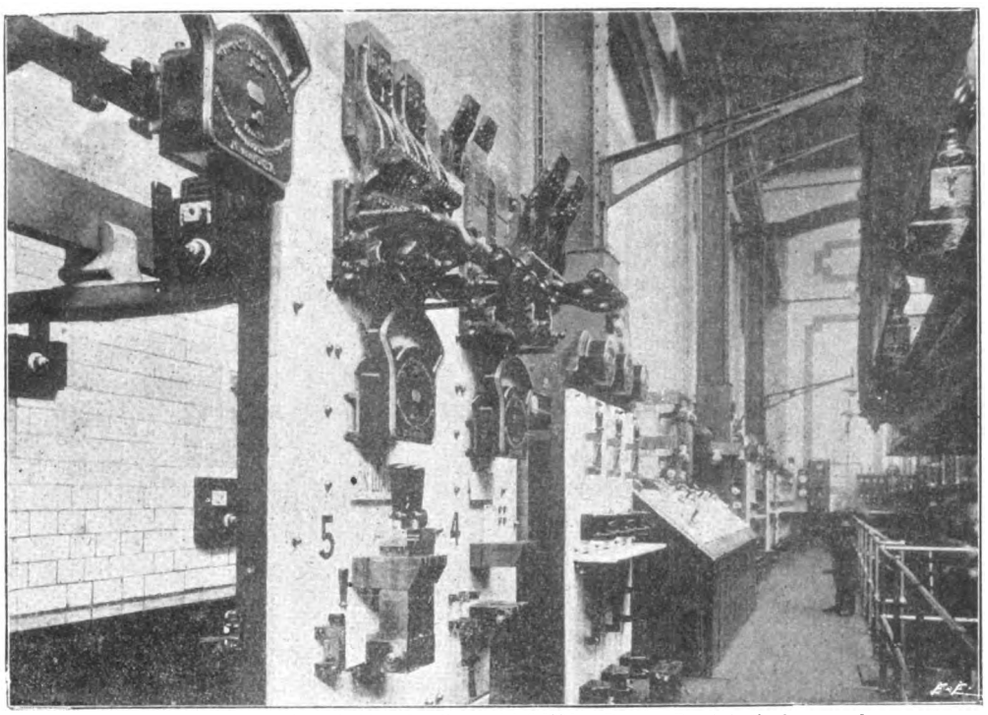

FIG. 10.—One Half of the Switchboard Gallery, with 2,000-kw. Dynamo Panels in the foreground.

FIG. 11.—View of the Shunt Regulators, showing also the two Bus Bars with their Insulating Supports.

The rest of the switch gallery is devoted to the feeder panels, which, as shown in Fig. 12, are arranged with the positive sections vertically above the negative. The division between the two marble slabs containing the positive and negative instruments is marked by a broad horizontal shelf of marble, which runs the whole length of the board. The

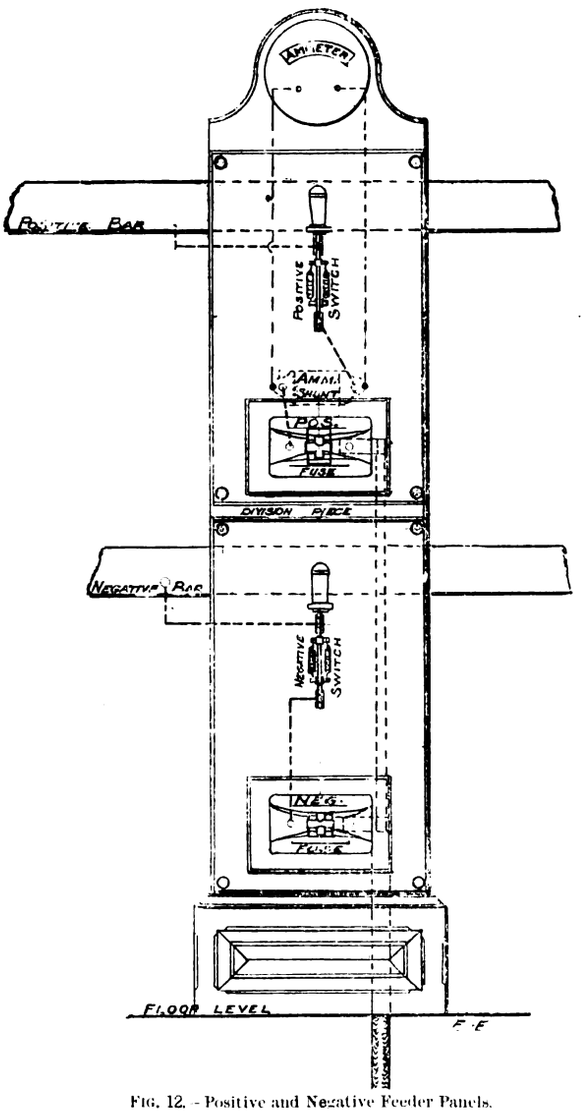

FIG. 12.—Positive and Negative Feeder Panels.

fuses used on these feeder panels are the design of one of the staff, Mr. O. L. Peard, and have been patented by him. The details of this fuse are illustrated in Fig. 13, 14, and 15. It will be seen from these that the fuse strip passes

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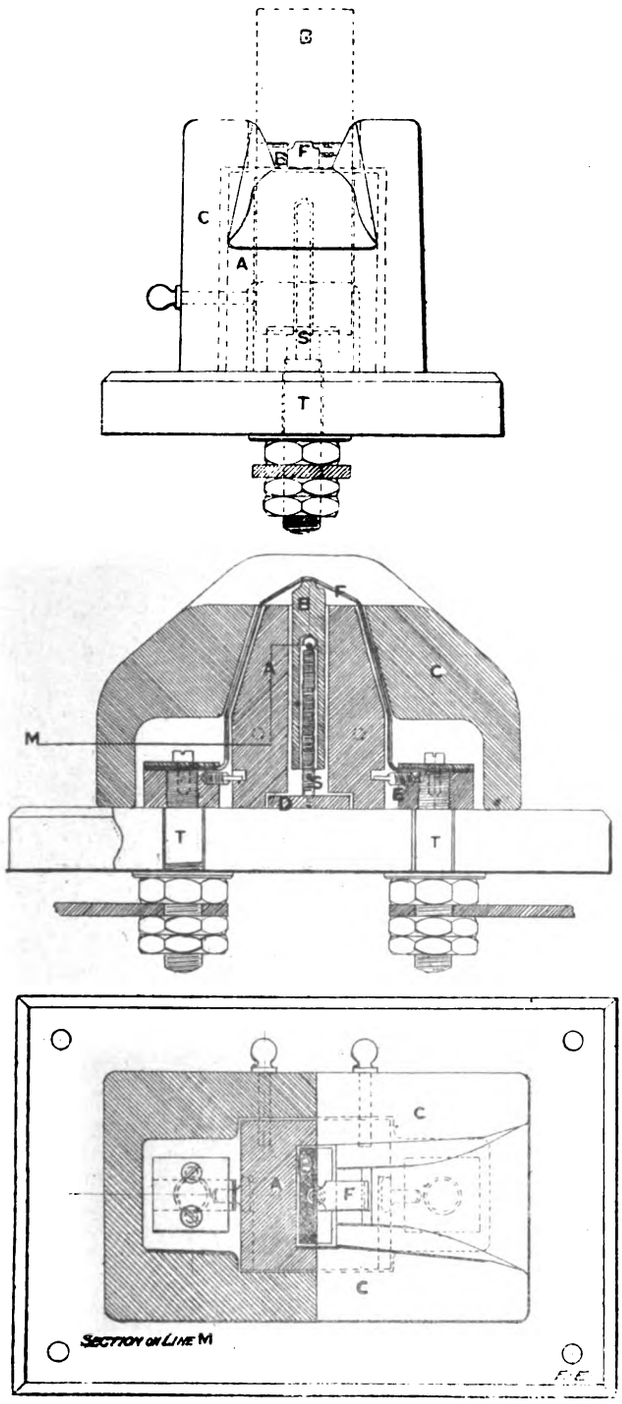
over a plaster block, A, in the centre of which is a spring plunger, B. This plunger is forced outwards by means of a spiral spring, S, which is held in compression by the fuse. At the point where this fuse rests against the plunger it is reduced in section, so as to have a well-determined point of fusion. Immediately a fuse goes, the block, B, springs out into the dotted position shown and breaks the arc. The outer cover, C, which is also of plaster, chills the arc as well These fuses have been found quite capable of breaking a short-circuit with the full power of a 2,000-kw. machine behind it. The fuses are placed at both ends of the



FIGS. 13, 14, AND 15.—Showing Construction and Details of the Peard Fuse.

feeders. The supply is given on the ordinary three-wire system, with about 404 volts across the outers at the point of supply.

Motor balancers made by Messrs. Parker, Limited, are in use. These balancers are of the ordinary hand-regulated type for the generating end, and self-regulating balancers of the "iron-clad" type are in use at the distributing end. The middle wire of all networks is earthed at the generating end, and every care is taken to ensure a mechanical and electrical perfection of this earth connection, to which is also attached all the lead covering of the various feeding and distributing cables. All the cables going from the stations to the sub-stations in the various districts have a uniform section of ·5 square inch for each conductor. They are concentric cables, paper insulated and lead covered. It has been found possible to draw these cables into the wrought-iron pipes which were previously laid to receive high-tension cables for the alternating-current system. In this way it has not been necessary to do much retaking up of streets in consequence of the change over. The ends of the pipes, where they come into the joint-boxes, and also into the sub-stations, are carefully plugged, to prevent as far as possible circulation of stray gases. The sub-stations, which were originally arranged for distributing by alternating currents, are, of course, utilised for the distribution. In this way the only change was the use of low-tension feeders for connecting on to the low-tension distributing switch gear, and the change over of the consumers' lamps to 200 volts. As regards the loss in these low-tension feeders, the average length of the same is now somewhere about one mile, and at maximum load the actual loss in the feeders comes out at about 10 per cent. This loss only occurs at maximum load in the winter, and the annual loss in kilowatt-hours per annum comes out, we are informed, much lower than would be the case with any system of high-voltage distribution with subsequent transformation to a low-voltage distribution.

We have to thank Mr. Frank Bailey, the engineer of the company, and his assistants for giving us the facilities for acquiring the information from which this article is prepared, and we have to congratulate the company on the large amount of constructional work which their staff is doing. Thus the whole of the buildings for the plant above described were erected under the control of the staff without the intervention of a contractor, and the work was finished well within the promised time.

NOTES ON PRACTICAL ELECTRICAL INSTRUMENT MAKING.

BY JOHN C. BAGOT.

(Continued from page 869, Vol. XXVIII.)

Another important type of measuring instrument, and one that is in very general use at the present time both for the measurement of continuous and alternating currents, is the electro-dynamometer, and, as the name implies, depends for its action on the mutual mechanical forces exerted between wires through which currents flow, or on that part of electrical phenomena which was originally designated electro-dynamics.

These electro-dynamic laws, as discovered by Ampère, were based upon the fact that when currents flow through two conductors so suspended or supported as to be capable of moving either towards or from each other, show mutual attraction or repulsion according as the current flow is in the same or contrary direction. Whether the conductors be parallel, perpendicular, diverging, converging, circular, or helical, all produce motion of a different nature in conductors, both rectilineal and circular in form, and also the rotation of a helix, such as were called electro-dynamic cylinders. But these so-called electro-dynamic cylinders are found to influence each other precisely the same as if they were magnets during the time they are carrying a current, and the tendency of all such circuits is to move so that each of them shall get more magnetic lines passing through it in the same direction as its own and fewer in the opposite direction.

Thus, on account of the magnetic condition of the space about two neighbouring and parallel conductors which forms part of two circuits, when looking at the end of the conductors, so that the direction of the current is away from the point of observation, the magnetic lines will revolve in a mechanical direction—that is, in the direction of a right-handed screw—and in that case the circuits will tend to move, so that more lines pass round both in the form of an ellipse. But when the current is in the opposite direction these magnetic lines will be likewise, and will therefore cause the conductors to move so that less lines pass round them which are in opposition to their own.

The action of the electro-dynamometer, however, may

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to a great extent be explained from the same point as the d'Arsonval galvanometer; in fact, it is simply another type of suspended-coil instrument with a variable magnetic field, which is strengthened or weakened in proportion with the current passing through the movable coil. Nevertheless, it was the behaviour of a circular coil carrying a current that suggested the construction of the instrument. It will therefore be more advantageous to consider what influence such a coil has on a small magnet suspended at its centre previous to going on to the action of the electro-dynamometer. It will be sufficiently elucidated by considering briefly the theory and working of the tangent galvanometer, which, however, has not come into what may be called practical use, chiefly on account of the influence of the earth's magnetism, which cannot have any definite value attached to it except in the laboratory.

The instrument in its simplest form consists of a metallic ring set vertical, through which the current passes, and in the centre of this ring is suspended a small magnetic needle. When in use it is placed so that the ring stands with its plane in the magnetic meridian; the needle will, of course, point in the same direction. On the passage of a current this needle will deflect, and supposing the length of the suspended magnet is very small compared with the diameter of the coil, we may calculate as if it were all situated at the centre; then the directive force that tends to deflect the needle will be equal to the strength of the current multiplied by the strength of the pole, multiplied by the length of the arc, and divided by

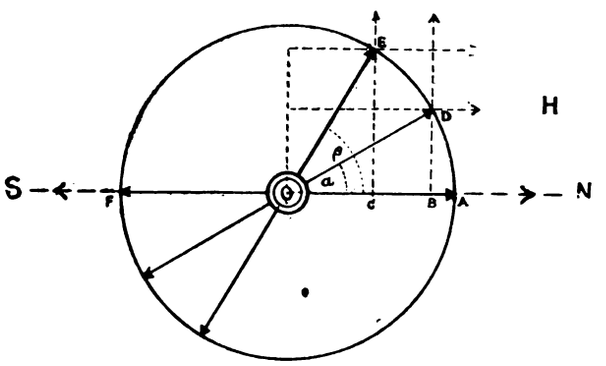

FIG. 10.

the square of the distance of the wire from the pole—that is,

$$F = \frac{1\ m\ C}{r^2}.$$

But in this case the factor 1 is a complete circle whose length is $2\ \pi\ r$. Thus the force

$$F = \frac{2\ \pi\ r\ m\ C}{r^2} = \frac{2\ \pi\ m\ C}{r}.$$

This force F is that which tends to force the needle out of the magnetic meridian. When there is a deflection, however, other forces step in that require consideration. In the first place, the perpendicular distance between the forces acting on the needle becomes less, whilst the force due to the earth influence becomes greater, so that the needle finally sets itself along the diagonal of a parallelogram which has these two forces as adjacent sides; and as the forces on each half of the needle are similar, one half only needs consideration.

In Fig. 10 the magnetic needle, F A, is shown in the magnetic meridian, S N, where the force of the earth's field has no deflecting influence, and the distance between the points of suspension and application of the force, F, is equal to O A. But when the needle deflects, say, to the position D, then the moment of the couple or length of the arm at which the force, F, acts is now only O B, whilst the length of the arm at which the earth's force, H, is applied becomes D B; on the needle moving to the point E, the arms of the forces, F and H, become O C and E C respectively. When the needle comes to rest, say, at the point D, then the force exerted by the current multiplied by the length of the arm O B must balance the force H multiplied by the arm D B; therefore neglecting the strength of the pole, m, and the length of the needle

$$\frac{2\ \pi\ C}{r} = H \times \text{the ratio } \frac{D\ B}{O\ B}.$$

But the ratio $\frac{D\ B}{O\ B}$ is the tangent of the angle a; hence the name of the instrument. Therefore

$$\frac{2\ \pi\ C}{r} = H \tan a.$$

Then, providing we know the constant of the instrument, which is

$$\frac{r}{2\ \pi\ n},$$

where n is the number of turns on the coil, then, by knowing the value of H for the place in question,

$$C = H \tan a \frac{r}{2\ \pi\ n}.$$

That is, in words the current is equal to the constant "which is obtained from the dimensions of the instrument," multiplied by the strength of the earth's magnetism in a horizontal direction, and again multiplied by the tangent of the angle of deflection.

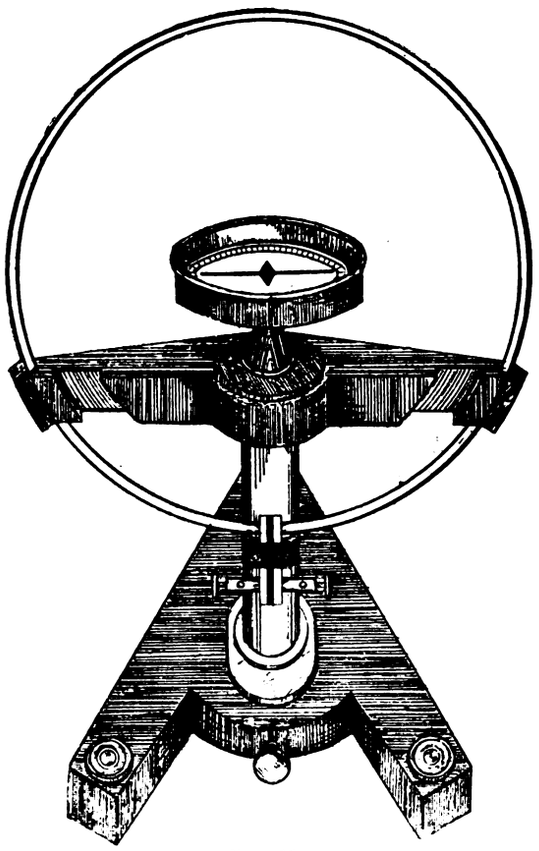

FIG. 11.

Thus by simply observing the deflection we have an absolute measure of the current strength. A special type of this instrument is shown in Fig. 11 with one of its coils removed, showing only the solid copper ring, to the ends of which are attached the brass blocks that support the terminals. These blocks are drilled and tapped to receive the screwed end of the rod, after which they are soldered in proper position. It will be seen that the coil is held in position by means of ebonite clamps screwed on to the ends of the cross-arm, also by a kind of an ebonite box, which is secured to the centre pillar. This brass pillar fits into a socket that passes through the base, that portion of the pillar that enters the base being brought out of the centre by means of the brass plate shown, so as to bring both coils together with the needle over the centre, about which they can be rotated. The wooden coil frame is secured by wood screws in the slots made in the cross-arm, as shown

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in Fig. 12. The four openings are for the purpose of counting the number of turns when necessary. There are two coils wound on this frame, arranged so that the mean radius of both are exactly the same; this is done by winding the coil with double wire, and bringing all four ends out direct to the terminals shown. Then, providing these two coils are the same distance from the needle, and are of the same number of turns, then if two currents of equal strength be sent through in a contrary direction there will be no effect on the needle whatever, so that by the use of these coils the instrument may be employed for the direct comparison of resistance, current, and E.M.F.'s; and by previously arranging the values of r_1 and r_2 and n, the constant of the instrument when using the coil of one turn only can be made 100 times greater than either of the coils in the wood frame, so that

$$\frac{r_1}{2\pi n_1} = 100\,\frac{r_2}{2\pi n_2}.$$

Then by using the single ring in conjunction with one of the coils of many turns, we can compare currents differing greatly in strength.

In the galvanometer illustrated, the force brought to bear on the needle by the current in the coil was $\frac{2\pi C}{r}$.

Now, if the magnet was rigidly fixed and the coil suspended so as to be free to move, the same force would act upon

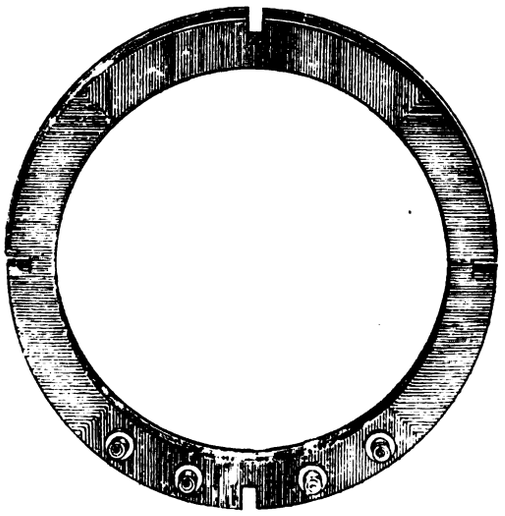

FIG. 12.

the coil, but if they were in the same position as before—that is, in the magnetic meridian—then the two forces, F and H, would both act in the same direction in deflecting the coil. But if the movable coil be placed in the same relative position as the magnet was in—that is, in such a position that the earth has no deflecting influence on it, which would be at right angles to the meridian—then on the passage of a current the two forces would be exactly as before, only now the coil would set itself as the diagonal of the two forces. But now, if by twisting the suspension the coil is brought back to its original position, then one of the two equal forces has been overcome by a certain number of degrees of torsion. If, now, the magnetic needle be replaced by a coil fixed with its plane at right angles to the movable one and arranged that the same current passes through both, we have, as already seen, the force

$$F = \frac{2\pi n_1 C}{r_1},$$

where n_1 and r_1 are the turns of wire and the radius respectively. This magnetic field of the large coil exerts a torque or twisting moment upon the small coil that is equal to $T = \pi n_2 r_2^2 C F$, where n_2 is the turns and r_2 the radius. Therefore, the total torque between the coils will be

$$T = \frac{2\pi^2 n_1 n_2 r_2^2 C^2}{r_1}.$$

Thus the value of C may be calculated when n_1, n_2, r_1, and r_2 are known, and T has been observed by the number of degrees of torsion. In the Siemens electro-dynamometer no account is taken of n_1 n_2, and r_1 r_2, but since the same current passes through both coils the current squared is taken to be equal to the angle of torsion multiplied by a constant, not, however, arrived at by measuring the parts of the instrument, but experimentally by calibrating with a known current. Then this constant multiplied by the $\sqrt{\text{of the angle of torsion}}$ = the current.

(To be continued.)

EARTH CURRENTS DERIVED FROM DISTRIBUTING SYSTEMS.*

BY E. BASIL WEDMORE, ASSOCIATE MEMBER.

Particular interest has recently been aroused in connection with the subject of earth currents, principally owing to the consideration which has been given to the question of the protection of observatories and other places from magnetic disturbances due to the use of the earth as a return conductor in traction work. Although some of the questions raised have been of only temporary interest, yet as it is certain that wherever there are electrical distribution systems there will certainly be earth currents, the consideration of the earth as a conductor and of the phenomena accompanying earth currents is a subject of permanent interest. My connection with the practical side of the subject has been hardly more than sufficient to enable me to see how many problems there are yet unsolved, but it has been thought that a general statement of some of the conclusions arrived at, accompanied by a demonstration of their application to the explanation of certain well-known facts would serve to open the subject for discussion, when undoubtedly a quantity of useful data and opinions will be forthcoming.

As the theoretical part of this subject has been built up in connection with the question of magnetic effects, the matter will be most easily approached from that point of view. I am indebted to Mr. Trotter, with whom I was experimenting in March, 1900, for drawing my attention to certain early work of Heaviside's written at a time when earth return currents were, to say the least, not likely to do away with gas and water pipes, and which forms the basis of the following considerations. The principal conclusions with reference to the magnetic effects were arrived at before April, 1900, but I was prevented at the time from publishing them, principally by illness, except among interested parties.

We shall commence by considering the current distribution accompanying the use of the earth as a return in a simple traction system, and we shall approach the subject from the magnetic side. On first consideration it might appear that the magnetic effects at any point away from the rails would be produced principally by the currents in the immediate neighbourhood, but this is not the case, for the magnetic forces due to the long-distance streams of current are roughly only inversely proportional to their distance, so that the large current flux passing through the enormous areas below the tract will have a relatively large effect as compared with that due to the small current flux in the immediate neighbourhood. In determining the magnetic effects at any point it is necessary, therefore, to consider the magnetic effect due to the current system as a whole. Should the whole current return by the rails the magnetic effects due to the current in the trolley wires and rails would practically cancel, except in the immediate neighbourhood. A large proportion of the current, however, returns by the earth, and at a distance from the trolley wire. The magnetic effects due to the current in the trolley wire, therefore, are not cancelled by the return currents. In this sense it is correct to say that the effects are due to the earth currents. When the engineer familiar with electric circuits turns his attention to problems connected with magnetic circuits, he is assisted by finding relations between magnetomotive force, magnetic flux, and reluctance, similar to those between E.M.F., current, and resistance. When he meets with problems involving the distribution of current fluxes in space instead of in linear conductors, he will be assisted by his familiarity with the distribution of magnetic fluxes under similar conditions. There is, perhaps, something more than an analogy here between the electric and the magnetic flux, and may be it is only due to the limitations of our present state that we do not recognise it. The two fluxes are always linked together in closed circuits, and there is a definite quantitative relation between the two. The difference in permeability between the most permeable and the least permeable substance is something of the order of 3,000. The difference in conductivity between the best conductor and the best insulator is, of course, of a higher order altogether. It is practicable, therefore, to carry current fluxes through very long conductors of small section without appreciable loss, while this cannot be done with magnetic fluxes. Perchance, some would-be pioneer has already applied for a patent for transforming up magnetomotive force, and it is only the difficulty of obtaining the necessary magnetic insulation between the turns in his magnetic circuit that will give him trouble. Two turns might be practicable. We are familiar with the calculation of magnetomotive force in a closed magnetic circuit from the current flux passing through that circuit from the relation:

$4\pi \times$ current flux = magnetomotive force, or line integral of magnetic force.

We know also that we cannot produce magnetomotive force in the

* Paper read before the Institution of Electrical Engineers.

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circuit by means of currents which do not link with the circuit. From this it follows that given the magnetomotive force in a closed circuit we can calculate the current which passes through, and is linked with, that circuit. In general in any magnetic system produced by a corresponding current system, we may calculate the current passing through any closed curve by taking the line integral of magnetic force round that curve and dividing by 4π. The first practical deduction to be made from these considerations is that at any point where the magnetic flux is relatively weak, the current must also be relatively weak. On the assumption that the specific conductivity of the earth is uniform, and that the return currents enter and leave at points, it may be shown that the magnetic force directly due to the earth currents has no vertical component. If this is so, then no part of the vertical component due to the current in the trolley wires and feeders is cancelled by the earth currents. We may see, also, that except close to the line the magnetic field due to the current in the trolley wire will have no horizontal component. In the hypothetical case, therefore, the horizontal component is wholly due to the earth currents, and the vertical component to that portion of the trolley and feeder currents that is not cancelled by the rail return current. We know that in the immediate neighbourhood of the track the trolley current will have a considerable horizontal component. Half a mile out, however, this component will be quite negligible, and the general statement holds good. Should the assumptions made not be representative of the real conditions, then in the real case some portion of the vertical component will be cancelled and the magnetic field reduced. The only exception to this would occur in case there were a large conducting system lying in and parallel with the current stream and having good electrical connection with the earth. As the above allocation of the horizontal and vertical components of the magnetic forces is of considerable importance, some amount of explanation is desirable. Take the simplest hypothetical case, in which a certain current goes from A to B in an insulated conductor lying on the earth's surface and returns by the earth, entering the earth at the point B and leaving it at the point A. The magnetic field due to the current in the insulated conductor will be a circular one, the lines of force entering and leaving the earth's surface at right angles, so that at the surface there is no horizontal component.

Consider now the current flux entering the earth at the point B. The current will tend to spread out uniformly in all directions, its density decreasing with the square of the distance and the potential varying inversely as the distance. The current flux distributes in a medium of uniform conductivity as a magnetic flux would distribute in a medium of uniform permeability, and we may calculate the resultant distribution of a current entering at one point and leaving at another just as we should calculate the resultant magnetic flux due to a north pole at the first point and a south pole at the second. The current strength at any point will be in direction and strength the resultant of the incoming and outgoing currents there would be at that point were there only an inconing or outgoing current flux. Now, the magnetic field due to a current entering the earth's surface at B and diverging uniformly will obviously be symmetrical about a vertical axis. It will have equal strength at equal radii at points on the earth's surface and in planes parallel to it. Whatever the distribution may be, we know that the line integral of the magnetic force round any closed curve $\div 4\pi$ will give us the current passing through that curve. We are most interested in the force at the earth's surface. Assume for the moment that the current arrives at B along a straight vertical wire, then any closed curve on the earth's surface including the point B will include the whole current. We have now found two conditions—namely (a) uniform, and therefore circular, distribution of the magnetic field, the circles having circumferences of $2\pi r$; (b) line integrals round these circles to be all equal and to have value $4\pi c$. The field strength, therefore, at any point will equal $\frac{2c}{r}$ The field at the surface, however, due to the long wire bringing up the current to the point, B, will $= \frac{c}{r}$; therefore the field around B due to the diverging current flux, which is what we require, will also equal $\frac{c}{r}$. It is obvious from symmetry that there can be no vertical component.

We may now resolve our forces due to the systems at A and B. For the horizontal component, if B is distant d from A, then the force at any point p distant r_1 and r_2 respectively from B and A $= \frac{c\,d}{r_1\,r_2}$ in absolute units. If the current is fed along a wire from A to B, the vertical component at $p = \frac{c}{l}(\cos\theta_1 + \cos\theta_2)$, where l = perpendicular distance of p from the wire and θ_1 and θ_2 are the angles between the wire and r_1 and r_2 respectively. It has already been shown that current passing along the trolley line and feeders and returning by the rails has no appreciable magnetic effect except in the immediate neighbourhood of the track. For the purposes of calculation, therefore, we neglect this portion of the current. For the purpose of a first approximation we may guess at two points, A and B, at which the current may be supposed to enter and leave the earth, and apply the above formulæ.

Mr. E. Parry has shown that on the assumption that the principal resistance offered to a current entering or leaving the track is in the immediate neighbourhood of the track, that the track is uniformly grounded, and that all the current enters the rail at one end and leaves it at the other, the amount of current leaving the track from point to point follows an equation of the same form as Fourier's equation for the heat flux radiating from a long conductor heated at one end. Prof. Rücker, who arrived independently at this result and also at the source and sink theory above described, has given a mathematical treatment of the subject in a contribution to the Physical Society, which appears in the *Philosophical Magazine* for April this year. Prof. Rücker shows how to calculate the vertical magnetic effects on the assumption of the Fourier bar theory and the source and sink theory combined, and Dr. Glazebrook has worked out some examples and deductions from the same. Fortunately, or unfortunately, the hypothetical cases rarely fit the real cases, and I find an intelligent use of the simple formulæ given above leads to quite as accurate results as the use of the more complex formulæ alluded to.

Before making practical application of these conclusions, there is another fundamental question which requires to be dealt with.

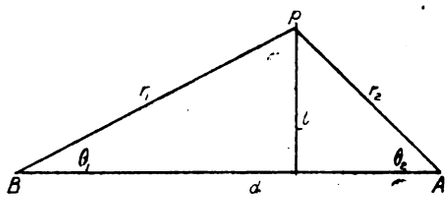

FIG. 1

Doubt has been thrown on the truth of the fundamental assumption of the source and sink theory. It has been suggested that while the experience of traction engineers goes to show that the earth is a very reliable quantity—that, for instance, the proportion of the total current which leaves six miles of line is nearly independent of the situation of that line—yet the earth may not be a homogeneous conductor. Dr. J. Edler has suggested that the return currents are carried by a layer of damp ground extending only a small depth below the surface, having founded this theory on the results of experiments performed near the electric tramway of Spandau. Now, a little consideration will show that the formulæ deduced above for the magnetic

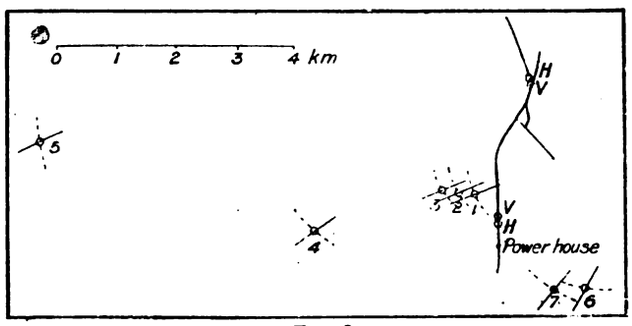

FIG. 2.

effects at the surface of the earth, due to return currents flowing through it as a homogeneous conductor, are equally applicable to the surface conditions due to certain conditions in a thin layer of earth.

TABLE I.

Observed.						Calculated.					
0·4 mile.			0·8 mile.			0·4 mile.			0·8 mile.		
V.	H.		V.	H.		V.	H.		V.	H.	
4·5	3·0	.....	1·5	1·5	.....	4·2	2·1	.....	1·7	1·25	
4·5	2·3	.....	—		.....	—		.....	—		
3·0	2·3	.....	—		.....	—		.....	—		
3·0	1·5	.....	—		.....	—		.....	—		
4·5	—	.....	—		.....	—		.....	—		
4·5	—	.....	—		.....	—		.....	—		

V = Vertical component. H = Horizontal component.

The vertical effects due to the outgoing current are obviously unaffected, while the reasoning previously applied to the calculation of the horizontal forces will be found to apply also in this case. As this is a point of considerable importance, I shall proceed to show that the theory fits the facts. Prof. Rücker has already shown

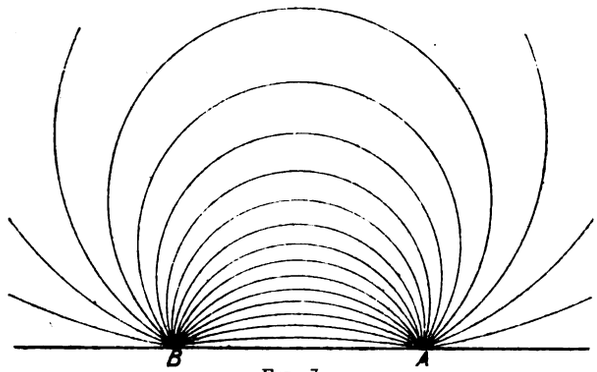

FIG. 3

an agreement between theory and experiment based on measurements made at Stockton. I give in Table I. the measured disturbances reduced to 100 amperes in the outgoing feeder, the line being two miles long and the observing stations 0·4 and 0·8 miles distant, along a perpendicular from the centre of the line, and side by side I give my calculated values on a first approximation. The units used $= \frac{1}{10000}$ absolute units. Dr. Edler's experiments covered a much larger area,

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the most distant observing station being nearly five miles from the track. Fig. 2 shows the relative position of the track and of the seven stations at which observations were made. From the observed forces I have calculated the leakage currents. I have assumed that a current flowing through the earth between the points H H would produce about the same horizontal disturbance as the actual current stream, and that a current of uniform strength flowing in the trolley

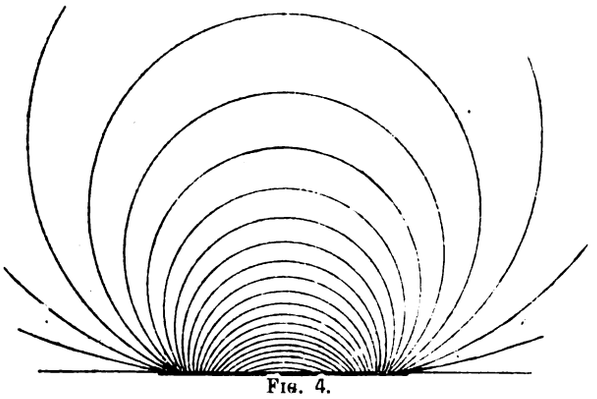

FIG. 4.

wire between the points V V would produce about the same vertical disturbance. The results obtained are given in Table II.

TABLE II.

Station.	Observed disturbance.		Leakage current calculated from observed disturbance.	
No.	V.	H.	From H.	From V.
1	25·2	9·5	53 amperes	64 amperes
2	10·6	6·1	47 ,,	57½ ,,
3	4·3	4·3	46½ ,,	42 ,,
4	0·95	1·3	77 ,,	66 ,,
5	0·24	0·44	113 ,,	59½ ,,
6	1·00	1·4	58½ ,,	37 ,,
7	1·10	1·7	52 ,,	36½ ,,

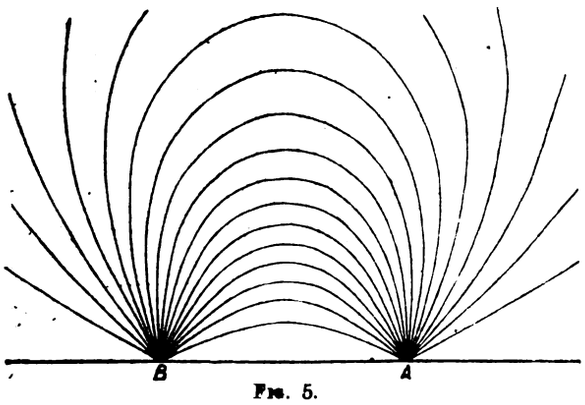

FIG. 5.

Although at first sight this may not seem a striking confirmation, on examination of the figures in the two right-hand columns, together with the diagram, reveals several interesting features. (1) Except at the first two stations the vertical force appears to have been proportionately less than the horizontal, showing that some portion of the vertical force has been cancelled by irregularities in the current streams. (The line bends outwards towards the two first two stations, which being the nearest are most affected thereby, thus accounting for the apparent discrepancy.) (2) The current fed along the part of the

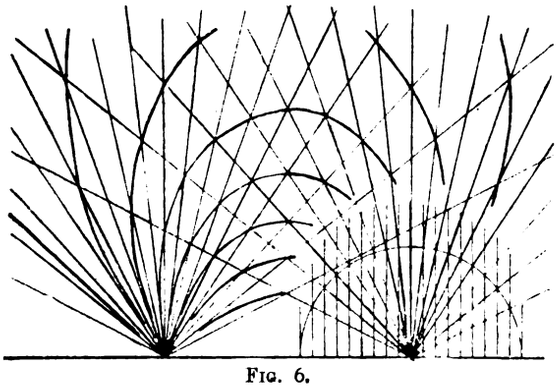

FIG. 6.

line below the power-house is reversed in direction, thus accounting for the apparent reduction of the vertical effects at stations 6 and 7, without affecting the horizontal disturbance. (3) Considering the above the vertical effects are far more uniform than the horizontal, which would be expected from the uniformity of distribution of the line current as compared with the earth currents. (4) It may be noted that, excepting station 5, at any particular station there is a good agreement between the currents calculated from the two disturbances, the differences between station and station being undoubtedly due to variations in the load from day to day, the experiments having been made on different days at different stations. At station 5 the whole calculation turns on the measurement of a few millionths of a line of force per square centimetre.

Taking the figures as a whole, we may estimate the leakage current as about 60 amperes—not an unlikely value, considering the length of the line and the service, 15 motor and two trailer cars. The agreement between the observed and calculated values given by Dr. Edler is, in the case of the horizontal disturbances only, closer than that just shown. The formulæ used, however, appear empirical, and the closeness of agreement more unfortunate than otherwise, as Dr. Edler was probably misled into accepting the theory, as was the writer at first, by the agreement obtained. Dr. Edler makes no attempt to calculate absolute values or to show agreement between the relative values of the horizontal and vertical disturbances. The direction of the observed horizontal disturbances is indicated in Fig. 2. In the case of a current sheet these disturbances should be normal to the current stream lines. These lines should be circles passing through the points H H. The dotted lines in the figure are portions of such circles, and it will be seen that they are approximately normal to the magnetic lines. The direction of the current lines would not be very different were the earth a solid conductor. In Fig. 3 are shown the current streams for a sheet, the current entering at B and leaving at A. Fig. 4 illustrates an approximation to the current distribution that would obtain in a hypothetical case in which all the current is fed into one end of the rail and taken out at the other, the leakage being distributed as in a Fourier bar. Fig. 5 gives the surface distribution of current streams on the assumption of a homogeneous earth, the current being fed in at B and taken out at A. A simple graphical construction for obtaining these curves is given in Fig. 6, and is the same as would be used for a magnetic flux.

(To be continued.)

FORTHCOMING EVENTS.

FRIDAY, FEB. 28.

Electro-Harmonic Society.—Ladies' night concert at St. James's Hall, W.

SATURDAY, MARCH 1.

Royal Institution.—At 3 p.m., Lord Rayleigh on "Some Electrical Developments."

Institution of Electrical Engineers (Students' Section).—At 10.30 a.m., visit to the generating station of the London United Tramways Company, Chiswick.

MONDAY, MARCH 3.

London School of Economics.—At 6.15 p.m., Mr. L. Macassey on "Electric Traction on Railways" (Lecture IV.).

Society of Engineers.—At 7.30 p.m., ordinary meeting. Paper: "British *versus* American Patent Law, Practice, and Engineering Invention," by Mr. B. H. Thwaite.

TUESDAY, MARCH 4.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be further discussed: "Electrical Traction on Railways," by Messrs. W. M. Mordey and B. M. Jenkin.

Royal Institution.—At 3 p.m., Mr. Wm. N. Shaw on "The Temperature of the Atmosphere" (Lecture II.).

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m. Paper: "Electric Furnaces," by Mr. B. Blount.

WEDNESDAY, MARCH 5.

Institution of Civil Engineers.—At 2.30 p.m., students' visit to the works of the Vauxhall Bridge in course of construction.

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "Sound Signals," by Mr. E. Price Edwards.

THURSDAY, MARCH 6.

Institution of Electrical Engineers (Dublin Section).—At 7.30 p.m., extra meeting. Adjourned discussion on "Notes on Irish Water Power and its Electrical Development," by Mr. W. Tatlow.

Institution of Electrical Engineers (Students' Section).—At 3 p.m., visit to the Thames Ironworks, Blackwall.

Rontgen Society.—At 8.30 p.m., ordinary meeting. Paper: "Localisation, with Demonstration of a Simple Direct-Reading Apparatus," by Dr. Barry Blacker.

Carpenters' Hall.—At 8 p.m., Prof. W. Ramsay on "The Bearing of Modern Chemical Theory on some Problems connected with the Building Trade."

FRIDAY, MARCH 7.

Royal Institution.—At 9 p.m., Prof. H. Becquerel on "Radio-Active Bodies" (in French).

SATURDAY, MARCH 8.

Royal Institution.—At 3 p.m., Lord Rayleigh on "Some Electrical Developments" (Lecture IV.).

Manchester Association of Engineers.—Ordinary meeting. Paper: "Efficiencies of Electric Cranes," by Mr. R. Matthews.

National Physical Laboratory.—His Royal Highness the Prince of Wales will open the National Physical Laboratory on Wednesday, the 19th prox. The ceremony will take place in the afternoon at Bushey House, Teddington, a special train conveying the guests from Waterloo.

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BETTER TO PAUSE.

The *Financial News* in a statistical article upon "British Corporation Debts," concludes with these sentences: "It will be seen that the debt is increasing out of all proportion to the increase of population. And it is a fact that many corporations have only just begun to realise their powers. The tendency is to 'municipalise' in every direction. Is it rash to prophesy that the next decade will see an increase in corporation indebtedness as great as the past?" The statistics of the *Financial News* relate to indebtedness per head of population—a merely academic way of treating the subject, interesting, no doubt, as figures, but absolutely valueless from a practical point of view. Let us briefly state our reasons for making such a sweeping statement. The incidence of rating falls, not upon each head of population, but upon individual ratepayers. A business man works for the support of a household, and all payments for that household fall upon this head, and he may be only one of five or ten, the total number of the household dependent upon the head. Indebtedness is not usually distributed per head through the whole family and dependents, but is concentrated upon the head of that family. This is, from a business point of view, as it should be, for unless the man is capable of obtaining funds for the payment of the family debt, it is certain that the twins in the cradle are not capable. Let our contemporary ascertain the total number of ratepayers in a given town and distribute the indebtedness of the town over that number, and then it will see the true inwardness of things concerning rates and rating Few people as yet realise what the corporation indebtedness of this kingdom means. The individual members of local authorities themselves are mostly in total darkness upon the subject. It would be forcibly brought home to many minds if the statistics were generally given in the manner we have indicated, but this would give but half a tale, and an equally untrue notion of the real incidence of rating debt. In most towns quite half the householders are compounders, and fluctuations in rating do not concern them. There may be only one ratepayer who feels fluctuations in these cases to every ten or twenty householders. Thus, when the question is so briefly discussed, it will easily be seen that the evils of such enormous indebtedness have to be borne upon the shoulders of probably less than a tenth part of the population. Taking our view of the case, the indebtedness of Huddersfield, instead of being thirty-three pounds twelve shillings and fivepence per head of population, is more like three hundred and thirty pounds per head of responsible ratepayers. The moral we have in view arises from such reasoning as is contained in the following sentences in our contemporary's article: "It has often been put forward that the indebtedness of a corporation reflects its enterprise, and to some extent there may be truth in this. If a town undertakes to 'run' its own trams, water, and what not, capital has to be found, but this is hardly debt in the strict sense. Such money is productive; frequently it earns substantial dividends in spite of the obvious desire to sell as cheaply as possible.' Now for the moral, and let us take it from electrical operations. The promoters of the huge central stations wherein millions of horse-power of energy are to be generated state, and state with a great amount of truth, that the time of small stations is more or less past, because the energy generated will have to be generated for the distribution of power, and not so much for lighting purposes. The latter will be more or less of a by-product, the direct operations being for power. It may be, then, that corporation indebtedness, not foreseeing such development, may be in the nature of a hindrance to progress rather than an

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accelerator, and in many cases should be avoided if the desire is to do the best for the whole community and not for the individual.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

WHEN DOCTORS DISAGREE.

SIR,—The first portion of Mr. Clirehugh's letter published in your current issue is practically an admission of my contention, that his statement was both unfair and misleading without qualification. He then writes me a lecture on the popular errors I have fallen into, and goes out of his way to show that his knowledge does not extend to the conditions of power supply in a modern cotton mill. I may say that I know such a mill in Bolton where the friction loss in the engine is 8 per cent., and the loss in gearing, shafting, and belting 17 per cent., so that 75 per cent. of the power is effective or brake horse-power. Further, the power does not vary 5 per cent. at any time during a week's run. This mill is merely an example of hundreds of its kind scattered throughout Lancashire. Mr. Clirehugh's assumption of 1 kw. being equal to 2 i.h.p. may be true in some cases, and if this be so, am I right in assuming that the 230 h.p. demanded by the Lancashire Dynamo Company from the Trafford Park Company was represented on the demand indicator by 115 kw.? This, however, has nothing to do with the main question.

In conclusion, I should like to compliment the Trafford Park Company on the extremely moderate price they appear to charge for current to a consumer with a 6 per cent. load factor. I wonder what their charge per unit is to a consumer with a 25 per cent. load factor? Possibly their diversity factor is so high that the load factor of individual consumers is a matter of indifference.—Yours, etc.,

J. E. PANTON.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

459. I wish to obtain two voltages from the same dynamo. Mr. Sayers stated in 1898 that this can be done for the purpose of exciting the field magnets by means of a third brush, the current, of course, in this case being small. Could I on a 100-kw. dynamo take off 60 kw. (variable load) at a third brush and the remaining 40 kw. at the usual brushes? If not, why not, and what must be done to render it possible? The high voltage (360) is desired for charging accumulators, and the lower voltage (250) for driving motors, etc.—D. S.

460. Explain what is meant by the limiting resistance and critical speed of a shunt dynamo.—C. E.

ANSWERS.

Question No. 453.—Mention some conditions and requirements to be taken into consideration in selecting a good oil for (A) cylinder, (B) ordinary lubricating, and give some simple tests which can be carried out in the workshop without elaborate apparatus?

Answer to No. 453 (*awarded 7s. 6d.*).—The points to be noted in the selection of oils are: (1) specific gravity; (2) viscosity; (3) gumming—*i.e.*, quick oxidation; (4) flashing and burning points; (5) acidity; (6) coefficient of friction.

1. The specific gravity of an oil is tested by a hydrometer, a small weighted glass tube with a bulb at the bottom and the weight underneath (Fig. 1) and a graduated scale above. The hydrometer is placed in the oil to be tested, and when it comes to rest the specific gravity is read off direct on the scale.

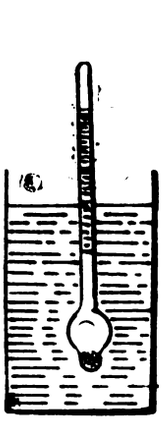

FIG. 1.

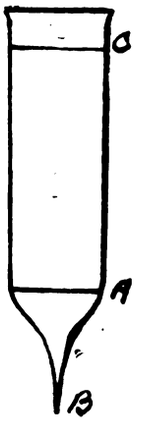

FIG. 2.

2. (*a*) One way to test for viscosity would be to take a fairly wide glass tube, C, A, B (Fig. 2), with a long point, A B, of small bore, and fill it up to a fixed mark, C, with the oil sample, and note the time taken for the oil to fall from C to A by discharging through A B. The same experiment could be carried out for water. The time taken by each is a measure of their relative viscosities. (*b*) Another method would be to suspend a heavy weight by means of a steel wire in the oil, and give it a fixed twist. The greater the viscosity the shorter time will the weight vibrate.

3. Lineham gives the following method for observing "gumming." The oils are dropped from a tube, A, and

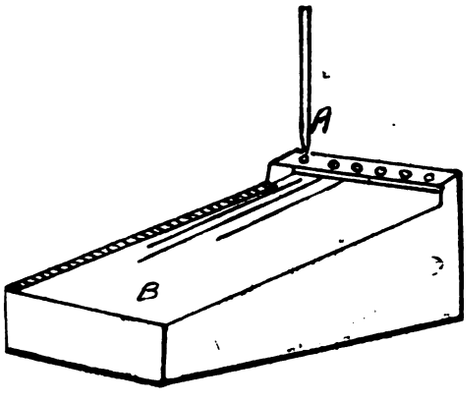

FIG. 3.

flow down a glass plate, B, having a scale fixed on its side, and the positions on the scale are taken daily.

4. Flashing point may be got by heating the oil and seeing at what point its vapour ignites.

5. Acidity can be tested for by keeping a piece of blue litmus paper immersed in the oil and seeing if it has any tendency to turn red.

6. I do not know any method of testing the coefficient of friction anything like accurately without proper apparatus. A very rough test would be to tilt a smooth metal door, A (Fig. 4), smeared with the oil and noting at what angle α the weight, B, on its surface began to slide. The tangent of the angle α would be the coefficient of friction.

For a cylinder oil or a lubricating oil required to stand high temperatures, an additional rough test is to heat up a bearing (experimental) and note the action at the required temperature. Any sign of effervescence in a cylinder oil at the temperature of the steam in the cylinder for which it is required denotes that the oil is not suited for its purpose. A cylinder oil is usually a heavy oil, having a specific gravity somewhere about ·89, and being able easily to withstand the heat to which it will be subjected. The viscosity is usually high, and the flashing point is

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likewise high, probably somewhere near 650deg. F. The oil would require to be free from acid and have as low a coefficient of friction as possible. A lubricating oil has a lower specific gravity—about ·87—requires to be more fluid, and has a lower viscosity. It would require to have sufficient body for its purpose, and be able to store and carry away the greatest amount of heat possible. If used for an ordinary worsted siphon feed it would require to have a certain amount of capillarity, and would be free from acid and have a low coefficient of friction. It ought

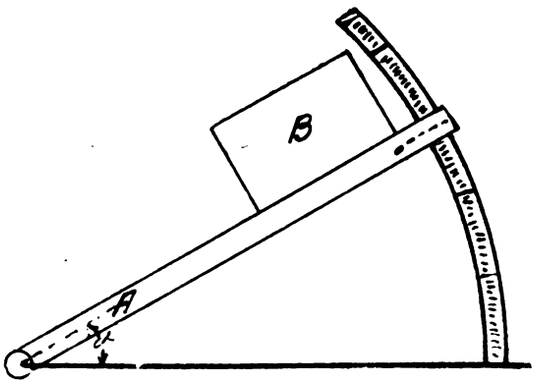

FIG. 4

also require to give satisfactory results under the "gumming" test.—T. M. C. G.

Answer to No. 453 (*awarded* 7*s.* 6*d.*).—In choosing an oil for lubricating cylinders of steam-engines, I always select a good black mineral oil, thicker than old-fashioned treacle, and with a very high flash point—*i.e.*, about 600deg. F. The specific gravity of this oil is 897, water being 1,000. I always rub it between my finger and thumb, and find that it has a good body, or, in other words, that it is not easily rubbed off. The high flash point is a guarantee that it will not be volatilised by the heat of the steam, and its "body" keeps the piston from rubbing the cylinder. This oil may be passed through hot or cold water, drop by drop, either in the usual sight-feed lubricators or by means of a little nozzle held under the surface of a bucket of water without alteration. Of course, as the oil is lighter than water, it must be set free from a tube drop by drop whilst held well under the surface, and then the drops will rise to the surface. Under these circumstances a good cylinder oil will not change its colour, or its consistency, or its general appearance. On the other hand, I have tried samples with a greenish tinge and specific gravity of 878, and these invariably turned brown by passing through water drop by drop as above, and when in the lubricators I find that they block the passages and nozzles in the course of a few hours—in fact, the oil turns brown and somewhat like a jelly. It is an inferior oil, and not so good a lubricant as the black oil by a very long way. A vegetable oil would not do in the cylinder of a steam engine, because the hot steam would decompose it into a glycerine and a fatty acid, both of which would be practically useless for lubrication, and the fatty acid would be worse, because it would attack any metal it touched and corrode, so making unnecessary wear and tear. These oils, and also tallow, may, however, be used safely and to good purpose in low-pressure cylinders, but mineral oil is safer and better, and also cheaper.

For lubricating machine bearings, a few years ago vegetable and animal or fish oils were used almost everywhere, but for some years past they have been gradually superseded by mineral oils, which for most purposes are cheaper, cleaner, and better. I use mineral oils exclusively on my machinery, and have done for at least 15 years. I select an oil which feels thick, and has a good "body," when rubbed for a few minutes between the finger and thumb. It is necessary to continue the rubbing for a few minutes, so that the oil may get fairly warm, because a good many of these oils lose their "body" or consistency by getting warm, and then they feel like water, hard to the touch, instead of soft and unctuous, as they should do. Such an oil is generally cheap and nasty, and would be unable to lubricate a bearing so as to keep it cool. All oils lose consistency or viscosity by warming. Having selected my samples by finger rubbing, I fill a sight-feed drop lubricator over a bearing which experience has taught me is the most troublesome I have, and if the oil I have selected as best can keep this bearing cool, then I buy from that sample. An oil which will not keep the bearings cool is useless. The number of drops per minute used should be noted with each sample, as they represent the quantity of oil used, but, of course, the oil running from the bearings is caught and used again. There is no risk to the machinery in this, because as soon as the bearing begins to get hot, good oil can be put in and the useless sample can be thrown away. As soon as the bearing is cool again, another sample can be tried. In many places an experimental bearing could be rigged up purposely, and its screws so adjusted that only a really good oil would keep it cool. Any oil which would pass this test could safely be used. With mineral oils no other test is necessary, as they are not likely to be acid, but if there is any doubt about this, or whether the oil may contain vegetable or other oil, then put a clean needle in it, and also a clean, bright piece of copper. Let these two metals touch each other, and if there is any acidity the needle will be rusted in the course of a few days. If copper alone is used it will turn green, and if iron alone it will rust, but it will take longer than it does when touching the copper. Vegetable oil is very apt to become gummy after exposure to the air. The quickest way to test this is to put some of the oil in a glass, soak some worsted in it, and then let the worsted hang well over the side of the glass, when it will siphon the oil over slowly and well expose it to the air, so that in a day or two the worsted will become swelled up where it is exposed to the air, and will be gummy or sticky to the touch, whereas the part of the worsted in the oil in the glass will in most cases be just as it was when the experiment started. This experiment should not be too prolonged, and it should be conducted under cover, which will allow free access of air and light, but not of dust. If tallow smells rank it is certain to be acid, and it is not then in its best state for lubrication. The best thing to do with such tallow is to sell it to the soap-maker.—F. G. A.

Answer to No. 453 (*awarded* 7*s.* 6*d.*).—All lubricating oils should possess the following properties in more or less degree according to the purpose for which they are to be used: (1) a high power of diminishing friction; (2) to fill the above requirement should have "body," "viscosity," or capillarity enough to keep the surfaces between which it is used from coming into contact at the maximum working pressure and temperature; (3) it should have the greatest fluidity consistent with the preceding requirement; (4) the coefficient of friction should be as low as possible under working conditions; (5) it should not "gum" in use; (6) it should not attack the surfaces with which it is in contact, hence it must be neither acid nor alkali; (7) the "flash point" where it starts giving off combustible vapour should be above the maximum temperature to which it may be heated in use; (8) it should be free from grit and suspended matter; (9) it should remain liquid at about 10deg. F.

Now, the great differences between cylinder oil and engine oil are that the cylinder oil has to work at the temperature of the boiler steam, which may be anything up to 400deg. F. or above, while the engine oil has only to do its work at the temperature of the bearings, which is probably only about 150deg. F. or so. The engine oil is, however, subjected to more churning than the cylinder oil, especially in engines where forced lubrication is employed, and the oil is used over and over again. Oils may be either animal, vegetable, or mineral. Of the first, sperm oil is unexcelled for very light, delicate machinery, and lard oil for heavy rolls, etc. Olive oil is the best vegetable oil, but almost all engine and cylinder oils are now mineral oils, as they do not "gum" or decompose into acids, as the animal and vegetable oils are found to do.

We will consider cylinder and engine oils in turn.

(A) *Cylinder Oil.*—The most important test which can be easily made is the determination of the flash point. The apparatus is shown in Fig. 1, which represents the

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type manufactured by Baird and Tatlock. The test is carried out by heating up a sample of the oil in a brass dish, A, fitting into a thick cast-iron "pot," B. This is made thick in order to keep the temperature from suddenly varying. C is a high-reading thermometer; D is a small fan worked by the handle, E, to keep the mass of oil at the same temperature throughout; F is a small sliding plate which covers two apertures, G, above which a tiny flame is kept burning. The temperature is gradually raised, and the flame is applied to the aperture, G, every now and again by means of sliding back the plate, F, until at last the oil begins to give off vapour and a "flash" occurs.

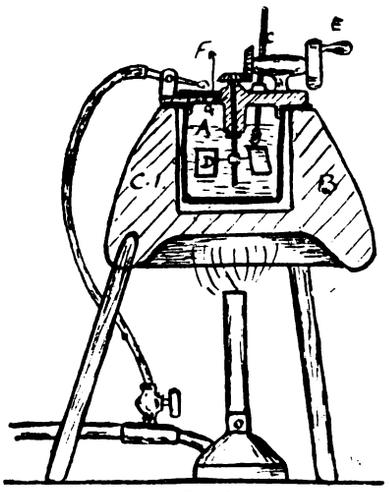

FIG. 1.

The temperature is then carefully noted on the thermometer. A good cylinder oil should have a flash point of about 600deg. F. Another small sample of the oil should also be shaken up in a test tube with litmus solution to test for acidity. A little may also be exposed in an open shallow dish for some time in an oven, or some place at a high temperature, to see if it becomes "gummy." Grit or suspended matter may easily be detected by thinning the oil with benxyolene.

(B) *Engine Oil.*—The principal thing here is the viscosity test, which should be taken at the normal working temperature of the bearings (80-150deg. F.). The apparatus shown in Fig. 2 is a Boverton Redwood viscometer. A is a sort of inverted copper saucepan, with an inner cylindrical centre, B, containing the sample of oil. The outer

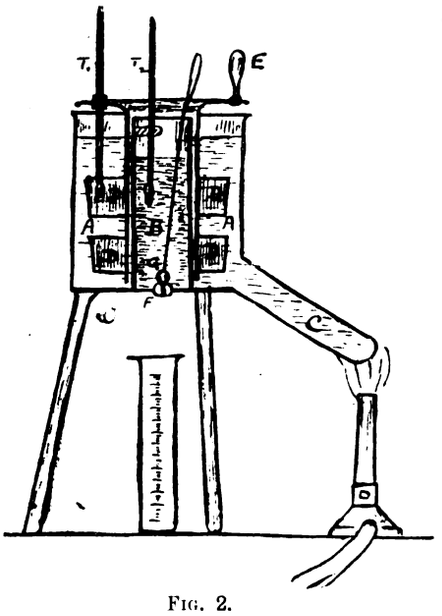

FIG. 2.

annular space is a water jacket, which is heated up by a Bunsen under the "handle," C. This keeps the oil at a uniform temperature throughout, with the assistance of the annular stirring vanes, D D, which are moved to and fro by the handle, E. T_1 T_2 are thermometers. F is a small amber bead, through which a fine hole is drilled. This hole is closed by means of a ball valve, G. When the oil has been raised to the required temperature the ball valve is removed, and the time that a certain standard volume of oil takes to run through into a beaker below is carefully noted on a stop-watch. This time, when compared with the time taken by the standard oil at the same temperature, is a measure of the viscosity at this temperature.

Cylinder oil may also be tested for viscosity, but there are difficulties in taking it at working temperatures. Its viscosity may, however, be taken at 200deg. F. to give a rough indication of its viscosity at higher temperatures. In addition to the above, engine oil may be mixed with water and churned up with an egg-beater (or something equivalent) for some time. It should then stand, and the time taken for the oil to separate from the water carefully noted. This is especially important for engines using forced lubrication.

The following are a few readings taken with one of Redwood's viscometers, where water at 60deg. F. takes one second :

Kind of oil.	Number of seconds taken at 120deg. F.	Number of seconds taken at 300deg. F.
Sperm oil	2·42	—
Rape oil	5·78	—
Tallow, beef	5·3	—
Russian spindle oil	3·55	—
General machine oil	4·0	—
Cylinder oil, No. 1	19·44	1·41
Cylinder oil, No. 2	12·0	1·31
Gas-engine oil	5·0	—
Gearing oil for heavy work	17·5	—

The coefficient of friction can be experimentally determined by various oil-testers, such as McNaught's, Thurston's, or Goodwin's, etc., but they are rather too complicated for workshop use. The coefficient depends on the kind of oil, the temperature, the pressure, and the speed, etc.; it decreases with the load and increases with the speed. Mr. A. M. Worthington, of the American Civil Engineers, gives the following table for good average engine oil, which shows this :

Speed in feet per minute of periphery of journal =	2·16	3·33	4·86	8·82	21·42	35·37	53·01	106·02
Coefficient of friction =	·094	·0705	·0685	·055	·047	·04	·035	·0255

—A. W. M.

Answer to No. 453 (*awarded* 5*s.*).—In deciding upon a lubricant for any purpose, it is necessary to ascertain in detail the conditions under which efficient lubrication has to be maintained. It is of first importance to know the pressure upon the bearing surface to be lubricated, so that a lubricant of sufficient "body" or "density" may be selected. The temperature to which the lubricant will be subjected must be ascertained. More especially is this necessary where cylinder oil is being selected, and an oil with a "flash" point well above the maximum temperature

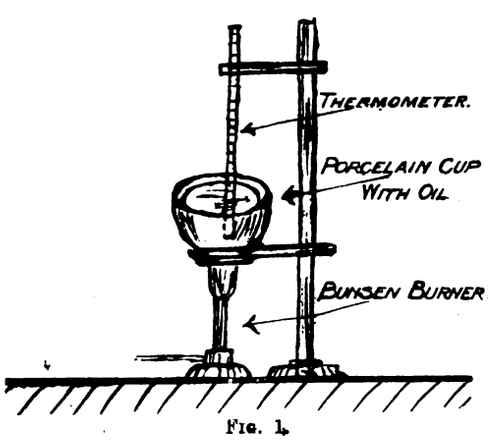

FIG. 1.

must be obtained. It is absolutely necessary this should be so, otherwise if a low-flash oil is used the high temperature of the cylinder will decompose it, and thus neutralise its lubricating properties. This is one of the chief difficulties experienced with superheated steam. Having briefly referred to the essential features of a lubricating

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oil, we will consider a few rough tests which may be made to determine how far a sample of oil complies with the requirements of any particular case. Taking first the "flash point." There are several simple means of ascertaining this, readily adapted for workshop use. Take an ordinary open porcelain cup, and fill it with the oil to be tested to within about ½in. of the top, and place underneath it a Bunsen burner, as shown in Fig. 1. Gradually heat the oil until vapour commences to rise from it, pass a lighted taper over it, and note when a flash shoots across the cup. This will be the flash point of the oil, and the temperature must be carefully taken by means of a thermometer dipping into the oil, but not touching the bottom of the cup. A similar and equally simple arrangement is shown in Fig. 2. This consists of two vessels arranged something after the style of a

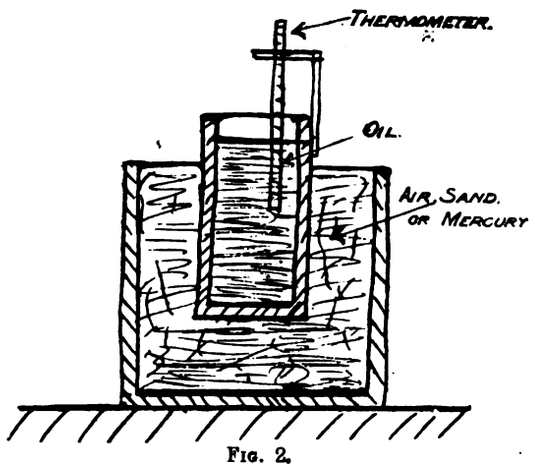

FIG. 2.

glue-pot. The inner vessel contains the oil and has an open top. The space between the two vessels can be filled with air, mercury, or sand, to ensure an even distribution of heat; or by making the outer vessel sufficiently strong to stand the pressure, steam may be used. The flash point and temperature to be taken as in the preceding test. Low-flash oils should never be used; a minimum of 350deg. F. for ordinary purposes, and 500deg. F. for cylinder lubrication is safe practice, but a lower flash point than this would not be satisfactory.

The viscosity or "body" of an oil is not easy to ascertain accurately without some good form of viscometer, but may be roughly taken as follows: Take a glass tube, say, ⅜in. to 1½in. diameter, and draw one end out to a taper point with an aperture at the end about $\frac{1}{32}$in.

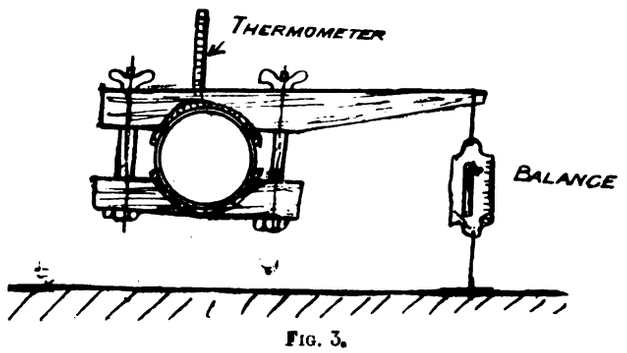

FIG. 3.

diameter. Fill this tube to a definite height with distilled water and note the time, either between each spot or the total time taken for the tube to empty. Now fill the tube with the same quantity of oil, and take notes as before: this is the viscosity of oil as compared with water. In order to test the oil for viscosity at various temperatures, the tube must be surrounded by water, the temperature of which can be varied for the different readings.

An essential feature of a lubricating oil is that it should be as free as possible from acid in any form. All animal and vegetable oils contain a certain quantity of acid, while mineral oils may be obtained practically free from acid. Metals are acted upon by acids in oils as follows: copper is affected by tallow, seal, olive, and rape, iron by tallow and sperm, lead by whale and lard oil, brass by olive oil, zinc by sperm, and tin by cotton-seed oil. The presence of acid may, of course, be detected with litmus paper. Gumminess is another point which has to be considered. The tendency of an oil to gum may be found by exposing it to a fairly high temperature for, say, 30 hours; or another practical test is to oil a spindle and note the friction. If there is any great tendency for the oil to gum, the friction of the spindle will be considerably increased after standing for, say, 24 to 48 hours. The specific gravity of the oil should be obtained by the aid of a hydrometer.

The above tests are intended to give a rough idea of the quality of an oil; a practical test may be made with a Prony brake, as arranged in Fig. 3, for its lubricating properties. The pulley is run at a constant speed and a fixed load in the break and some form of lubricant may be used on the break and the rise in temperature taken with a thermometer. After allowing the apparatus to cool down the test must be repeated, the oil to be tested being used as a lubricant. Thus a good estimate of its value may be obtained.—F. A.

Question No. 454.—What are the best data for the erection of a tramway overhead trolley line in England in order that the rise and fall due to change of temperature in each span shall be taken up by the dip, the line not to move longitudinally, and the greatest sag to be as small as possible. Materials to be used are No. $^3/_0$ hard-drawn copper trolley wire, with a maximum span of 120ft., and $^7/_{14}$ galvanised steel span wire, with a maximum span of 50ft.

Best Answer to No. 454 (*awarded* 10*s.*).—In England, at least, there is usually a sweet simplicity in the erecting of trolley wire, and one does not often run across the foreman of an erecting gang with a thermometer in one hand and a slide rule in the other, calculating the correct dip to allow at the current temperature for each span strung up. The operation is usually judged by rule-of-thumb and the foreman's eye, and that there has been too much of this rule-of-thumb is apparent enough in several towns, where the wires hang in graceful festoons during the summer season and break at the ears during the winter. Truth to tell, however, there is no very precise and accessible data to base calculations upon, so much depending upon local circumstances, and the fact that the elasticity of copper wire is not allowed for in the text-book formulæ. Therefore, as a general thing, it is safer to trust erection to the rule-of-thumb of an experienced man than to a man who is relying principally on mathematics. Dawson's (shooting-coat) pocket-book gives a formula for No. 0 wire, which is here altered to conform to the above question. D = dip in inches; T = tension in pounds; F = number of degrees F. between actual temperature and the temperature at which the strain is 2,500lb., which is the maximum allowable for $^3/_0$ wire:

$$\text{then } D = \sqrt{8{\cdot}1\,F + 14} \text{ and } T = \frac{7{,}477}{D}.$$

An uncertainty here is the lowest temperature to allow for—30deg. is about right; if colder than this, the elasticity factor will come in to prevent actual damage, though if over-taut, the wire will stretch permanently. A span-wire formula is also given in Dawson's, but for general work this is simply academic; the united efforts of a couple of men on a single sheave block and fall is usually deemed sufficiently near for final adjustment by the strain insulators. A more approximate rule for trolley wire is from the same authority as follows: "Where 20deg. of frost is the maximum to be expected, allow ¾ per cent. of the span at 60deg. to 65deg. F. The dip in warmest weather should not exceed 15deg." An article by B. Hopkinson further summarises that at 25deg. F. the dip should be 4in., at 60deg. 6in., and at 107deg. 9in. This will not be found to agree with either of the above rules, and to the enthusiast in search of further data of a more or less contradictory character, the paper on "Overhead Construction," published in the current Institution *Journal*, may be recommended. To save possible trouble, owing to a somewhat obvious misprint, the opening formula should read: "Dip = length of span in feet × weight per foot (say ·36lb. for $^3/_0$), divided by the product of the maximum stress (say 2,500) × 8." Apart from such publications, one at least of the overhead construction firms furnishes to its

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engineers very simple and precise data as to dip, etc. It is unlikely, however, that permission can be obtained to publish this, for obvious reasons.—B. C. H. J.

Answer to No. 454 (*awarded* 5*s.*).—The method by which a longitudinal or a tendency to move longitudinally is prevented both in tramway and telegraph equipments, is to make the spans equal, also the dips or pull. With this arrangement the pulls at each side of the span wire or trolley standard will be equal at all temperatures. Longitudinal movement only takes place where the pull is greater on one side of the suspension than the other. The pull being greater on one side, a balance is only brought about by the suspended point moving in the direction of the greater pull until the forces are equal. In England, where there is not such a great variation in temperature, it is quite good practice to sling the wires so that at an average temperature the pull will be equal. This, of course, is where the spans are unequal. Where it is possible, it is much better to give your pole or span wire an equal pitch. This can be done on the straight or a slight curve. At the end of a long straight it is usual to put an anchor wire so that the pull of the straight will not fall on the curve.

In practice the trolley wire is paid out from a drum mounted on a cart, at the rear of which is a tower, over which the wire passes. The erector stands on this tower, and as each suspending point is reached a loose fastening is made, so that the pull on each span will be practically equal to the tension on the wire, being made by means of a brake on the wire-drum. Sometimes, however, a draw-vice is used as well, or the draw-vice may be used when the insulators are being erected. In calculating pull, one-eighth of the breaking strain is usually taken. The span wire is taken by some at one-twelfth of the breaking strain, or the weight of the maximum span is added to its own weight.—T. W. S. H.

TRADE NOTICES AND NOVELTIES.

Electric Heating and Cooking Apparatus.

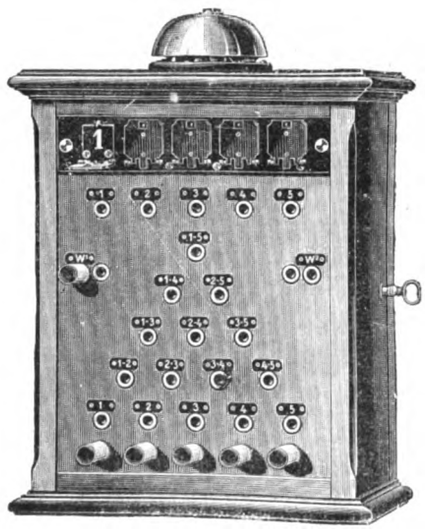
From the publishing department of the General Electric Company, Limited, Queen Victoria-street, London, E.C., we have received a copy of Section H of the firm's new catalogue, which section deals exclusively with electric heating and cooking apparatus. The cooking utensils listed cover the whole range of domestic requirements in this department, while the heating appliances are scarcely less comprehensive, and include a number of useful articles for laundry and workshop use, etc. It is interesting to note the rapid progress which is being made with the standardisation of such apparatus. This progress will be especially welcomed by the central-station engineer in search of a day load whereby to improve his load factor, and at the same time reduce the cost of electrical energy per unit generated. Saucepans, frying-pans, fish-kettles, hot-plates, and other cooking utensils of the smaller order are listed in considerable variety, full particulars as to size and energy consumption being given in each case. We notice also an electric breakfast cooker of particularly neat design, being a combination of a small oven and a hot-plate. With regard to electric ovens generally, the firm have, we are told, developed an entirely new principle of manufacture whereby a great advance as to saving of current, durability of heaters (which are separate from the oven sides, and readily replacable), and lower first cost is claimed. Besides, to the "Apollo" and "Aurora" types of electric radiators, which, it will be remembered, were the subject of a separate notice in a recent issue of this journal, attention is called in the list before us to various other forms of electric radiators for general and special purposes, including pillar-pattern radiators, ship radiators, and car heaters. Electric irons for various purposes are shown, also electric glue-pots, sealing-wax heaters, bookbinders' tool ovens and hot-plates, and soldering irons for light and heavy work respectively. The soldering iron for heavy work, such as jointing tinned meat cans, packing cases, etc., is arc heated, and will, it is claimed, perform twice the work in a given time of the ordinary type of soldering iron. These several articles belong strictly to the utilitarian class, but other articles, which may be termed luxuries, such as electric shaving pots and cigar lighters, are also listed. Enough has been said, however, to prove the efforts which are being made by the above enterprising firm to multiply the useful applications of electricity in our homes and workshops.

Perfecta Resistance Apparatus.

We have received from Messrs. Monté Callow and Co., 39, Victoria-street, Westminster, S.W., who are the London agents for "Perfecta" resistance apparatus, some circulars wherein are set forth at considerable length the advantages claimed for their apparatus. Motor starters of three different types are shown. The first of these—a simple form of starter—is made for capacities of from ½ h.p. to 200 h.p.; the second—of the automatic release type—for capacities of from ½ h.p. to 100 h.p.; while the third, which is of the automatic reversing enclosed type, can be supplied from 2 h.p. to 30 h.p., with or without no-voltage release. The range of pressure for which these starters are constructed is the same in each case—viz., from 50 to 550 volts. Shunt field regulators are also listed, and attention is further drawn to a full line of polyphase resistance apparatus of the "Perfecta" type. Among the special advantages claimed for "Perfecta" resistance apparatus, we note the following: The circuit is never through the spindles, large contact surfaces being always provided, and in the case of all but the smallest apparatus, laminated copper rubbing bridge contacts of very low resistance. In all apparatus in which the circuit is broken, special additional copper contacts with carbon brushes are provided to minimise the sparking and preserve the working surfaces. All current-carrying material is but moderately loaded, and there is, therefore, owing to this and to the excellent ventilation, only a moderate temperature rise and a moderate variation in resistance; all resistance material is enclosed so as to obtain a fireproof piece of apparatus; all motor starters are so arranged as to take, when starting, but a moderate current, whereby the fluctuation of pressure or demand entailed on circuit is but small; the contact surfaces are all calculated at a very low ampere density, thus increasing the durability and lowering the internal losses.

Pyramid Switchboard.

At the Royal Institution last Friday the library was given up exclusively to electrical exhibits. We noticed a very venerable contrivance, entitled "Faraday Magnet" and a "Spottiswoode Coil," by Apps, 433, Strand. Messrs. Crompton showed a potentiometer, a reflecting bifilar galvanometer, and a very useful voltmeter with an illuminated dial. The International Electric Company, 23, Red Cross-street, E.C., had a number of telephone exhibits, including portable telephones, magnet telephones for 10 miles radius without wires for the use of mines, a new telephone transmitter of great delicacy, fitted with a spring and filled with polished carbon filings behind the diaphragms. They also showed a very neat switchboard in the shape of a cabinet. For railway lines, municipal offices, industrial, mercantile, or agricultural establishments, where a rapid intercourse between various telephone stations is required, and where unskilled labour is employed for the making of connections, this contrivance will recommend itself through its simplicity. The connections are made by means of plugs; no connecting cords are used.



Our illustration shows the principle of the arrangement as represented by a switchboard accommodating six metallic circuits, in which case connections between 1 and 2, 3, 4, 5, between 2 and 3, 4, 5, between 3 and 4, 5, between 4 and 5, respectively, can be established; or a variety of 11 connections in all. On inserting the two-way plugs into any of the 11 spring-jacks, a connection between such two lines as are indicated by the numbers above the corresponding hole is established. All metallic circuits are connected to the terminals. Smaller exchanges can easily be extended by gradually adding more switchboards of a similar construction without discarding the switchboards previously fitted up. When a Pyramid switchboard is used in connection with a toll line, small junction boxes specially constructed for the purpose are connected. There were also various voltmeters, ammeters, and other measuring instruments by Messrs. Foxcroft and Duncan, 24, Queen's-road, Dalston, N.E., and by Jules Richard, Paris, the latter being shown by Messrs. Joseph Levi and Co., 97, Hatton-garden, E.C.; and the Hiram Maxim Light Company made a big show out of little reflectors, or, rather, flexible cases for incandescent lamps, made of rolled glass. Mr. Duddell showed the potential differences of currents on the screen by his oscillograph, and also explained a portable apparatus of the same kind which was exhibited for the first time. A number of "Sappho" and "New Century" arc lamps were fitted in the gallery, and gave rather more light than was needed.

Delivery Vans.

The Imprimis Motorcar Company's one-ton delivery van carries useful load up to 1½ tons. This vehicle obtained the highest award at the Crystal Palace Motor Show last week. By the use of iron tyres great economy in running and maintenance is effected, but rubber tyres are fitted in special instances. One entirely enclosed spring-borne series motor is applied to each of the back wheels. The motor is driven by single-reduction helical spur wheels and pinions, accurately machine cut, and, therefore, smooth and silent running is obtained.

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These spur wheels are shielded by mild-steel guards. The motors are each of 3 h.p., at the railway rating, with high efficiency on overload, when they can develop up to 5 h.p. for short periods. By series-paralleling these motors and intermediate positions of the controller four speeds, from two to nine miles per hour, are obtained. The simple backward movement of the controller also operates an electric brake, which by shunting the armatures through resistances quickly brings the car to rest. Further backward movements of the controller handle give two reverse speeds. The controller is of massive construction, with insulation of a special vulcanite composition. The brushes are of special construction to maintain an even pressure without causing stiffness of operation. The metallic sectors on the rotating drum and the brushes are of hard phosphor bronze. Fuses are provided for the battery, motorcar, and lamp circuits of the Edison screw type. The accumulators are separately suspended on special springs. This arrangement ensures a minimum of vibration to the cells, and consequently as long a life as is obtained by the use of expensive rubber tyres. The steering is by an upright pillar with horizontal leather-covered handwheel. The arrangement of axle is on the Ackerman principle, giving an easy manipulation. Electric sidelights of handsome finish are fitted, also a band brake on the back wheel worked by a foot-lever, and a hand-lever brake on the back tyres. The van weighs unloaded just under two tons, and the maker claims an average speed of eight miles per hour and 40 miles on one charge. Loaded with one ton it will climb a hill of 1 in 7 at five miles per hour. The same company also exhibited a lighter car on which a series motor is used, placed under the centre of the car, with gunmetal pinion gearing with steel spur wheel on a differential countershaft.

LEGAL INTELLIGENCE.

HIRAM MAXIM COMPANIES.

On Friday, before Mr. Justice Swinfen Eady, in the Chancery Division of the High Court, the case of the Hiram Maxim Electrical Lamp Company, Limited, *v.* Sir Hiram Maxim's Electrical Engineering Company, Limited, was mentioned.

Mr. Eve, K.C., said in this case he had a motion to stay further proceedings in the action on the ground that there was a submission to arbitration in the agreement between the parties.

Mr. Macnaghten, K.C., said an important matter was that there was still another motion in which his learned friend was for the plaintiff, in which he sued, as shareholder of the company, to restrain the plaintiff company from enforcing certain calls.

The motions were adjourned for a week.

NEW COMPANIES REGISTERED.

Edmonson and Purdom, Limited.—Capital, £6,000. Object: to acquire and carry on the business of an electrical and mechanical engineer carried on at the Albert Electrical Works, Hey-street, Longside-lane, Bradford.

Reno Electric Stairways and Conveyors, Limited.—Capital, £80,000. Object: to acquire the benefit of certain inventions for constructing inclined elevators and for improvements in the means of transport by ascension, to adopt an agreement with J. G. Wainwright, W. H. Aston, and C. T. Aston, and to carry on the business of suppliers of electric light, electricians, electrical, hydraulic, mechanical, gas, and general engineers, suppliers of electricity for heat, power, and other purposes, manufacturers of lifts, meters, accumulators, cells, pipes, cables, wires, and electrical apparatus and fittings, etc.

Drakes, Limited.—Capital, £90,000. Object: to acquire the freehold works belonging to Jonas Drake and Son, at Ovenden, Halifax, and the freehold works occupied by the Leeds Fireclay Company, Limited, at Wortley, Leeds, and to carry on the business of gas and carbonising engineers, electrical and hydraulic engineers, etc.

APPOINTMENTS VACANT.

Chief Assistant Electrical Engineer, Council for the Foreign Community of Shanghai, 200 taels per month (equal at present rate to about £300 per annum), with quarters, fuel, and light. Agreement will be for three years. First-class passage out and liberal leave rules. Half salary while on voyage. Applications not later than March 5 to Messrs. John Pook and Co., 63, Leadenhall-street, London, E.C. Full particulars in our advertisement columns.

Mains Superintendent, Oldham, £100 per annum. March 10. Particulars in our advertisement columns.

Electric Wireman, accustomed to colliery work. Full particulars in our advertisement columns.

Switchboard Attendant for combined D.C. traction and lighting station, £1 per week of 56 hours. Full particulars in our advertisement columns.

Estimator, one with experience of municipal work preferred. Full particulars in our advertisement columns.

Draughtsman for switchboards, switches, and accessories. Full particulars in our advertisement columns.

Assistant Engineer, Whitby Urban District Council Electricity Department, £100 per annum. Particulars can be obtained from the Resident Electrical Engineer, Council Offices, Whitby, March 6.

LIVERPOOL ELECTRICITY ACCOUNTS.

The accounts of the Liverpool Corporation electricity supply department for the year ended Dec. 31, 1901, show a total expenditure to date on capital account of £1,187,621. Abstracts of the revenue account and general balance-sheet are given herewith:

REVENUE ACCOUNT.

Expenditure.

Dr. Generation of Electricity.	£ s. d.	£ s. d.
Coal	£41,600 5 3	
Oil, waste, water, and stores	5,294 12 10	
Wages at generating stations	13,154 9 3	
Repairs and maintenance	3,628 7 10	
		63,677 15 2
Distribution of Electricity.		
Wages	1,480 2 1	
Repairs and maintenance of mains	1,105 11 9	
Repairs and maintenance of meters	168 0 6	
Repairs of machinery	963 16 1	
		3,717 10
Rents, Rates, and Taxes.		
Rents	1,933 18 10	
Rates and taxes	5,324 1 4	
		7,258 0
Management Expenses.		
Salaries, engineer's department	6,601 16 2	
Contribution to the city fund	2,000 0 0	
Stationery, printing, etc.	505 8 8	
General establishment charges	460 2 3	
		9,567 7 1
Special Charges.		
Insurances, buildings, plant, etc.	346 4 1	
Expenses for certification of meters.	221 10 0	
Proportion of cost of management of Liverpool Corporation stock	127 10 6	
Stamp duty on ditto	127 14 3	
Repairs, etc., of property	34 13 5	
Auditors' fees	26 5 0	
		883 17 3
Amount written off for bad debts		82 6 7
Balance carried to net revenue account		83,302 5 10
		£168,489 2 6

Cr. Income.	£ s. d.
Sales of electrical energy for lighting and power	91,311 5 8
Ditto public street-lighting	1,907 18 2
Ditto electric tramways	68,912 10 7
Rental of meters	2,438 19 5
Rents of property	577 4 9
Manufacturing account	3,341 3 11
	£168,489 2 6

BALANCE-SHEET.

Dr. Liabilities.	£ s. d.
Loans as per capital account	1,155,749 19 0
Sundry creditors	51,307 5 3
Surplus and sinking fund	142,808 19 8
	£1,349,866 3 11

Cr. Assets.	£ s. d.
Land, building, plant, etc.	1,187,621 13 1
Stocks on hand	4,816 0 6
Sundry debtors	48,035 14 2
Investment of sinking fund	45,982 1 6
Bank of Liverpool (Heywood's Branch)	63,410 14 8
	£1,349,866 3 11

COMPANIES' MEETINGS AND REPORTS

WESTMINSTER ELECTRIC SUPPLY.

Lord Suffield presided over the ordinary meeting of the shareholders in this Company on Wednesday, at the offices, Eccleston-square, S.W. The report and accounts appeared in full in our last issue.

The **Chairman**, in proposing the usual motion for the adoption of the report, said the Company's business continued to advance in a very satisfactory manner. The number of lamps (calculated in 8 c.p.) added during the 12 months ended Dec. 31 last, taking into account the public lighting, was 63,873, which was the largest number connected in any one year since the Corporation commenced business. Unfortunately, rates and taxes had risen £4,150, and he regretted that no reduction in the price of Welsh steam coal was possible until July last. The increase in expenditure under this head was £3,000. The public lighting of the Company's district had advanced very satisfactorily, and he thought he might fairly say that the lighting of that part of the city of Westminster which they had undertaken compared very favourably with that of other London districts. They hoped that the trunk mains

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that had been laid to connect the Westminster Company's stations with the Central Company's station at St. John's Wood would be carrying energy for the requirements of the ensuing winter. Meanwhile some of the high-tension plant, which had been running already at Eccleston-place station, had done and was doing most important service in maintaining their supply. The recent issue of cumulative preference shares, with the exception of a very small surplus, was taken up by the shareholders. The Board regretted that there was so small a balance left that they were unable to allot any further shares to those proprietors who had applied for an additional number should there be any surplus. The extra applications exceeded 35,000 shares, whereas the whole issue was only 30,000.

Mr. Boulnois, M.P., seconded the motion, which was unanimously adopted.

On the motion of **Mr. Goulding, M.P.,** a resolution was subsequently passed authorising the issue at par to the directors, officers, and staff of the 480 ordinary shares remaining unissued.

LONDON UNITED TRAMWAYS (1901).

The statutory general meeting of this Company was held on Wednesday at the Company's offices at Chiswick. Mr. Samuel White presided.

The **Chairman**, speaking of the Company's operations, said that everything was making very satisfactory progress. The whole of the materials and plant for the Hampton Court group of lines had been ordered some time since, and the work of constructing these lines was proceeding as rapidly as weather conditions would permit. Of the 12 miles of this group nearly three miles of route had already been laid, and the electric cableways and cables had been laid for a considerable portion of the route.

An extraordinary general meeting was then held for the purpose of passing the following resolution: "That the following Bills now being promoted in Parliament and the following draft order now being promoted before the Light Railway Commissioners—namely: (1) a Bill for conferring further powers on the London United Tramways (1901), Limited, for constructing tramways and widening and altering roads in the counties of London, Middlesex, and Surrey, and for other purposes; (2) a Bill for incorporating the London United Electric Railways Company, and for empowering them to construct underground railways from Shepherd's Bush and Hammersmith to Barnes, Charing Cross, Clapham Junction, and the Marble Arch, in the counties of London and Surrey, for authorising agreements between the said company and the London United Tramways (Limited) and others, and for other purposes; (3) an order of the Light Railway Commissioners authorising the construction of light railways in the county of Middlesex, between Acton and Chiswick, and between Southall and Hounslow, and between Hanworth and Hampton, be and the same are hereby approved subject to such additions, alterations, and variations as Parliament may think fit to make in the said Bills, or either of them, and as the Light Railway Commissioners or the Board of Trade may think fit to make in the said order." The **Chairman** having explained and commended the schemes, proposed the resolution, which was carried unanimously.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY.

The annual general meeting of this Corporation was held at the Savoy Hotel on Wednesday, Mr. W. F. Fladgate presiding.

The **Chairman,** in moving the adoption of the report and accounts (which will be found in our last issue), said the Company's progress in the West-end districts still continued. The total additional lamps which had been connected during the past year numbered 27,906. That increase was in districts in which there was competition in all parts. It showed there was still a vital demand for electricity. The sales had increased by 31 per cent. over those of 1900. With regard to the supply of motive power, this matter was receiving very careful attention, and the directors believed it would bring additional benefits to the Company. The increase in the supply of motive power had been nearly 32 per cent. in the West-end districts alone. The revenue had been augmented by 16 per cent. and the net balance by 50 per cent. The reserve amounted to £90,000, and if they included the share premium account, the total sum was £157,000, which he thought was sufficient for them to have on reserve. With reference to the City, the progress made was very satisfactory, and he expressed the belief that in the course of the current year, unless anything unforeseen occurred, they would be supplying 150,000 lamps in the City. Their prospects were altogether good, for they were showing progress in every possible way. As to the competition with the City of London Company, he had only to repeat what he said several years ago—namely, that in the City there was room for both companies to do a successful business at a fair price.

Mr. John M. Gatti seconded the motion, which was agreed to unanimously, and the proposed dividend of 10 per cent. was also approved.

A resolution was afterwards passed fixing the remuneration of the directors at 1,500 guineas for the current year.

HART ACCUMULATOR.

The third ordinary general meeting of the shareholders in this Company was held on Wednesday at Essex House, High-street, Stratford, E., Mr. G. W. Kidd presiding. The report of the directors stated that the profit for the year is £7,875 and the balance brought forward from last year £1,492, amounting together to £9,367. The directors recommended a dividend of 12½ per cent. per annum on the ordinary share capital, which will absorb £4,937, leaving £4,430 to be carried forward. The Company's buildings, plant, tools, etc., have been augmented by £1,478, which has been charged to capital, and due depreciation on same has been made. The maintenance of the works, plant, etc., has been well kept up at a cost of £606, which has been paid for out of revenue.

The **Chairman,** in moving the above report, congratulated the shareholders upon the great success which had attended the Company during the year. They had in that period installed batteries in something like 98 towns and villages, in addition to private installations. The peculiarity about battery companies at the present time was that there were only two companies paying a dividend besides this Company. That state of things he ascribed to the extreme competition and the willingness to take orders at a sacrifice in order to keep works going. He only knew of one company—a German firm—paying 10 per cent., and only one English company paying 5 per cent. The biggest battery company in England paid nothing at all. During the past year or so another trade had started which he anticipated would bring a good deal of work to their firm, and that was the motorcar industry. During the year they had done a tremendous amount of experimenting in their laboratory; they had considerably increased it, and made it three or four times as large as formerly, and their manager had been able to design a plate which he, at any rate, anticipated would be very efficacious in connection with motorcar work. Their manager claimed for it greater mechanical strength and electrical efficiency, together with reduced weight. He might tell them that there was a scheme on foot which, if carried out, would bring more capital into the Company without going to the public and asking for money; but before anything was absolutely done in that direction the shareholders would be called together and taken into the confidence of the directors. They were paying 12½ per cent. dividend, and it had struck him that some of their customers might wonder at that, in view of the position of other battery companies. The dividend was obtained by good management, keeping pace with the times, and using all up-to-date machinery. They had hardly a machine in the place that was not driven by electric motors. That they were not charging more than was reasonable for their goods was proved by the fact that they obtained the largest portion of their work in open competition. He might tell them that they had entered into a large contract with a foreign Government—a very advantageous contract for this concern—that would occupy them in a small way for the best part of the year. In conclusion, the chairman alluded in terms of praise to the work of Mr. Edward J. Clark (the engineer and manager), Mr. John H. Poulton (the secretary), and Mr. Holmes, and the whole of the staff.

Mr. Leslie W. Spratt seconded the motion, which was carried unanimously.

The retiring directors (Messrs. L. W. Spratt and S. W. Hart) were re-elected, and the proceedings terminated with votes of thanks to the chairman.

BAKER STREET AND WATERLOO RAILWAY.

A special general meeting of this Company was held on Wednesday at the Westminster Palace Hotel, Mr. Quinton Hogg in the chair, for the purpose of submitting for the consideration of the proprietors three Bills now before Parliament: (1) to confer further powers on the Company; (2) to confer further powers on the Brompton and Piccadilly-circus Company for the construction of new railways and works, and for the use of part of the Metropolitan District Railway, to extend the time for the compulsory purchase of land and the completion of works, and to authorise working and other agreements with other companies; (3) for conferring further powers upon the Charing Cross, Euston, and Hampstead Company with respect to their undertaking, for authorising agreements with the Metropolitan District Railway Company, the South-Eastern and Chatham Railway Companies' Managing Committee, the South-Eastern Company, and this Company.

On the motion of the **Chairman**, seconded by **Major-General C. S. Hutchinson,** the Bills were approved.

SCARBOROUGH ELECTRIC SUPPLY.

The annual meeting of the shareholders in this Company was held at Scarborough last week, Mr. G. Smith in the chair.

The report of the directors showed that the Company have 702 consumers, which is an increase of 110, and equivalent to 40,197 8-c.p. lamps connected, which is an increase of about 7,000. The total revenue is £8,847. 11s. 3d., as compared with £7,788. 4s. 0½d. The accounts show that after placing a sum of £600 to depreciation account, the balance available for dividend is £4,119. 5s. 7d., from which the directors recommend a dividend at the rate of 7 per cent. per annum, free of tax, should be paid, absorbing £4,038. 4s. 11d., and leaving a balance of £81. 0s. 8d. to be carried forward to 1902. The capital expenditure now stands at £67,281. 10s. 11d., being an increase of £14,087. 13s. 2d. in the year. The outlay has been mainly incurred in the purchase of a 500-kw. generator, the working of which has conduced to efficiency and economy; the improvement of the works; and the extension and duplication of the mains. The 6,000 shares issued up to Dec. 31, 1900, are now fully paid up, and 1,000 additional shares have been issued during 1901, on which £4 per share has been paid. Further capital will be required during 1902 but probably not to so large an extent as in 1901. A Bill is being promoted in Parliament for powers to construct electric tramways in Scarborough. If satisfactory arrangements can be entered into with the promoters the enterprise will be of advantage to this Company, whose interests in the matter are having the careful attention of the directors.

The **Chairman,** in moving the adoption of the above report, said the increase in the number of consumers was extraordinary. It was sometimes said the Town Council had an interest in the concern, but really the interest of the Town Council, he did not believe, was repre-

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sented by more than 10 shares; therefore they had clean hands in that matter, whatever might be said of their arrangements.

Mr. John Dale seconded the motion, which was adopted unanimously.

NORTHWICH ELECTRIC SUPPLY.

The annual meeting of this Company was held on Monday under the presidency of Mr. T. Ward.

The report showed that gradual progress had been maintained, and that the number of lamps in use was 12,510 8 c.p., as compared with 607 in the first year of the Company's existence—*i.e.*, in 1897. The installation of motors had been a feature during the year.

The **Chairman,** in moving the adoption of the report, commented upon the fact that Northwich possessed the first two electrical swing-bridges in the kingdom, and that the Weaver navigation had recently commenced to work the whole of their machinery by electrical power. It was found necessary to extend the works, and £5,000 further shares were to be issued. After writing off £30 from preliminary expenses, and £43 off free wiring account, and setting aside £350 for depreciation, making, with the £305 previously set aside, a reserve fund of £655, the net profit for the year was £690. Adding to this the sum of £92 carried forward last year, there was a total available for distribution of £782. The directors recommended the payment of a dividend of 4½ per cent., which would absorb £675, and allow £107 to be carried forward.

Major Sauer said theirs was a pioneer company of the Kingdom, being the first to dispense with steam. They generated with Mond gas, and had entirely banished smoke, a fact which he recommended to the study of local authorities.

The report was adopted.

W. T. HENLEY'S TELEGRAPH WORKS.

The secretary of this Company has issued the following: "It has been our custom to hold the annual ordinary general meeting of the Company in the last week in February, and to present the accounts for the past year to that meeting, and declare a final dividend. But, as you have probably heard, negotiations have been for some time going on with the directors of Messrs. Callender's Cable and Construction Company, Limited, for the amalgamation of the two companies by merging them both in a new company to be formed for that purpose. The terms have now been generally agreed, and the solicitors are preparing the contract for adoption by the two Boards, subject, of course, to the approval of both classes of shareholders of each company, to whom it will be submitted at special meetings to be called for the purpose of considering it. In these circumstances, your directors have thought it advisable to postpone the ordinary general meeting until the whole matter can be brought before the shareholders. Meanwhile, however, the directors have satisfied themselves that a dividend of 20 per cent. for 1901 on the ordinary shares is fully justified by the accounts, and, therefore, an interim dividend of 5 per cent. having been paid on Sept. 1, the Board has this day declared a further interim dividend of 10 per cent., and purpose to submit to the ordinary annual meeting, with the accounts, a proposal to declare a final dividend of 5 per cent., making 20 per cent. in all. The full dividend on the preference shares for the half-year ended Dec. 31, 1901, at the rate of 4½ per cent. per annum, will be paid as usual on March 1, 1902."

NORTHAMPTON ELECTRIC LIGHT.

The annual meeting of the proprietors of this Company was held at Northampton, Mr. F. H. Thornton presiding.

The directors' report stated that since the presentation of the last annual report the steps then being taken with a view to more economical working and greater efficiency had been diligently followed up, and important improvements in management and administration had been brought about. The saving in fuel, oil, etc., had been most marked, and in all respects the Company was at present working under new conditions. The year opened very badly, but in spite of this the net result was of a gratifying character. The second half of the year showed a profit, after ample provision for contingencies, which would have admitted of a very substantial dividend on the ordinary shares. The change-over to the higher voltage was successfully effected in April last. The boilers and accessories suffered much in the past from the hardness of the water, but an effectual remedy has been found in a softening apparatus, provided at a moderate expense. The lamps fixed had increased by 2,962, and motors (reckoned in their equivalent of lamps) by 700, making 29,121 in all at 8 c.p. The growing use of current for motive power was very satisfactory, being conducive to a larger day load, always a great desideratum. From the beginning of the new year the price of current for motors and heating purposes was reduced to a uniform rate of 2d., whereby the advantages of electricity were made available for all classes of the community using machinery or requiring electric stoves. The meter rents had also been considerably reduced. The consumers now number 502. The directors had abstained from any large extension of mains during the year. the additions amounting to 436 yards, making a total of 7 miles and 1,026 yards. Enquiry had been made by the Corporation of Northampton whether the directors would be willing to enter into negotiations for the sale of the Company's undertaking. Any further steps would be notified to the shareholders in due course. After setting apart £800 for depreciation, and £43 in reduction of preliminary expenses, there remained applicable to dividends a sum of £1,526. 11s. 10d. It was proposed to pay a year's dividend on the 6 per cent. preference shares, £226. 10s.; on the 5 per cent. preference shares, £466. 1s.; also 3½ per cent. on the ordinary shares, £798. 3s. 7d.; and to carry forward £35. 17s. 3d.

In moving the adoption of the above report, the **Chairman** said he was sure those shareholders who had been with the Company since its formation would fully appreciate the satisfactory nature of the same. With regard to the probability of the Corporation purchasing the undertaking, there was nothing very particularly being done. He really did not much care whether they did or did not, because the Company still had a long lease of life, during which time he was perfectly confident they would be able to set aside a large sum, and they would get their undertaking into such form that whether the Corporation bought the undertaking now for a large sum, or whether they waited, the Company were perfectly safe. The Company were quite ready to supply the Corporation with current to run the trams. They would, however, require fresh mains.

Mr. W. Tomes seconded the motion, which was adopted unanimously.

BLACKPOOL AND FLEETWOOD TRAMROAD.

Presiding over the half-yearly meeting of the shareholders of this Company at Manchester, **Mr. G. Richardson,** the chairman, said the number of passengers carried and the number of miles run had increased, and the expenses had decreased in the half-year by about £200. They had paid 4 per cent. dividend for the first half-year, and the 9 per cent. now proposed would give a dividend of 6½ per cent. for the year. He was glad to say that the number of season tickets was increasing. It was intended to spend £3,000 out of the reserve fund in building a new accumulator-house halfway between the power station at Bispham and Fleetwood, and to obtain a large storage battery with the necessary accessories. This would give their engines a more economic load, equalise the current in the overhead conductors, and avoid the transmission losses that at present took place through having to send the current so far. By the expenditure they would reduce their coal bill by nearly £300 per annum, and doubtless in addition the regular speed the cars would attain would enable them on busy days to earn more revenue. He moved the adoption of the report and accounts.

Mr. R. H. Prestwich seconded the motion, which was carried unanimously.

BRISTOL TRAMWAYS AND CARRIAGE.

At the annual meeting of shareholders in this Company, held at Bristol on the 20th inst., **Mr. George White,** who presided, said the year had been an eventful one, inasmuch as it was the first during which they had carried on the whole of their tramway traffic by electric traction. It had also been interesting because they had had various events crowded in of an unusual character which, in the result, he was inclined to think, had not been without profit to the Company. He knew directions in which less money might have been spent and increased profit made, but they were so determined to make the electric tramway system popular that they spared no expense in doing so, and in his opinion their policy in that respect had been absolutely judicious and businesslike. Nothing had come of the appointment of a Corporation committee to negotiate for the purchase of the undertaking, and therefore no comment was necessary, especially as they were certainly not anxious to sell. They had an electric system for Bristol and the suburbs which was simply in its infancy. Each year would bring developments and, he believed, steadily increasing traffic, while from time to time they would be better able to control expenditure.

Mr. J. Wethered seconded the motion, which was adopted.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING.

Directors: Sir Frederick J. Bramwell, Bart., F.R.S.; Colonel R. E. Crompton, C.B.; Sir Charles Grant, K.C.S.I.; G. H. Hopkinson, Esq.; R. W. Wallace, Esq., K.C.

Report by the directors (with abstract of accounts) to be presented at the fifteenth ordinary general meeting to be held at 5, Great George-street, Westminster, on March 5, at 4 p.m.:

During the year the number of houses and shops connected with the system has increased from 2,324 on Dec. 31, 1900, to 2,605 on Dec. 31, 1901, while the number of lamps calculated on the usual basis of 8 c.p. has increased from 193,098 to 222,158. The renewal account now stands at £38,266. 14s., being an increase of £292. 3s. 8d. over the amount of the account at the end of the previous year. After providing for the amount placed to renewal account, and after paying the dividends on the 6 per cent. first preference shares to June 30, 1901, on the 5 per cent. second preference shares to Sept. 30, 1901, and an interim dividend at the rate of 10 per cent. per annum on the ordinary shares for the first half of the year, the balance standing to the credit of the net revenue account for the year 1901 is £9,215. 5s. 3d. Of the above sum, £1,500 has been appropriated to the payment of the first preference dividend to the end of the year, and £625 has to be set aside to meet the portion of the dividend on the second preference shares accrued to the same date. It is proposed to pay out of the balance of £7,090. 5s. 3d. a further dividend on the ordinary shares of 5 per cent. for the past half-year, making, with the interim dividend paid on Aug. 8, 10 per cent. for the year. This will leave a balance of £1,840. 5s. 3d. to be carried forward. The directors have the pleasure to report that the new generating station which has been constructed in conjunction with the Notting Hill Electric Lighting Company, Limited, which was available for a partial supply during the early part of the year, has been constantly used during the past nine months. Since the supply from Wood-lane has been available by means of the transformer station at Albert Hall and by other transformers at Kensington Court, which have replaced some of the steam power at that station, the battery station at Queen's-terrace-mews has been dismantled. The first cost of the batteries and plant, less amounts realised by sale, has been written off through the renewal account. The freehold of the property in Brompton-road previously held under leases has

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been acquired. The cost of the leases is written off from the sinking fund for leasehold property. It is with deepest regret the directors have to formally announce the death of Mr. Granville Ryder, who, from its formation until his retirement in the spring of 1901, had been chairman of the Company, and they further have to announce with equal regret the death of Mr. A. S. Bolton, who had been a director of the Company from its foundation. They have filled the vacancy caused by the death of Mr. Ryder by the election of Mr. G. H. Hopkinson, who had been previously on the Board, and of whose services his colleagues entertained a high appreciation; they now recommend the confirmation of their choice by his re-election at this meeting. With respect to the vacancy caused by the death of Mr. Bolton, Colonel R. E. Crompton, C.B., who has resigned his position as advisory engineer, has been elected to a seat on the Board, and the directors now recommend the confirmation of their choice by his re-election. The remaining directors are Sir Frederick Bramwell, Bart., F.R.S., who on the retirement of Mr. Ryder was appointed by his colleagues chairman of the Company, Sir Charles Grant, K.C.S.I., and R. W. Wallace, Esq., K.C. Mr. Wallace retires under the articles of association, but is eligible, and offers himself for re-election. The auditors, Messrs. Price, Waterhouse, and Co., offer themselves for re-election.

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£ s. d.	£ s. d.
Coal or other fuel	£7,629 13 6	
Oil, waste, water, and stores	822 19 4	
Proportion of salaries	798 6 5	
Wages at generating stations	2,184 3 8	
Electricity from Wood-lane works	5,233 0 7	
Repairs, maintenance, and renewals	2,940 11 1	
		19,608 14 7
Distribution of Electricity.		
Proportion of salaries	259 3 4	
Wages to linesmen, etc	720 14 6	
Repairs, etc., of mains	966 13 6	
Repairs, etc., of meters	246 3 8	
Sundry expenses	21 5 10	
		2,214 0 10
Rents, Rates, and Taxes.		
Rents payable	444 13 11	
Rates and taxes	4,755 6 6	
		5,200 0 5
Management Expenses.		
Directors' remuneration	1,000 0 0	
Salaries of engineers and staff	2,527 12 6	
Stationery and printing	359 3 10	
General establishment charges	530 0 3	
Auditors of Company	73 10 0	
Auditor under the order	65 0 0	
Trustees' remuneration	64 11 6	
		4,619 18 1
Law expenses		296 2 4
Depreciation.		
Depreciation of property	290 0 0	
Renewal and maintenance of buildings, plant, etc., less repairs	8,576 4 7	
		8,866 4 7
Special Charges.		
Insurances	452 9 1	
Cost of conversion to 200 volts	133 8 3	
		585 17 4
Total expenditure		41,390 18 2
Balance carried to net revenue		20,445 12 10
		£61,836 11 0

Cr.	£ s. d.
Sale of current per meter	58,566 8 11
Sale under contracts	745 1 6
Rental of meters and other apparatus on consumers' premises	1,839 14 9
Freehold and leasehold property	672 10 10
Transfer fees	12 15 0
	£61,836 11 0

GENERAL BALANCE SHEET.

Dr. Liabilities.	£ s. d.
Capital account—amount received	295,000 0 0
Sundry tradesmen and others	9,844 14 8
Net revenue, less dividends	9,215 5 3
Renewal fund account	38,266 14 0
Depreciation fund account—leasehold property	288 15 1
	£352,615 9 0

Cr. Assets.	£ s. d.
Capital account—amount expended for works	324,716 5 4
Stores on hand	2,236 2 2
Amount owing by consumers to Dec. 31, 1901	19,516 6 8
Other debtors	160 18 5
Cash at bankers and in hand	5,985 16 5
	£352,615 9 0

TELEGRAPH CONSTRUCTION AND MAINTENANCE.

The report of the directors to be submitted to the members at the thirty-eighth ordinary meeting to be held on March 4, 1902, at 1 p.m., states that the directors deeply regret to record the death, on June 21, 1901, of their highly-esteemed colleague Admiral Sir Anthony H. Hoskins, G.C.B., who had been a member of the Board since January, 1895. The accounts for the year show a net profit of £105,695. 9s. 11d., after charging the interest on the debentures. To this sum must be added £75,564. 2s. 10d. brought forward from last year, making a total of £181,259. 12s. 9d. From this amount is deducted the interim dividend of 5 per cent., paid July 16, 1901, amounting to £22,410, leaving £158,849. 12s. 9d. to be dealt with. Of this sum the directors propose to distribute a dividend of £1. 4s. per share, together with a bonus of 12s. per share, absorbing £67,230, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend and bonus for the year of £2. 8s. per share, or 20 per cent., free of income tax, leaving £91,619. 12s. 9d. to be carried forward to the next account. The business of the Company has been satisfactorily maintained during the year, and the factories at Wharf-road and Greenwich have been fully occupied in the manufacture of submarine telegraph cables and of insulated wire. The Company's steamships have been actively engaged in the laying of submarine cables and also on cable-repairing operations. The Company's factories and steamships are in a thoroughly efficient condition. The directors have entered into a contract for the building of a cable steamer, which has been named the "Colonia." This vessel was successfully launched on the 14th inst. The "Colonia" is about 7,700 tons register, and her cable gear, machinery, and general arrangements are of the most recent designs, and include the latest appliances for facilitating the work on which she will be engaged. The directors propose to add a further sum of £20,000 to the pension fund established in 1899 for the benefit of the Company's staff. The directors have the pleasure to announce that they have elected Mr. Paget Vyvyan Luke, C.I.E., to a seat at the Board. The retiring directors are Sir Robert G. W. Herbert and Sir James Pender, who, being eligible, offer themselves for re-election.

NEWCASTLE ELECTRIC SUPPLY.

The report of the directors for the past year shows that, including the balance brought forward, the profits of the year amount to £13,813. After meeting interim dividends, further returns are recommended, making the year's dividend 5 per cent. on the preference and 8 per cent. on the ordinary shares. A sum of £243,341 has been expended in the year in completing the power station at Wallsend, in laying high-tension transmission mains to Newcastle, and in other works. New capital is to be authorised and debentures issued. The directors retiring are Messrs. T. G. Gibson, R. Spence Watson, and J. Tennand, who are eligible and offer themselves for re-election.

CHELSEA ELECTRICITY SUPPLY.

Directors: J. Irving Courtenay (chairman); Nugent Daniell; Wm. Reginald Davies; G. N. Marten; William Page; Major-General Webber, C.B. (retired R.E.). Chief engineer: Percy Still. Secretary: S. J. Cluer.

Report of the directors (with abstract of accounts) to be submitted to the shareholders at the ordinary general meeting to be held at the Town Hall, Chelsea, S.W., on March 5 at 12 noon:

The profit for the year amounts to £23,564. 17s. 5d., which, with £190. 13s. 1d. balance of interest and £121. 17s. brought forward, makes a total of £23,877. 7s. 6d. After deducting £6,750 interest on debenture stock, £900 interim dividend on the preference shares, and £4,902. 5s. interim dividend on the ordinary shares, at the rate of 5 per cent. per annum, there remains a balance of £11,325. 2s. 6d., which the directors recommend shall be appropriated as follows: to credit of renewals and depreciation fund (as against £3,000 for 1900), £6,500; to final dividend on the preference shares, at the rate of 6 per cent. per annum, making 6 per cent. for the year, £900; to final dividend on the ordinary shares at the rate of 3 per cent. per annum, making 4 per cent. for the year, £3,463. 3s.; leaving a balance to be carried to the next account of £461. 19s. 6d. The reduction of the dividend on the ordinary shares is not due to any diminution in the net profit, which, on the contrary, has increased by £2,756. 10s. 6d., notwithstanding an increase in the rates and taxes (which now amount to £2,642. 9s. 4d. as against £1,453. 5s. 9d., as a result of the recent quinquennial revaluation), but to the decision of the directors to place to the credit of the depreciation fund a considerably larger sum than in past years. The question of an adequate appropriation to this fund is one which has for some time engaged the earnest attention of the directors. They have, until lately, been of opinion that the improvement in the Company's business from year to year would allow of a regular increase in the amount set aside for depreciation, without disturbing the rate of dividend paid to the ordinary shareholders; but they regret that the annual improvement in the Company's revenue has not been sufficiently rapid to confirm this view. It will be within the recollection of the shareholders that the Company has in the past suffered considerably from claims arising out of vibration and from other causes. These troubles, the directors believe, have at last come to an end, and they have had under their consideration the question as to how the losses caused thereby can be best dealt with. They have also had before them the general question of the present value of the plant and property of the Company, and have come to the conclusion that £56,495. 9s. 6d. of the capital expended is not now represented by existing assets. They have decided that this sum should be written off capital account by an appropriation from the reserve fund, and that the balance of the reserve fund should be applied to further strengthen the renewals and depreciation fund. These adjustments have been given effect to in the accounts now presented. Expenditure amounting to £764. 10s. was incurred during the year in connection with the appeal to quarter sessions against the heavy increase in the rating assessment, and the enquiry before the Board of Trade in the matter of changing the system of supply to a

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higher voltage. One-fifth of this amount has been charged against revenue in the present accounts, and the balance has been placed to a suspense account, which the directors propose to write off during the next four years. During the year 631 ordinary shares were allotted, the price being £6 per share. The number of lamps connected on Dec. 31, 1901, was 161,031, an addition of 15,754 during the year. The directors are glad to report a steady improvement in the units sold per 8-c.p. lamp, the number in 1901 being 12½, as against 11½ in 1900 and 11 in 1899. The total number of units sold in 1901 was 2,011,150, being 339,124 more than the previous year. Mr. William Page and Mr. William Reginald Davies have been elected directors during the year, and the shareholders will be asked to confirm the appointments. The retiring directors, Mr. J. Irving Courtenay and Major-General C. E. Webber, C.B., offer themselves for re-election. The auditors, Messrs. Cooper Bros. and Co., offer themselves for re-election.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£6,821	1	10			
Oil, water, and stores	770	4	4			
Proportion of salaries	2,132	9	9			
Repairs, etc., of plant, etc.	1,366	9	6			
Sundry costs not included in above	331	0	3			
				11,421	5	8
Distribution of Electricity.						
Wages at out-stations, etc.	1,185	16	2			
Stores used at out-stations	167	19	2			
Repairs, etc., of mains and meters	1,497	6	7			
				2,851	1	11
Rents, Rates, and Taxes.						
Rents payable	543	5	0			
Rates and taxes	2,642	9	4			
				3,185	14	4
Management Expenses.						
Directors' remuneration	1,000	0	0			
Salaries of staff	1,218	12	0			
Salary or commission of collector	150	0	0			
Stationery and printing	120	1	10			
General establishment charges	365	11	7			
Auditors of Company	52	10	0			
				2,906	15	5
Law and parliamentary expenses				4	10	0
Special Charges.						
Insurance	319	3	10			
Wayleaves	7	0	0			
Fees to trustees	100	0	0			
Exceptional expenses	546	8	2			
				972	12	0
Balance carried to net revenue account				23,564	17	5
				£44,906	16	9

Cr.	£	s.	d.
Sale of current (less allowances and bad debts)	42,462	19	10
Rental of meters	1,942	11	2
Transfer fees	25	0	0
Discounts, and sundry small accounts	476	5	9
	£44,906	16	9

Dr. GENERAL BALANCE SHEET.	£	s.	d.
Capital account—amount received	402,680	0	0
Sundry creditors	5,442	2	7
Debenture stockholders for interest accrued	3,178	2	6
Net revenue account	4,825	2	6
	£416,125	7	7

Cr.	£	s.	d.
Capital account—amount expended less renewals, etc.	370,538	7	2
Stores on hand	2.587	9	3
Sundry debtors for current supplied	16,214	12	0
Sundry debtors on other accounts	1,907	19	4
Suspense account	611	12	0
Cash at bankers and in hand	24,265	7	10
	£416,125	7	7

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Edinburgh.—The Corporation invite tenders for annual supplies from May 15 for the electric supply department.

Bucharest.—The Administration of Government Monopolies invite tenders for supply of electric carbons for the year 1902-3. Tenders by March 3.

St. Pancras.—The Borough Council invite tenders for supplying overhead travellers. Tenders by March 14. Details in our advertisement columns.

Bournemouth.—The Town Council invite tenders for coal and ash conveyors, bunkers, etc. Tenders by March 15. Details in our advertisement columns.

Bournemouth.—The Town Council invite tenders for traction and arc lighting switchboards. Tenders by March 8. Details in our advertisement columns.

Madrid.—The time for receiving tenders for the electric lighting of the Madrid prison for 15 years has been extended from Dec. 26, 1901, to March 7, 1902.

Bacau (Roumania).—The Mayor invites tenders for electric lighting of the town by March 15. The estimate is £5,646.

Rockhampton (Queensland).—The contract for the municipal tramways, full particulars of which appeared in a former issue, will remain open until March 31.

Fulham.—The Borough Council invite tenders for the supply of electrical stores for the year ending March 31, 1903. Tenders by March 5. Details in our advertisement columns.

Burgess Hill.—The Urban District Council invite tenders for the construction of electricity supply works in the district. Tenders by March 12. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of electrical equipments for cars and tramcar trucks. Tenders by March 10. Details in our advertisement columns.

Pontypridd.—The Urban District Council invite tenders for Section M, comprising the overhead equipment and bonding for their tramways. Tenders by March 7. Details in our advertisement columns.

Aberdeen.—The Tramways Department invite tenders for the supply of 12 double-deck single-truck cars, complete with motors, controllers, etc. Tenders by March 6. Details in our advertisement columns.

Hackney.—The Electric Lighting Committee invite tenders for the construction and erection of three water-tube boilers and accessories, and water-softening plant. Tenders by April 9. Details in our advertisement columns.

Madrid.—The Public Works Department invite tenders for extensions to the San Sebastian tramways and working the same for not more than 60 years. Particulars may be obtained from the Department. Tenders by April 5.

London and South-Western Railway Company.—The Directors invite tenders for the supply and fixing of plant and fittings for the electric lighting of Salisbury Station. Tenders by March 4. Details in our advertisement columns.

Wallsend.—Tenders are invited for providing, fixing, and erecting a complete refuse destructor, pug mills, electric lighting machinery, electric crane and motor for driving same. Tenders by March 19. Details in our advertisement columns.

Ilford.—The Ilford Urban District Council invite tenders for supply of motor and trailer cars, trucks, motors, and equipments. Specification may be obtained at the offices of Mr. John W. Benton, clerk, Public Offices. Tenders by March 24.

West Ham.—The Corporation invite tenders for the erection of an electric generating station at Quadrant-street, Canning Town. Specification, etc., can be obtained from the Borough Engineer, Town Hall, West Ham. Tenders by March 11.

Edinburgh.—The Council invite tenders for the electric lighting installation, etc., of the third portion of the Colinton Mains Fever Hospital, the number of lighting points being about 600. Tenders by March 3. Details in our advertisement columns.

Llandudno.—The Urban District Council invite tenders for two Babcock and Wilcox water-tube boilers and necessary steam exhaust pipes. Full particulars, etc., can be obtained from Mr. H. Morton, electrical engineer, Electricity Works, Llandudno.

Blackpool.—The Corporation invite tenders for the supply and delivery of steel rails, points, points and crossings, etc., at their Rigby-road depot. Specifications, etc., can be obtained from Mr. John S. Brodie, A.M.I.C.E., borough engineer. Tenders by March 1.

Great Central Railway Company.—The Company invite tenders for the supply of electric light and telegraph materials for 12 months ending April 30, 1903. Specifications, etc., can be obtained from Mr. Oliver S. Holt, secretary, London-road Station, Manchester. Tenders by March 4.

Halifax.—The Tramways Committee invite tenders for the supply of various stores and materials during 12 months ending March 21, 1903. Specifications, etc., may be obtained on application to Mr. W. M. Rogerson, borough electrical engineer, Foundry-street, Halifax. Tenders by March 1.

Aberdeen.—The Tramways Committee invite tenders for the electrical equipment of their Rosemount circular route, comprising overhead equipment and bonding (poles and bonds supplied by Corporation), and supply and laying of cables. Tenders by March 6. Details in our advertisement columns.

Ilford.—The Urban District Council invite tenders for the supply of meters and demand indicators, house service fuse boxes, incandescent lamps, oil and engine-room stores, and cables, boxes, and jointing materials for year ending March 31, 1903. Tenders by March 11. Details in our advertisement columns.

Southend-on-Sea.—The Corporation invite tenders for the supply and fixing complete of two storage batteries at their electric lighting station, London-road, Southend. Specification, etc., may be obtained from Mr. W. E. J. Heenan, M.I.E.E., borough electrical engineer, Southend-on-Sea. Tenders by March 6.

Elland.—The Urban District Council invite tenders for the supply of quick-speed engines for direct coupling to dynamos, dynamos, booster, and balancers, storage battery, switchboard, travelling crane, supply and laying of cables, and condenser apparatus. Tenders by March 11. Details in our advertisement columns.

Oban (Scotland).—The Corporation invite tenders for roadwork, conduits, manhole covers, arc lamp-posts, etc. Specifications, etc., can be inspected and all information obtained from Messrs. Burstall and Monkhouse, consulting engineers to the Corporation, 14, Old Queen-street, Westminster, S.W. Tenders by March 7.

South Shields.—The Corporation invite tenders for supply of coal, oils, waste, hardware, and other engine-room stores for their elec-

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tricity works at West Holborn during year ending March 31, 1903. Specification, etc., may be obtained from Mr. J. H. Cawthra, borough electrical engineer, West Holborn. Tenders by March 5.

Morecambe.—The School Board invite tenders for the wiring of the new schools, Station-road; about 270 lights are required. Specifications, etc., may be seen at the offices of Messrs. Newton and Lawson, architects, Victoria-street, and further information obtained from Mr. R. Pape, Electricity Works. Tenders by March 3.

Stalybridge.—The Tramways Committee of the Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board invite tenders for the supply of rails, anchor plates, and fishplates, points, crossings, filling pieces, tie-bars, bolts, nuts, and rivets, and trolley wire (43 tons). Tenders by March 3. Details in our advertisement columns.

London, S.W.—The London County Council invite tenders for two lots of 50 double-decked double-bogie electric tramcars, equipped with a plough for working on a conduit system, and to be capable of seating about 68 persons. Specification and other particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by March 4.

Madrid.—Tenders are invited by the Spanish Government for the supply of 141 tons of iron wire for the Government telegraph service. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m. Tenders by April 2.

Dewsbury.—The Electricity Committee invite tenders for the supply, delivery, and erection at their generating station of cooling-tower and pond, piping, valves, and tank, centrifugal pump and motor. Specification, etc., can be obtained from the Borough Electrical Engineer, Electricity Works, Bradford-road. Tenders by March 10.

Oldham.—The Corporation Electricity Committee invite tenders for supplying the whole of the work and material comprised in Contract No. 4, which includes steam, exhaust, feed and drain pipes, feed pumps, feed heaters, tanks, barometric condensers, condenser pipes, oil separators, motor-driven pumps, tools, etc. Tenders by March 25. Details in our advertisement columns.

Swansea.—The Corporation invite tenders for the supply, delivery, and erection at their generating station, Swansea, of two 600-kw. continuous-current steam dynamos, together with condensing plant, steam and exhaust pipes and valves. Specifications, etc., may be obtained from the borough electrical engineer, Mr. C. A. L. Prusmann, Electricity Works, Swansea. Tenders by March 8.

Aberdeen.—The Tramways Committee invite tenders for work required to be done in laying new double line in Rosemount-viaduct and new single line in South Mount-street and Rosemount-place; also for strengthening rail joints and equipping for electric traction existing lines in Rosemount-place, Beachgrove-terrace, and Fountainhall-road. Specifications, etc., may be obtained from Mr. Wm. Dyack, burgh surveyor, Aberdeen. Tenders by March 3.

Heckmondwike.—The Electric Lighting Committee invite tenders for the supply and erection of the following plant for the extension of the electricity works: steam, water, and exhaust piping, etc., steam traction generator, storage battery and automatic reversible booster, alterations and extensions to main switchboard, condenser and oil separator, water-cooling tower, and underground traction and return feeders. Tenders by March 15. Details in our advertisement columns.

Oban (Scotland).—The Corporation invite tenders for the supply and erection of steam, exhaust, drain, and other pipes, pumps, condensing plant, etc., balancing transformers and motor-generators, storage batteries, switchboard, arc lamps, incandescent lamps, and fittings, cable work, and travelling crane. Specifications, etc., can be obtained at the offices of Messrs. Burstall and Monkhouse, consulting engineers to the Corporation, 14, Old Queen-street, Westminster, S.W. Tenders by March 7.

Brighton.—The Council invite tenders for supplying and laying telephone conduits and cables, erecting telephone poles, standards, arms, etc., fixing subscribers' instruments, supply of creosoted telephone poles, manufacture and supply of telephone insulators, oak arms for telephone poles, ironwork used in telephone construction, galvanised iron arm bolts, nuts and washers, hard-drawn, semi-hard, and soft copper wire, silicium bronze wire, iron and steel stay wire, insulated wires, lightning arresters, high-tension guards and test jacks, primary batteries, telephone instruments and telephone switchboard. Tenders by March 24. Details in our advertisement columns.

RESULTS OF TENDERS.

Fulham.—The Borough Council have accepted the tender of W. E. Burnand and Co., Sheffield, for 29 transformers at £1,340.

Bournemouth.—The Town Council have accepted the tender of J. G. White and Co., at £18,933. 3s., for overhead equipment, with sectional poles.

Buxton.—The Urban District Council have accepted the tender of Chamberlain and Hookham for electricity meters, 50 being the probable requirement for the year.

Shoreditch.—The Borough Council have accepted the tender of Wilson Bros. and Lamplough, at £2,069, for the extension of the electric lighting station, Coronet-street.

Llandudno.—The Electric Lighting Sub-Committee have accepted the tender of Crompton and Co., of Chelmsford, at £2,809, for the extensions required at the electricity works.

Portsmouth.—We hear that the contract for the electric lighting and other electrical work connected with the new naval barracks has been entrusted to Messrs. Bergtheil and Young.

Bexhill-on-Sea.—The Urban District Council have accepted the tender of the Chloride Electrical Storage Company, Limited, at £140, for cleaning and restoring storage battery.

Wigan.—The Electric Light and Tramways Committee have accepted the tender of the Telegraph Manufacturing Company, Limited, for cable, and that of Messrs. Back and Manson for trolley wire.

Norwich.—The Norwich Electricity Company, Limited, have accepted the tender of the Electrical Power Storage Company, Limited, of 4, Great Winchester-street, E.C., for the storage battery for their generating station for the sum of £1,771. 4s.

Redruth.—The Urban District Council have accepted the tender of the Urban Electric Supply Company, Limited, for the lighting of the town with 25-c.p. electric lamps at £1. 18s. per lamp per annum, and all-night lamps of 32-cp. at £2. 8s. each, the price to include the provision and maintenance of lamp-posts, lanterns, lamps, and fittings, with attendance and renewal, and the running of 30 lamps all night.

BUSINESS NOTES.

TRACTION.

Nottingham.—The new tramway along St. Ann's Well-road was opened on Friday for public traffic.

Blackpool.—The Tramways Committee have decided on a very considerable reduction of the tram fares.

Military Motorcars.—It is reported that the German Government will spend £15,000 on military motorcars.

Aberdare.—The Board of Trade have intimated that they will hold an enquiry into the proposed tramway scheme.

Bournemouth.—The Town Council have decided to proceed with the Richmond Hill tramway at once, at a cost of £7,300.

Loughborough Light Railway.—The final order for the construction of this railway has been granted by the Board of Trade.

Lastingham Light Railway.—The operations in connection with the laying down of the railway will be commenced in March.

Greasborough.—It is proposed to obtain parliamentary powers next session to construct a tramway from Rotherham to this place.

Totnes.—The Town Council have agreed to the Totnes Electricity Supply Company obtaining a tramway provisional order from the Board of Trade.

Walker.—The Urban District Council have sealed their agreement with the Corporation of Newcastle with reference to the extension of the tramway system to Walker.

Sunbury.—The Urban District Council have decided to join the Heston and Isleworth Urban District Council in their opposition to the Middlesex tramways scheme.

Battersea.—The Law and Parliamentary Committee report that the City, Wandsworth, and Wimbledon Electric Railway Bill is not being proceeded with this session.

Glasgow.—March 5 has been fixed by Sheriff Fyfe on which to hear parties in connection with the complaint of a Pollokshields gentleman as to the speed of the electric cars.

Barnes.—An agreement has been arrived at between the Rural District Council and the London United Tramways Company with reference to the proposed Barnes-Richmond tramway.

Ayr.—All the plant, including the steel rails from America, is now on the site in connection with the extension of the Corporation electric tramways for the two miles to Burns's Monument, and material progress has been made.

Reddish.—The inhabitants of North Reddish are anxious that the Stockport Corporation tramways should be extended to the north end of the town. The Stockport Corporation will likely be approached on the subject shortly.

Colwyn Bay Light Railway.—On the 5th of next month the Light Railway Commissioners will open an enquiry into the application of the Llandudno and Colwyn Bay Light Railway Company for an extension of time.

Swinton and Pendlebury.—It has been decided by the District Council to oppose the Salford Tramways Bill with a view to having a clause inserted giving the Council a right to representation on the Tramways Joint Board.

Leeds.—The chairman of the Corporation Tramways Committee, accompanied by two other councillors, has paid a visit to Glasgow in connection with the appointment of Mr. Baillie Hamilton as manager of the Leeds tramways.

Cavehill and Whitewell Tramway Bill.—Petitions have been lodged in the House of Commons against this Bill on behalf of the Antrim County Council, the county borough of Belfast, and the Belfast Water Commissioners.

Plymouth.—With the extension of the electric tramways to Beaumont-road on the east boundary, and to the Octagon on the west, the Council have readjusted the system of running to meet the requirements more beneficially of the public.

Stockton Heath.—The Parish Council will oppose the proposal of the Warrington Corporation to extend the tramway system to Stockton Heath at the forthcoming enquiry on March 4. The two authorities have been unable to come to terms.

Bridlington.—The Town Council on Wednesday decided to offer "the strongest opposition" to the application of the promoters of the Flamborough-Bridlington light railway for a further extension of the provisional order held by them to March 31, 1903.

Liverpool.—The Tramways Committee have decided to lodge an appeal against the decision of Mr. Justice Wills at the assizes last week, in the case against the Corporation for assault and false imprisonment. The case was duly reported in our last issue.

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Tyneside Tramways Bill.—In the case of this Bill, Lord Morley, chairman of the Standing Orders Committee in Parliament, has allowed the Standing Orders to be dispensed with and the Bill to proceed subject to the Tynemouth tramways being withdrawn.

North Metropolitan Tramways.—The London County Council have agreed to forego the payment by the North Metropolitan Tramway Company of 12½ per cent. of the increase of the company's gross receipts in respect of any all-night tramway service it may establish.

Southwick.—The terms of agreement between the Urban District Council and the tramway company have been modified. The question of postponing the Council's right to purchase for 42 years, provided electric traction is introduced within the next two years, has been adjourned.

Electric Omnibuses.—We understand that the London Road Car Company intend to introduce an electric omnibus to carry 26 passengers. It will occupy only about half the space of those omnibuses which ply at the present moment. It is expected to be ready in three or four months.

Selby and Goole Light Railway.—It is reported that this scheme is likely to be taken over by the North-Eastern Railway Company. The Light Railway Commissioners had named yesterday as the day for opening the official enquiry into the matter, but the proceedings have been postponed.

Light Railways in Derbyshire.—A report emanating from Sheffield states that a scheme is being promoted for an electric light railway to Baslow and Bakewell. It will commence at Grindleford Station on the Dore and Chinley line of the Midland Railway. The cost is estimated at £90,000.

Huddersfield.—We are informed that the British Westinghouse Electric and Manufacturing Company have received the order for complete electrical plant for 25 tramcars. The equipments will consist of 49B motors, No. 90 controllers, automatic circuit breakers, and resistances for "service" braking.

Newcastle.—The Arthur's-hill route of the new electric tramways was fully opened out on Monday, and four cars were run between the toll bar and St. John's Church. The system has also been extended along Scotswood-road to near the toll bar. There are 14 cars running on this route, and the fare charged is a penny.

London United Tramways.—The Parliamentary Committee of the London County Council recommend the Council to refuse their consent required by the Standing Orders of Parliament to the construction of such of the tramways proposed by the London United Tramways Bill as would be within the county of London.

Watford.—A resolution was adopted by the Parish Council at their last meeting that the Council were opposed to the proposed tramways being in the hands of the body not representing the public. The enquiry into the County Council's scheme before the Light Railway Commissioners will be resumed on 10th prox.

Wolverhampton.—A section of Darlington-street is now in the hands of the workmen engaged in laying down the tramlines, and the members of the local tradesmen's association have decided to appoint a deputation to request the mayor to cause double shifts of men to be employed, in order that the work may be carried out as expeditiously as possible.

Manchester.—At a meeting of the Tramways Committee on Tuesday it was reported that the Electricity Committee would be in a position on April 15 to furnish more current for the working of the electric tramways. It is intended to partly utilise this extra power on the Upper Brook-street route, and to place 35 additional cars on the three main routes now in operation.

Pontypridd.—Mr. Wilson, the consulting electrical engineer to the District Council, has been asked to stay for the present all contracts recently accepted in connection with the supply of electrical energy for the tramways and lighting of the town, pending an interview with the South Wales Electrical Company, who have offered to supply current at a cheaper rate than the Council.

The Potteries.—The Bills now being promoted in Parliament by the North Staffordshire Tramways Company and the Potteries Electric Traction Company for further powers are meeting with great opposition in the Pottery district. Among the local authorities who have agreed to oppose the schemes are the Stoke and Longton Town Councils and the Fenton and Tunstall Urban District Councils.

Kirkcaldy.—Owing to a disagreement between the Town Council and the Water Commissioners in regard to the fire-plugs and water-pipes, the work of laying the tramrails in Links-street has been practically stopped. Although the causeway has been removed, no concrete or rails can be put down until an arrangement has been arrived at. The construction of the generating station is being rapidly pushed forward.

Birkdale.—The shareholders in the Birkdale and Southport Tramways Company have sanctioned the voluntary winding up of the company, and have empowered the liquidators to accept, with or without any modification, as they may think fit, the offer made by the Urban District Council of Birkdale to purchase the tramways belonging to the company, situate within the district of Birkdale, for the sum of £5,000.

The Westinghouse Magnetic Brake.—Among the more important orders recently placed with the Westinghouse Company for their magnetic brake are those of the Glasgow Corporation for complete brake equipments for 100 cars; the Nottingham Corporation for complete brake equipments for 16 large four-motor cars; and the Tyneside Tramways and Tramroads Company for magnetic brake equipments to be fitted to four large 80-passenger four-motor cars.

North Shields.—On Monday, Colonel Boughey and Mr. H. A. Stewart, Light Railway Commissioners, held an enquiry into the application of the Tynemouth and District Tramways Company to extend the tramways to Whitley Links. The estimated cost of the new line is £4,360. At the conclusion of the evidence Colonel Boughey intimated that they would recommend the Commissioners to send the order to the Board of Trade for confirmation.

County Council Omnibuses.—The Highways Committee of the London County Council, reporting on the result of the appeal to the House of Lords, recommended at Tuesday's meeting that as the Council had no legal power to run feeder omnibus services in connection with its tramways, the committee be authorised to make the necessary arrangements for the sale of the omnibuses, horses, etc., in such manner as might be most advantageous to the Council. This was agreed to.

The Tyne Tunnel Scheme.—The promoters of the Tyne Tunnel Bill have intimated their willingness to satisfy the North Shields Corporation upon the several points in dispute between the two parties. There is, therefore, every probability that the Corporation's opposition to the Bill will be withdrawn. The company have also made a concession to South Shields Corporation, and instead of the proposed 40ft. road in Mile End-road, where the entrance to the tunnel will be constructed, have agreed to a width of 57½ft.

Central London Railway.—In the House of Commons yesterday week Mr. Crombie asked the President of the Board of Trade whether he had control over the arrangements made for the safety of passengers on the Central London Railway, especially in the case of a train breaking down in the tube at some distance from a station. Mr. Gerald Balfour said the line in question was duly inspected by the officers of the Board of Trade before it was brought into use. The Board has no control over the arrangements made for passenger traffic.

Crewe.—A meeting of the Crewe Tradesmen's Association has passed this resolution: "That this association, whilst endorsing the action of the Crewe Town Council in introducing electric traction into the borough, fully recognises the claim put forth by the ratepayers of High-street and Mill-street, and considers that the introduction of a tramway which does not traverse this section would be disadvantageous to the scheme and an inconvenience to the general community, and, further, that it be recommended to the Town Council to take both lines of route to the station."

The Monorail in Russia.—A monorail tramway between St. Petersburg and Moscow, which, it is claimed, would reduce the journey now covered by an express train in 13 hours to a tenth of that time, is the latest project (says the *Globe*) in which Mr. Yerkes is asked to interest himself. M. Roumanoff, a Russian engineer, puts the speed on the new system at a modest 200 miles an hour, and his idea is to have 400 cars running continuously suspended on rails. The invention provides for the automatic stopping of all the cars should an accident happen to any one of them.

Barrow.—A settlement of the tramway difficulty at this place is announced. A committee of the Corporation have interviewed the British Electric Traction Company in London, and have been able to come to terms as to the exact basis of agreement upon which the latter secured a lease for 26 years. There is only one local difficulty to settle—with the Furness Railway Company—and that will be easily arranged. It is probable that within a few days arrangements will be made whereby the work of transforming the present steam trams and substituting electric traction can be commenced.

Devonport.—An electric tram accident occurred here on Friday afternoon. While proceeding down Albert-road, a steep thoroughfare, a car containing 10 passengers got out of control, in consequence, as is supposed, of the greasy state of the metals, and dashed down the incline at a great speed. At the bottom the car jumped the rails and came in contact with an iron fence, being finally brought to a standstill by a large tree standing in the ground beyond. The car was completely wrecked, and the driver sustained a fractured knee-cap and several bruises. Most of the 10 passengers also sustained injuries.

Portsmouth.—Mr. C. Rotter having resigned his position as manager of the new municipal electric tramways, the Tramways Committee have decided to advertise for a new manager. The salary offered is £300 per annum, rising to £350 in two yearly increments of £25. In the advertisement the committee make the proviso that candidates must have previous traffic management experience, and the age limit is 45 years. The committee have not yet come to a decision as to Mr. Rotter's connection with the undertaking in an engineering capacity. The loss to date on the tramway undertaking is reported to be £5,400.

Hammersmith.—A deputation of residents and ratepayers of Hammersmith, including representatives of both political parties, has approached the London County Council with the view of obtaining the latter's consent to the construction of electric tramways in the borough by the London United Tramways Company. The London United Tramways Company have signified their assent to the terms and conditions of the Borough Council with regard to their Bill before Parliament, and the formal consent of the Council to the proposed tramways which is required for the purpose of Standing Orders will shortly be given.

Private Bills Advanced.—In the House of Lords on Tuesday the Northumberland Electric Tramways Bill was read a second time. One of the Standing Orders was considered and dispensed with in the cases of two Bills—one being the London United Electric Railways Bill, and the other the City and North-East Suburban Electric Railway (No. 2) Bill, so that Earl Cadogan, in the one case, and the Borough Council of Bethnal Green in the other, might be allowed to present petitions praying to be heard in committee on the Bill, although the time limited by the Standing Order in question for presenting such petition had expired.

Liverpool Motor-Wagon Service.—As a result, presumably, of the recent motor-wagon trials in South Lancashire, held under the

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auspices of the Liverpool Self-Propelled Traffic Association, the Road Carrying Company, Limited, has been registered this month with a capital of £20,000 in £1 shares. Its object is to carry on the business of carriers, carters, passenger carriers, railway and forwarding agents, collectors and warehousemen, and dealers in self-propelling vehicles, or vehicles drawn by any motive power, self-contained or otherwise. The head offices are at Fowler's-buildings, 7, Victoria-street, Liverpool, and that city is to be the centre of operations.

London-Brighton Electric Railway.—Further proof of non-compliance with the Standing Orders of Parliament by the promoters of this scheme was given this week before Mr. Campion, senior examiner of petitions for private Bills, by the South-Eastern and Chatham Company and others. At the conclusion of the enquiry the examiner certified that Standing Orders had not been complied with in a great many respects. In the event of the Standing Orders Committee, to whom the examiner's certificate will go, declining to dispense with the compliance, the scheme will be "dead" as far as the present year is concerned.

Aberdeen.—Following up their resolution to electrically equip the outlying tramways—viz., those to the bridges of Don and Dee and by Albyn-place to Bayview—the Town Council have accepted contracts for the various work. The total amount of these tenders, for permanent way, overhead wires, cables, etc., is £23,356. The Corporation have up to this date expended in the purchase and extension of the tramway system a grand total of nearly £240,000, and Ferryhill and Torry districts have yet to be provided with electrical lines. A special clause for the protection of the Corporation is to be inserted in the provisional order of the company promoting the suburban tramways.

Motor Bicycle Racing.—An open race meeting for motor bicycles was held in the Crystal Palace grounds on Saturday. The programme of six events, held under the auspices of the Motor Cycling Club, included path races of five miles each for machines of 1½ h.p. and under, over 1½ h.p. and under 2 h.p., and over 2 h.p. The race for 1½-h.p. machines was won by T. H. Tessier on a Werner bicycle. His time was 9min. 29⅕sec. for the five miles. The winning time of the race for the over 1½ h.p. and under 2 h.p. was 9min. 40sec., and that of the over 2-h.p. class 9min. 4⅘sec. In addition to these races a hill-climbing and speed contest was held in the grounds over a selected course for each class.

Tramway Statistics.—A parliamentary return just issued states that there are 1,304 miles of street tramway open for traffic in the kingdom. The total capital authorised is £41,877,046, and the total number of passengers carried in 1901 was 1,198,226,758. The total receipts from passengers were £5,735,444; from parcels and mails, £15,915; from animals, goods, and minerals, £6,497; from all other sources, £203,206—making a gross total of £5,961,062. The total expenditure was £4,525,179, and the net total receipts £1,435,883. The number of miles run by cars was 123,176,561. The number of horses employed was 34,422, the number of locomotive engines 527, and the number of cars 7,184.

Alexandra Park.—The trustees of the Alexandra Palace have been approached with the object of their sanctioning the introduction of electric tramways into the extensive park. The offer comes from the Metropolitan Electric Tramways, Limited, who undertake to pay a rental of £300 a year for permission to work a double line of cars from the Hornsey entrance to the Wood Green gate, passing the front of the palace along the terrace. The proposed new lines would be linked up with the Middlesex County Council's system of light railways, both north and south of the park. The scheme was considered by the trustees on Tuesday night, and a decision was postponed until the adjourned meeting next Saturday.

Barnsley and Doncaster Light Railway.—The promoters of this scheme have decided not to persevere with their application to the Light Railway Commissioners, but to proceed later in another way. The inference is that they will apply to Parliament for the necessary powers to construct the line. The plans show a line of about 16 miles from Barnsley to Doncaster, with a branch to Mexborough, and passing through Ardsley, with Stairfoot, Wombwell, Wath, and the colonies surrounding the Denaby and Cadeby Collieries, with a total population of 150,000 or thereabouts. The estimated cost of the scheme is over £140,000—£91,400 representing the contracts for construction, and £48,950 the cost of electrical equipment and rolling-stock.

Scarborough.—In the House of Commons the Scarborough Tramways Bill has passed its second reading, and has been referred to a Select Committee. Another petition opposing a certain portion of the tramways scheme has been handed to the town clerk, emanating from Eastborough tradesmen, who object strongly to the construction of tramway lines down Eastborough to the Sandside. The petitioners ask the Corporation to terminate the Westborough and Newborough lines at St. Helen's-square. If the tramways are carried beyond this point, they argue that it will lead to a great depreciation of business, as excursionists would be carried to and from the Sandside, and thus prevented from patronising the many shops in Eastborough, whose chief source of income is derived from the excursion trade.

Manchester-to-Bolton.—The day when there will be a complete through service of electric tramcars between the city of Manchester and the county borough of Bolton has just been hastened by the opening for traffic of another link in the chain of communication in the shape of the new tramway which joins the Bolton and Farnworth route at the junction of Longcauseway and Manchester-road, and runs through the township of Kersley. A short gap now only remains to be filled between this point and the terminus of the Manchester tramway system at Pendlebury. The new line which has just been opened by the Urban District Council of Kersley is a single one with loops, and has attaching to it a special interest from the fact that in conjunction with the Farnworth system it is said to be the first electric tramway in Lancashire carried out by an urban district council.

London Tube Railways.—Sir J. Dickson-Poynder asked the President of the Board of Trade in the House of Commons the other day whether he could state if he had considered the advisability of making some special arrangement as to the committee stage of the several underground tubular railway Bills introduced this session so as to ensure these Bills being considered as part of a comprehensive scheme of metropolitan locomotion; also whether, with that object in view, he proposed to grant the London County Council a *locus standi* before these committees. Mr. Gerald Balfour replied that he had carefully considered this subject and conferred with the authorities of both Houses. He understood it was proposed to send the Bills if read a second time to one or more Private Bill Committees, and to give the London County Council and the Corporation of the City, if they desire it, a special *locus*.

Hull.—The Tramways Sub-Committee held a special meeting last week to consider a report from an inspector of the Board of Trade with respect to the safeguard in use on the tramcars. The inspector's report stated that this guard was never now accepted on new tramway systems, and it clearly must not any longer be accepted on extensions of existing systems. As long as this guard was in use accidents were sure to continue. On the other hand, there was a form of guard now largely in use—*e.g.*, at Newcastle, Birkenhead, etc.—which had up to the present time been singularly efficient in preventing fatal accidents. It was the form fitted with a front shutter, which, on coming in contract with an object lowers the guard behind it actually on to the ground. The Corporation should be strongly urged to fit their cars with this form of guard. The committee eventually left the matter in the hands of the chairman and the engineer to report. It was stated that if the commitee are compelled to adopt the new form of guard, it will involve an expenditure of £5,000.

Bradford.—A deputation representing the shopkeepers of Darley-street, Godwin-street, and Kirkgate waited on the Tramways Committee on Tuesday to urge upon them the desirability of reconstructing the tramway on North-parade and to maintain the present terminus in Rawson-square. The deputation pointed out that the method which the committee had proposed to pursue of running all the electric tramcars on the Manningham-lane line through to Forster-square would create a considerable amount of unnecessary traffic at the awkward corner by the Midland Hotel, and on this ground, as well as on that of public convenience, the reconstruction of the lines in North-parade would repay the cost. The committee, after consideration, assented to the request of the deputation, and the lines will be reconstructed for electric traction, though not until other lines which are more urgent have been completed. A trial journey of a successful character was on Wednesday made over the newly-electrified tramway from Thornbury to Bradford, and a frequent service of cars commenced on this route yesterday.

Manchester-Salford Dispute.—Negotiations are still in progress, the favourable nature of which, it is said, give good prospect of Manchester and Salford coming to an agreement on tramway matters and avoiding an appeal to Parliament. Later reports, however, state that the Manchester Tramways Committee have refused to agree to the latest proposals made by Salford with regard to the working of the tramways. These, it is stated, contained the suggestion that the Salford Corporation should work the tramway traffic from the various bridges into Deansgate and jointly from Deansgate to the Grove Inn, and pay to the Manchester Corporation a mileage rate equal to the annual gross receipts per mile earned on the whole of the Salford system. It was further suggested that Manchester should work the Bury New-road traffic and pay to Salford a sum per mile equal to the annual average gross earnings per mile made on the whole of the Manchester routes. Salford were to have the exclusive use of the lines leading from Deansgate to the Blackfriars, Albert, and Regent Bridges, but the Corporations were to work jointly on the Deansgate lines.

Sunderland.—The chairman of the Tramways Committee of the Corporation has presented to his committee the following statement relating to the estimated net profits for the year ended March 31, 1902: "Income: balance brought forward from 1901, £4,757. 12s. 10d.; traffic receipts, rents, and bank interest, £56,300—total, £61,057. 12s. 10d. Expenditure: electric current (2d. per unit), £10,300; drivers and conductors, £9,700; management and office expenses, £1,600; inspectors, cleaners, and other staff, £3,600; rents, rates, and taxes, £1,400; insurance on buildings, cars, and workmen, £120; car-shed expenses, running stores, lighting, and water, £800; tickets and uniforms, £400; compensation for injury, £700, £500 of which goes to form a reserve fund of £2,000. Repairs and renewals fund: buildings, £150; cars, motors, and instruments, £705; track, £4,160; overhead equipment, £735; interest, £6,811; sinking fund requirement, £6,712; reserve fund; amount set aside in accordance with provision of Tramways Act, £5,000—total, £52,893. This leaves an estimated net profit of £8,164. 12s. 10d., £7,000 of which the Tramways Committee recommend should be given in relief of the rates.

Wakefield.—Colonel Boughey and Mr. H. Allan Steward, Light Railway Commissioners, held a public enquiry on Tuesday into the case for the promoters of the Wakefield and District Light Railway. The complete scheme embraces 30 railways, which, if constructed, would form a network of communication, with Wakefield as the centre, between Horbury, Ossett, Dewsbury, Soothill, Leeds, Oulton, Rothwell, Castleford, Normanton, Pontefract, etc. Opposition to the scheme was put forward on behalf of the Great Northern Railway Company, the Lancashire and Yorkshire Railway Company, and the North-Eastern Railway Company, on the ground of unfair competition. At the conclusion of the evidence, Colonel Boughey said they were prepared to recommend an order for the tramway from Oulton to Rothwell, thus connecting it with the proposed line to Leeds. As to the route between Wakefield, Ossett, and Dewsbury, the Commissioners felt that they could not submit an order for this line to the

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Board of Trade. But as to the line from Wakefield to Oulton and Rothwell, the Commissioners would be prepared to submit a draft order, so that the question of the effect upon the railways might be left to the decision of the Board of Trade. It was afterwards stated that the promoters would certainly promote a Bill in Parliament with regard to the Ossett and Dewsbury scheme.

LIGHTING AND GENERAL.

King's Norton.—The District Council's electric lighting scheme has been shelved.

Whitby.—We understand that the electric light was switched on last week for the first time.

Epsom.—Applications for energy received by the Urban District Council equal 2,013 8-c.p. lamps.

Wrexham.—The salary of the electrical engineer (Mr. W. Sillery) has been increased by £25 per annum.

Doncaster.—An electrical exhibition was opened on Tuesday under the auspices of the electrical department of the Corporation.

Long Eaton.—The Urban District Council have obtained sanction to borrow £13,500 for the proposed electric light installation.

Newark.—The Urban District Council are conferring with the Derbyshire and Notts Electric Power Company as to the supply of electricity.

Indo-European Telegraph Co.—This Company notify that the tariff to Ceylon will be reduced from 4s. 1d. to 2s. 7d. per word on and after March 1.

Mutford and Lothingland.—A small committee has been appointed by the Guardians to report upon the question of lighting the workhouse by electricity.

Cambridge.—The Telephone Committee are consulting Mr. A. R. Bennett, M.I.E.E., who will visit the town and report upon the proposed municipal telephone.

Newton Abbot.—We understand that the Urban District Council are pressing the Edmundsons' Company to proceed with the proposed lighting of the town with electricity.

Ramsgate.—It is proposed by the Corporation to apply to the Board of Trade for two years' extension of the powers granted under the municipal electric lighting order.

Bournemouth.—Plans of a transformer chamber at the corner of Latimer and Wimborne roads, and of main in Alma-road, have been disapproved by the Roads Committee.

Kensington and Knightsbridge Electric Lighting Co.—The directors recommend a further dividend of 5 per cent., making 10 per cent. for the year, carrying £1,840 forward.

Fareham.—Application is to be made for sanction to borrow £250 for the purpose of buying meters, transformers, etc., for the purpose of connecting electric light customers as required.

Greenwich.—The Borough Council have decided to retain the services of Messrs. Handcock and Dykes, of 1, Victoria-street, S.W., to advise them with regard to electric light matters.

Caucasus.—Belgian engineers have arrived at Vladicaucase, and have commenced work on the establishment of electric trams and an installation for the supply of electric light to the town.

Cardiff.—The desirability of the Corporation applying for a license for the establishment of a corporate exchange having been suggested, a special meeting will be held shortly to consider the matter.

South Africa.—In three months' time the Transvaal will have an entirely new telephone system. In Johannesburg alone 10,000 subscribers will be accommodated, as compared with 800 at present.

Annfield Plain.—The District Council have approved the draft of the Board of Trade regulations, which it is proposed to issue as to the laying of electric cables under the Annfield Plain electric lighting order.

Electric Stamp Obliterator.—An electrically-driven automatic stamp obliterator which is to be used in the New York Post Office can mark nearly 50,000 postal packets an hour, whatever their size or shape.

London-to-Scotland Cable.—The Postmaster-General will receive a deputation from the Glasgow Chamber of Commerce on March 6 in reference to the provision of a telegraph cable between London and Scotland.

Western Telegraph Co.—The directors declare an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended Dec. 31 last, and payable March 21.

United Alkali Co. The directors recommend the payment of the preferred dividend in full, carrying forward £35,000. The sum of £50,000 will be placed to reserve. This includes £60,166 brought forward from last year.

Chepstow.—At the last meeting of the Rural District Council a resolution was passed assenting to the application of the Chepstow Electric Light and Power Company to carry their wires into various parishes in the district.

Hull.—We understand that at a conference on Tuesday between the Telephone Committee of the Corporation and representatives of the National Telephone Company it was suggested that the Corporation should purchase their undertaking.

Louth.—The Town Council have decided to apply to the Board of Trade for a provisional order for supplying electricity for lighting and other purposes throughout the borough. The cost of establishing the undertaking is estimated at £10,000.

Dover.—The Corporation on Tuesday decided to purchase the electric light undertaking for £142,228, an increase of £13,000 on the sum they originally agreed to offer. The price accepted is based on the payment of £8. 10s. for £5 ordinary shares.

Hammersmith.—Since the last Council meeting eight additional consumers have been connected, representing a maximum of 252 8-c.p. lamps; these added to the number previously reported, show a total of 975 consumers taking current from the mains.

Eastern Extension, Australasia, and China Telegraph Co.—This Company announces that the last section—viz., between Perth and Adelaide—of the Cape-Australian cable has now been successfully completed, and will be opened for traffic on March 1.

Coventry.—The City Council intend to apply for sanction to a loan of £22,485 for extensions to the plant at the electric light works and the purchase of motors to be hired by consumers. The Council have decided upon the substitution of two-phase for single-phase generation at the works.

Power Bills.—A new committee of the House of Commons has been appointed, with Sir William Houldsworth as chairman, to consider the Electric Power Bills. The other members are Sir E. Strachey, Colonel Lucas, and Mr. H. Samuel. The first meeting of the committee will take place March 4.

Mansfield.—Enquiries are being made as to the feasibility of laying the telephone wires at the same time as the electricity main. Two foundation stones are to be laid at the electricity works, one at each side of the main entrance to the building. The tender of the Custodis Company for the erection of a Custodis chimney at the works has been accepted.

Falkirk.—The new library is to be lighted with electricity, and the Building and House Committee have been empowered to get estimates for the work. The Town Council have agreed to approve generally of the electric station plant as recommended by Mr. Burstall, and also to instruct Mr. Ronald to proceed with the preparation of the plans of the buildings.

Vickers, Sons, and Maxim.—The directors recommend the following further dividends for 1901—namely, a dividend of £2. 10s. per cent. on the 5 per cent. stock and 5 per cent. preference shares, and a final dividend of 2s. per share on the ordinary shares, making, with the interim dividend of 1s. paid in August last, 3s. per share, or 15 per cent. for the year.

London County Council.—At Tuesday's meeting of the Council it was agreed to lend the Poplar Borough Council £20,000, the Shoreditch Borough Council £18,000, and the Hampstead Borough Council £7,480 for electric light installation, and sanction for a loan of £3,000 for electric light installation, street light, and meters was given to the Stoke Newington Borough Council.

Alnwick.—The Urban District Council are conferring with the representatives of the Northern Counties Electric Supply Company with regard to the laying of the proposed cables underneath and along the footways. The Council recently let a paving contract to Mr. John Whinham, and the company's officials do not consider it advisable to lay the new cement until the cables were put down.

Bridgend.—The Board of Trade have agreed to the system proposed to be adopted by the District Council for electric lighting, and application will be made for sanction to borrow £4,000 to carry out the scheme. The Council have also decided to ask the South Wales Electrical Power Distribution Company to state their intentions with reference to the laying of an electric tramway from Bridgend to the outlying districts.

Electric Punkahs.—That useful and at the same time so much abused institution, the punkah wallah, is doomed, and he must seek a new way of earning his rice—and very difficult he will find it, poor chap. After long and patient experimenting with mechanical substitutes for manual labour in punkah-pulling, the Indian Government has decided to solve the problem by resort to electrical power. The *Globe* says installation will at once be taken in hand at the principal military stations, and it may be taken for granted that the better lighting of barracks will be accomplished concurrently.

Nottingham.—Colonel A. C. Smith has held an enquiry into the application of the Corporation for sanction to borrow a sum of £15,000 for the purposes of electric lighting. Mr. F. B. Harris, Mr. Arthur Brown (city engineer), and Mr. H. Talbot (electrical engineer), attended on behalf of the City Council, and it was explained that the loan was required in respect of extensions of the existing system, and of its natural growth during the next 12 months. New applications were being received continuously. Of the total sum of £15,000 an amount of £10,000 was put down as an estimate for the underground mains.

Chesham.—The Urban District Council have accepted an offer of the United Electric Light and Power Company—which is understood to be a syndicate of Wycombe capitalists—to take over the Council's provisional order upon the condition that the Council may repurchase the undertaking at the end of 10, 17, or 24 years. The Council also agree to give the company a seven years' contract to light the public lamps at £2 each per annum; while the company agrees that the price to be charged for current private lighting shall not exceed the price of 7d. per unit for the first hour and 4d. per unit for every hour afterwards.

Presentations.—Two presentations were made on the 19th inst. at the electric station at Wallasey, when Mr. G. Starkey, shift engineer, was presented with a handsome ornamental clock suitably engraved, being a wedding present given by the members of the staff of the gas, water, and electricity departments; and Mr. P. S. Thompson, mains engineer, who has been appointed assistant mains engineer at Manchester, was presented with a portmanteau and dressing case, as a token of the respect and esteem in which he was held by the members of the staff. Mr. Starkey has been appointed to the position vacated by Mr. Thompson.

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Huddersfield.—The surplus balance of the electricity department for last year was £2,561. 16s. 3d., as against £110. 0s. 4d. in the previous year. The Council have decided to transfer the amount to the depreciation and contingencies account. The income amounted to £20.574. 6s. 6d. and the expenditure £9,722. 16s. 2d.; £4,342. 0s 11d. has been set aside for interest on loans, £2,722. 5s. 6d. contribution towards redemption of debt, and £1,225. 7s. 8d. amount repaid Public Works Board.

Aberdeen.—The Telephone Committee have adopted a resolution to recommend the Town Council to apply to the Postmaster-General for a license to carry on a municipal telephone service in the area of Aberdeen district, and that it be remitted to the committee to take steps to ascertain how many of the present subscribers and the public generally will take the service from the Corporation, the rate for unlimited service being £6. 6s. and for restricted service £3. 10s., with 1d. in addition per call.

Kingston.—The Town Council have decided that 35 new arc lamps be provided on the public roads. It was explained that this will involve a net additional cost to the ratepayers of £305 per annum. On the other hand, assuming the Council paid the same price of £20 per lamp for the 76 lamps as they now paid for the 41 at present existing, it would enable the committee to show a balance of profit in the arc lighting, instead of a deficiency, as at present. The Council have accepted the offer of a loan of £5,800 at 3½ per cent. for 25 years.

Stirling.—Mr. Hanson, the electrical engineer, in his last report stated that the number of units generated during the week ended Jan. 25 was 4,656, making a total for four weeks ended Jan. 25 of 18,637 units. Applications are in hand for 380 equivalent 8-c.p. lamps, and 180 have been connected during this period, making a total connected and applied for up to date 6,875 equivalent 8-c.p. lamps, as compared with 5,000 for the corresponding date last year. The new steam dynamos and boilers are practically installed. Mr. Hanson has been authorised to sell meters at market price to those desiring to purchase, the customer to pay the cost of repairs.

Stepney.—At the last meeting of the Borough Council the Electrical Committee reported upon the question of "free wiring" of consumers' premises. They had received replies from the three firms who, whilst stating their prices for different styles of wiring and fitting, did not quote any terms for free wiring, and stated that in view of the action of the London County Council, who are seeking powers to authorise the council of any metropolitan borough supplying electrical energy to expend money upon the wiring and fitting and supplying with wires, fittings, apparatus, etc., and of the unsatisfactory nature of the tenders, they have decided to take no further action in the matter at present.

Penzance.—The Town Council on Tuesday received a report from Alderman W. Bazeley, the chairman of the Electric Lighting Committee, explaining that the time for carrying out the lighting order taken out by the committee in the year 1900 expired in May next. The committee had two schemes submitted to them, one at an estimate of £28,650, and the other at £22,840, the cost of production in the latter scheme being 2¾d. per Board of Trade unit. After a long discussion the following resolution was passed: "The Council are of opinion that the Electric Lighting Committee should wait to see if the Cornwall Electric Power Bill be passed before proceeding further with their supply of electric lighting for the town."

Brighton.—The Brighton and Hove General Gas Company recently complained that they had been put to the expense of laying on gas to a number of public street lamps which had very shortly afterwards been converted to electric lights, and pointing out that the profit on the sale of the gas was not nearly sufficient to recoup the company the cost of the services, some of the lamps being converted within six months and others within one, two, and three years respectively. The Corporation have now adopted the company's suggestion that in the event of any lamp service being laid and discontinued within seven years the Corporation should refund to the company a portion of the cost, say one-seventh for each year less than the seven.

Blackpool.—Our Blackpool correspondent last week misled us to crediting "Mr. Burgess" with the appointment obtained by Mr. Charles Furness, who has held the post of borough electrical engineer at Devonport for the past three years, and who has been appointed to a similar position at Blackpool at a commencing salary of £520 per annum. Mr. Furness has superintended the establishing of the Devonport electricity works, which is now supplying two tramway systems, and will in a few weeks be providing street lighting. Last Friday a deputation from Blackpool waited on the Devonport Electricity Committee, and expressed their appreciation of Mr. Furness's credentials. Mr. Furness is a member of the Institute of Mechanical Engineers and an associate of the Institution of Electrical Engineers.

Royal Visit.—In connection with the visit of the King and Queen to Devonport next month, orders have been received on board the various ships in port to make preparations for illuminating the respective vessels with the electric light during the stay of their Majesties. The list of ships will include the gunnery school ship "Cambridge," the torpedo depôt "Defiance," the training ships "Impregnable" and "Lion," the port-guardship "Nile," the "Barfleur," "Edgar," "Sharpshooter," "Howe," "Conqueror," the whole of the destroyer flotilla, and all the commissioned ships in harbour at the time. The spectacle promises to be one of the most brilliant ever witnessed in the port. It is intended to illuminate every part of the vessels, from the masts and yards down to the water-line.

The March "Smart Set."—The March number of the *Smart Set* brings another acceptable batch of short stories, poems, and witticisms. One of the latter, "A *parvenu* is a man with aspirations but no aspirates," must have caught the editor napping, for it belongs to Dean Swift or to someone else thereabouts. In an English magazine such Americanisms as "The Day I Quit" and "Commuters" might perhaps be avoided, and the excellent story "Araby," by Baroness von Hutton, is spoiled by careless reading, such as Bremen and Kiepstein, when Brenner and Kufstein is evidently what it was meant to convey; also a supposedly well-educated Englishman does not say, "I have been most places." But these are only very minor details. As a whole, the number is by far the best of any magazine we have seen this month.

Grantown.—A meeting of ratepayers was held last week to consider the question of the lighting of the burgh. The following resolution was proposed: "That this meeting of ratepayers return thanks to the committee for the report on lighting. The meeting is of opinion that the idea of water power should not be abandoned, and suggest that a qualified hydraulic engineer be asked to survey and report as to the extent of horse-power available from the Spey, and at what cost. If the committee are satisfied that sufficient power can be obtained at a reasonable cost, they are further empowered to have specifications drawn up and estimates taken from a first-class firm for an overhead installation, with the view of submitting the entire cost to a future meeting of ratepayers." Ultimately both the motion and the amendments were put aside, and the following gentlemen were added to the Lighting Committee to bring up a report: Messrs. A. C. Grant, A. W. Fraser, Macbain, Gilbert, Stewart (plumber), Duncan, Alex. Macpherson, John S. Grant, Kerr, Beale, Harvey, and Mackintosh.

Stock Exchange.—The Stock Exchange Committee have appointed March 5 as a special settling day for National Telephone Company's 200,000 6 per cent. preferred shares of £5 each, £2 paid, Nos. 590.001 to 790,000; and March 12 for National Telephone Company's £983,333 preferred stock and £1,966,667 deferred stock. The committee have also ordered National Telephone Company's £983,333 preferred stock and £1,966,667 deferred stock, in lieu of the ordinary shares now quoted, £200,000 6 per cent. preferred shares of £5 each, £2 paid, Nos. 590,001 to 790,000, and a further issue of £100,000 4 per cent. debenture stock (redeemable), to be quoted in the official list. Applications have been made to the committee to appoint a special settling in and to grant a quotation to Charing Cross and Strand Electricity Supply Corporation's further issue of 20,000 ordinary shares of £5 each, fully paid, Nos. 50,001 to 70,000, and 20,000 4½ per cent. cumulative preference shares of £5 each, fully paid, Nos. 50,001 to 70,000; and City of London Electric Lighting Company's further issue of £100,000 4½ per cent. second debenture stock (redeemable).

Bedford.—The engineer has been instructed to make alterations to the mechanical stokers at an estimated cost of £50, and to fit two feed pumps to replace two existing ones at an estimated cost of £200; also to make sundry pipe connections, alterations, etc., recommended by him at an estimated cost of £175, and to repair existing machinery at an estimated cost of £200, and repairs and additions to switchboard at £120. Tenders are to be obtained to supply economisers for Nos. 1 and 2 boilers, at an estimated cost of £1,062. A new storehouse is to be erected and alterations made to offices, including raising of roof and building second storey, and the necessary furniture is to be obtained for the same, at a total estimated cost of £670. The electrical engineer has also been instructed to instal new transformers at an estimated cost of £1,800 (less proceeds of existing transformers, estimated at about £500); also to provide separate conduits for high-tension cables where necessary, and to carry out sundry alterations to mains, at an estimated cost of £280, as shown on pp. 10 and 11 of the engineer's report. A main electricity meter is to be obtained at an estimated cost of £25 to enable the supply of power to private consumers to be accurately measured.

Swansea.—The Electric Lighting and Tramways Committee's minutes, approved at the last County Council's meeting, showed the following totals: expenditure in connection with the electricity undertaking of the Corporation to Jan. 31, 1902—capital account, £57,252. 5s.; revenue account, £4,172. 11s. 4d.; making a total expenditure of £61,424. 16s. 4d. The following estimate of the proposed works was submitted: two 600-kw. generators, £11,600; condensing plant, £1,400; foundations, £1,000; pipework, valves, etc., £1,000; economiser, £350; feed pump, £65; switchboards and connecting cables, £1,000; balancer, £340; feeders, distributors, pillar-boxes, etc., £2,900; spare pipe ways, £500; excavation and reinstating, £600—total, £20,755. The resident engineer has been instructed to forthwith prepare complete specifications for the whole of the proposed works, and tenders are to be invited for the supply and fixing of the generators. The charge for current supplied for power and heating will be at the rate of 2d. per unit for the first five hours of maximum demand, and 1½d. per unit for current consumed beyond those five hours. It appears that Swansea had supplied electric light at an average price of just 3½d. for the past six months, and 300,000 units had been supplied during the year. Application will also be made for sanction to the borrowing of £18,000 for telephone purposes. Telephones are to be fixed (*a*) at £5 per annum, payable in advance, to cover an unlimited number of calls; and (*b*) at £3 per annum, payable in advance, with a toll of 1d. per call payable quarterly, both tariffs (*a*) and (*b*) to be increased to £5. 10s. and £3. 10s. respectively in the event of a subscriber refusing to enter into a three years' agreement. Subscribers to the municipal system are to be allowed the use of telephones for the first three months free of charge. Mr. Bennett's services have been engaged.

London Gazette.—The last day for receiving proofs in the estate of C. A. Church (trading as H. Connolly and Co.), manufacturing electrical engineer, lately residing at Aldborough Hatch, Ilford, Essex, and carrying on business at 42, Hampstead-road and 120, Kentish Town-road, London, is March 8. Mr. L. H. Lemon, 32, King-street, Cheapside, is trustee.—The discharge of W. V. Scott, electrical engineer, lately residing at 1, Shaftesbury-road, East Hammersmith, has been suspended for two years; bankrupt to be discharged as from Jan. 21, 1904, on the grounds that his assets were not of a value equal to 10s. in the £, and that he had been guilty of misconduct in relation to his property and affairs.—A final meeting of the Midland

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Rubber Company (in liquidation), at Ryland-street, Birmingham, on March 27, at three o'clock.—The last day for receiving proofs in the estate of T. Morley, 16, Walley-road, Accrington, is March 14. Mr. C. H. Plant, 54, Chapel-street, Preston, is the official receiver.—A supplementary dividend of 8s. 2½d. has been declared in the estate of Herbert Sewel, 63, Birklands-road, Shipley, Yorks; payable March 5, at official receiver's chambers, 31, Manor-row, Bradford.—Mr. P. Ravenscroft, Jewry House, Old Jewry, has been released as trustee in the estate of G. T. Godfrey (trading as Godfrey Bros.), at 40, Trinity-road, Tooting.—First meetings of creditors and contributors in the Automobile Manufacturing Company, Limited, 48 and 49, Long-acre, will be held on March 11, at 11.30 and 12.30 respectively, at 33, Carey-street, W.C.—Application has been made to the Board of Trade under the Electric Lighting Acts, 1882 and 1888, and the Electric Lighting (Clauses) Act, 1900, for a license to enable the Market Drayton Electric Light and Power Company, Limited, to produce and supply electricity for motive power and all public and private purposes within the parish of Drayton in Hales, in the rural district of Drayton, in the county of Salop; power to construct works, to acquire lands, to make charges, to make arrangements with local authorities, to open streets, to erect and lay electric lines, and other purposes.

Battersea.—With reference to the Electric Lighting (London) Bill, the Electric Lighting Committee mentioned in their last report (*a*) that the present Bill provided that the transfers should not include areas in which works had been carried out previous to Jan. 1, 1902: (*b*) last year's Bill provided for agreements for taking over of mains and works upon terms to be agreed upon, with appeal to the Board of Trade failing agreement—the present Bill, however, only empowered the Board of Trade to act after agreements have been arrived at. The works carried out by the Council previous to Jan. 1, 1902, in the transferred areas were very few, whilst numerous works had been carried out by the County of London and Brush Provincial Electric Lighting Company, Limited, in parts of Wandsworth transferred to Battersea. Having regard to the serious complications which would undoubtedly arise if the present Bill became law, the committee had, as a matter of urgency, directed the town clerk to communicate with the Board of Trade, pointing out the vital alterations and omissions, and strongly urging upon them the necessity for reinstating the provisions of the Bill of last year. In the specification for the work of providing the condensing plant, etc., at the central electric generating station provision was made in the original scheme for all excavation, cutting away, and making good all building work, erection of buildings, sinking of pits, etc., to be carried out by the Council, but no estimate appeared to have been submitted for such work. The work is to be carried out by the works department at an estimated cost of £240. A turbine tube cleaner, bricks, meat clothes, gauge glasses, galvanometer set, and other articles and materials, as per list accompanying the report, for use in the electricity department, are to be procured, and small works of repair to gauge-glass guards carried out at an estimated cost of £43. 19s. 10d. Certain material is to be taken over from Callender's Cable and Construction Company, Limited, consisting of cables, waybridges, bitumen, guttering, joint services and network boxes, accessories for guttering, etc., at a cost of £522. 10s. 7d. The committee had further considered as to the necessary steps to be taken with a view to giving effect to the revised scale of charges for the supply of electrical energy to premises within the borough. The residential portion of the central electric generating station has been rearranged, and accommodation has been offered to the assistant electrical engineer (Mr. W. A. Kemm) and the second assistant (Mr. E. J. Bergersen).

Cables.—The first report of the Inter-Departmental Committee on Cable Communications has just been issued as a parliamentary paper. This committee was appointed in November, 1900, "to enquire into the present system of telegraphic communication between different parts of the Empire, and to consider in what respects it requires to be supplemented." In the report, which has just been presented to Parliament, but which was made in August last, the committee state that while they had not then been able to arrive at a conclusion upon all the complicated and important points submitted to them, they desired to express an opinion without delay upon one subject—viz., the question of the Indian telegraph rate. That rate now stands at 4s., and it had been definitely agreed between the India Office, the Eastern Telegraph Company, and the Indo-European Telegraph Company, that the rate should be reduced to 2s. 6d. The committee, however, learnt "with much surprise" that in spite of the fact that the Eastern Telegraph Company possessed a complete independent system of cables from London to Bombay, and that they had every disposition to make the stipulated reduction, the assent of Russia, and apparently of Germany, also was required before it could be carried into effect. This assent has not in either case been obtained. The report refers at length to the manner in which the power of veto possessed by the foreign Governments has arisen. It is derived from (1) the joint purse agreement between the Indo-European Telegraph Department, the Indo-European Telegraph Company, and the Eastern Telegraph Company; and (2) the International Telegraph Convention and the service regulations thereto attached. The committee recommend with regard to (1) that the "earliest opportunity should be taken to terminate the existing agreement, and that, if subsequently it appears desirable, on a review of all the circumstances, to renew it in a revised form, such a renewal should be made for a moderate period, not exceeding say five, or at most seven or ten years. With regard to (2), they recommend that the clauses in the regulations giving foreign administrations a voice in the fixing of the rate, even in cases where direct and wholly independent communication by cable exists, should be amended. Finally, the committee declare that apparently in view of the foreign Governments concerned persisting in their objections—that while they have received ample evidence of the value of the advantages of the service regulations, it is clearly possible that these "may be outweighed by the restrictions upon policy imposed, and the arguments advanced in favour of the convention did not in our opinion disprove the desirability of withdrawing from it in certain contingencies."

Southampton.—The borough electrical engineer, Mr. H. F. Street, has recently laid before the Electricity Committee important proposals in connection with the reorganisation of his department, embodying the erection of new works on the Western Shore and the provision of new plant to meet the increasing requirements of the borough. The committee have approved the proposed scheme, and recommend the Council (1) to adopt the same, to obtain the additional plant, and carry out the works advised by the electrical engineer on the Western Shore site; (2) to apply, subject to the approval of the Finance Committee, to the Local Government Board for sanction to borrow the sum of £28,000; and (3) to authorise the committee, on the Local Government Board sanctioning the loan, to forthwith proceed, employing Corporation labour, to fill up and wall the suggested site for the proposed works; to accept the estimate of Dick, Kerr, and Co., Limited, for the engines and dynamos at £4,257 each, erected (being the lowest of the 27 estimates obtained by the committee); and to proceed with the foundations and buildings under the joint superintendence of the electrical and borough engineers. Mr. Street says in his report: "The cost of putting the plant on a new site, say, for example, the Western Shore site, will only involve the expenditure of about £2,700 in excess of placing the same, even if there were room, on the present site; and I am confident that the amount would be more than swallowed up in the purchase and preparation of land at the Back-of-the-Walls. I estimate the saving of working expenses on the new site with the proposed new plant at about £1,600 a year. This £1,600 can be looked upon as a net gain, as the capital will, in any case, have to be spent to buy new plant, and interest and sinking fund charges on same; but the saving of £1,600 cannot be effected at the present site. The saving is principally in coal, effected by the use of condensing engines, but wages and repairs will be less. Another small saving can also be effected, as the yard at the back of the dairy, which we occupy and pay £26 yearly rental, can be given up. You will observe that two 500-kw. sets are required. This, with the present available plant, will give us about 1,500 kw. (direct current) to meet an estimated demand of, approximately, 2,200 kw. This leaves a reasonable margin for reserve plant. Estimate: buildings, £7,900; two 500-kw. sets, £9,000; foundations, £400; two boilers and superheaters (£800), £1,600; foundations, £200; piping, £200; economiser and fixing, £300; switch gear, £200; crane, £400; filling up and walling, £2,100; new mains, £1,600; tools, £660; permanent chimney, £1,400; 18 spare conduit ways from site to clock tower, £800; enlarging existing mains in East-street, High-street, Above and Below Bar, new public lighting, and meters, £1,340—total, £28,000. The interest and sinking fund charges on this amount will be £1,562. The engine-room of the new station will accommodate four 500-kw. machines, and sufficient boiler-room is provided."

Gloucester.—At a meeting of the Gloucester City Council on Wednesday, Alderman Fielding, of the Atlas Ironworks, in moving the minutes of the Electricity Supply Committee, referred to the "splendid" plant possessed by the city, and said that, with the object of getting more customers, the committee had taken the course suggested in the minutes from the report of Mr. Bache, borough electrical engineer, who stated that the heavy winter load had been satisfactorily dealt with, and suggested that a special effort should be made to obtain additional consumers during the period of lighter load. He (Mr. Bache) pointed out that the committee might with advantage arrange for someone to call on present and probable consumers, and explain the advantages of the electric light and the scale of charges now adopted, which compares very favourably with that in other towns, and how excellent results may be obtained at moderate cost by carefully arranging the installation and using a sufficient number of switches and good lamps of suitable capacity. It seemed, said Alderman Fielding, that nearly all cases of dissatisfaction on the part of the users of the current were explained by the fact that either the installation was defective or the lamps had ceased to be efficient, or that consumers had not got into the way of regulating their use of the current by switching off the light when not required. In one case Mr. Bache informed him the current used had been reduced 50 per cent. after the matter had been investigated and the consumers directed as to the proper regulation of the light. An examination of about 100 lamps showed that half of them were wasting 50 per cent. of current. That was a very important point, and should be remembered by the consumers. There was an idea prevalent that electricity, however good it might be, was very expensive. Mr. Bache had put into his hands a comparison between the cost of electricity and gas, which showed that they were now supplying current as cheaply as any place in the West of England except Bristol. That comparison was very opportune, in view of the question raised by Alderman Simons as to the illuminating power of gas at the last meeting. If they took the annual cost of electric lamps and ordinary gas burners giving 8 c.p., they found that for a daily use of three hours electricity cost 10s. 4d., and gas 10s. 11d.; whilst for a daily use of four hours the cost was: electricity, 12s. 2d.; gas, 14s. 6d. In addition to that saving, there were the other advantages attendant on the use of the electric light—the question of health and the absence of damage to house decorations and fittings, the stock in shops, etc. The Electricity Committee thought that the minds of the public ought to be disabused in regard to these points of the prevalent idea referred to, and they ought not to rest satisfied until they had a much larger demand for the current than they had at the present time. Mr. Bache had informed him that the demand was slightly on the increase, but it was not so large as they could wish. Alderman Fielding added that the public should distinctly understand that a unit of electricity was current giving 16 c.p. for 16 hours.

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PROVISIONAL PATENTS, 1902.

FEB. 17.

3967. Improvements connected with electrically connecting tram and like rails. George Henry Archer, Sunbridge-chambers, Bradford.

3983. Improvements in lightning and current arresters and equalisers, condensers, and the like. George Lewis Hogan, 27, Chancery-lane, London.

4009. Improvements in electrical needle registering devices. Pierre de Chimkévitch and Edouard Barazer, 1, Queen Victoria-street, London.

4032. Improvements in and relating to electrical distributing systems. Leonard Andrews, 46, Lincoln's-inn-fields, London.

FEB. 18.

4043. Improved means for making electrical connections. Claud Hamilton, 121 West George-street, Glasgow.

4044. The new street conduit electric trolley system for tramcars. Sam Blight, 1, Waterloo-bank, Blackpool.

4054. Improvements in terminals for secondary batteries. Harry Ramsbottom and Jasper Myers Richardson, 427A, Strand, London.

4076. Improvements in electrical and mechanical time-checking apparatus. Charles Miles, Glenview, Withleigh-road, Upper Knowle, Bristol.

4091. Improvements in electric arc lamps. John Allen Heany, Norfolk House, Victoria-embankment, London. (Complete specification.)

4096. Improvements in or relating to dynamo-electric machines. Alfred Julius Boult, 111, Hatton-garden, London. (Tracy Barbour Hatch, United States.) (Complete specification.)

4097. Improvements in magnet cores applicable to dynamos, transformers, and other electromagnetic apparatus. Robert Lyne Wills and James Alfred Ewing, 111, Hatton-garden, London.

4104. A new or improved device for preventing accidents in connection with electric tramways and railways. Bela Klein, 13, King-square, Goswell-road, London.

4107. Improvements in the transmission and utilisation of electrical impulses, variations, and energy. George Lewis Hogan, 27, Chancery-lane, London.

4134. Improved revoluble telephone mouthpiece. Friedrich Wilhelm Moenninghoff, 322, High Holborn, London. (Complete specification.)

4147. Signs illuminated by electrical current. Emile Plançon, 81, High Holborn, London.

4161. Improvements in the lighting of electric cars operated by the overhead conductor system. Hugh McGillivray, 18, Buckingham-street, Strand, London.

4179. An improved speed regulator for electromotors. Charles Bauer, 72, Cannon-street, London. (H. L. Rochat, India.)

4180. Improvements in electrical synchronism indicators. Kenelm Edgcumbe, Edgar Isaac Everett, and Franklin Punga, 22, Charterhouse-square, London.

FEB. 19.

4185. Improved advertising devices for use with electric lamps. Walter Wardle and James William Cutler, 55, Market-street, Manchester.

4188. An improved device for use in connection with trolley heads of electric overhead tramcars and the like. William Barry, 6, Finkle-street, Stockton-on-Tees.

4196. An improved appliance for making holes in the ground for standards employed to carry overhead electric wires and the like. John Hetherington and Sons, Limited, and Edward Palmer Hetherington, 17, St. Ann's-square, Manchester.

4254. Improvements in or relating to electric cells or batteries. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Société Anonyme "Le Carbone," France.)

4262. Improvements in or relating to telegraph instruments. Harry Cunningham, 111, Hatton-garden, London. (Edward Bing and Harry Nevill, Brazil.)

4271. Improvements in automatic electric brakes. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Invention Developing Company, United States.)

4273. Improvements relating to automatic electric fire-alarms. Peter Offenbroich and Lorenz Mafell, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

4274. Improvements in or relating to electric cells or batteries. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Société Anonyme "Le Carbone," France.)

4285. Improvements in sockets for incandescent electric lamps. The Yost Miller Company, 118, Fenchurch-street, London. (Complete specification.)

FEB. 20.

4357. An improvement in flexible electric conductors. Siemens Bros. and Co., Limited, and Wilhelm Dieselhorst, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

4368. Improvements in microphones for high-tension currents. Raoul Gaillard and Eugène Ducretet, 40, Chancery-lane, London. (Complete specification.)

4372. Improvements in and relating to electrical warp and weft controlling mechanisms for looms. Frederic Ellsworth Kip, 6, Lord-street, Liverpool. (Complete specification.)

4374. Improvements in or relating to electric arc lamps. Joseph Albert Rignon and Ernest Eisenmann, 111, Hatton-garden, London. (Complete specification.)

4377. Improvements in electrically printing typewriter. John Corry Fell, 1, Queen Victoria-street, London. (Union Typewriter Company, London.) (Complete specification.)

FEB. 21.

4396. Advertising and illuminating on arc and other lamps in colours. A. E. Carter, 64, Church-street, Brighton.

4397. Improvements in towing boats by electricity. Frederick Robbins Lane, Honey Street, near Pewsey, Wilts.

4416. A device to prevent sparking on overhead electric trolley lines. Alfred Herbert Mayes, 40, Walsingham-road, Hove, Sussex.

4426. Horizontal adjustable pendant electric light fittings. Herbert John Philip Kimpton, 76, Gaythorpe-street, Moss Side, Manchester.

4445. Improved automatic telephone system. Ernest August Faller, 19, Holborn-viaduct, London. (Date applied for under Patents Act, 1901, Aug. 22, 1901, being date of application in United States. (Complete specification.)

4463. An improved electric switch. Harold Faraday, 53, Chancery-lane, London.

FEB. 22.

4473. Improvements in electric railways. James Swinburne, 82, Victoria-street, Westminster, London.

4492. The improved electrical signalling apparatus. Arthur William Ellwood and Alexander Harcourt Porter, 17, Somerleyton-road, Brixton, London.

4496. An electromagnetic gravity pin indicator, telegraphic. William Hayden, 3, Little London, Chichester.

4520. Improvements in or relating to electric batteries. Vincent Groby Apple, 111, Hatton-garden, London. (Complete specification.)

4521. Improvements in or relating to storage batteries. Vincent Groby Apple, 111, Hatton-garden, London. (Complete specification.)

4522. Improvements in or relating to electric ignition apparatus for internal-combustion engines. Vincent Groby Apple, 111, Hatton-garden, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published March 13.

1901.

1527. Automatic electrical attachment for clocks for ringing bells and other purposes. Clapham, Clapham, and Clapham.

3087. Electrical starting and regulating switches. Hickley.

3438. Apparatus for recording the time an electric car passes a station. Spencer.

3487. Carrying of strikers upon motor railway and tramway vehicles for mechanically operating electric switches. Kingsland.

4005. Electrical ship log apparatus. Walker and Walker.

4422. Electric primary batteries. Hussey and Clarke.

4777a. Electromagnets. Barker. (Murphy Safety Third Rail Electric Company.) Date claimed under Patents Rule, March 6, 1901.)

6043. Trolley conductor insulated fitting for electric tramways and railways. Kleinsteuber.

6491. Vote recorder and checking apparatus. Rowlands.

6685. Automatic magnetic circuit breakers. Lake. (Scott.)

6857. Treatment of zinc chloride for electrolytic purposes. Swinburne and Ashcroft.

7016. Electric arc lamps. Jandus Arc Lamp and Electric Company, Limited, and Jones.

7397. Process for the electrolytic production of caustic alkalies. Brochet and Ranson.

8306. Current collectors for use on electric railways or tramways. Woodward and Torr.

9350. Electric furnaces for heating or reheating objects to a predetermined degree. Grobet.

10191. Manufacture of the plates of electric accumulators. D'Arsonval and Vaugeois.

15517. Motor controllers for electric railways and the like. British Thomson-Houston Company, Limited. (Potter.)

20455. Electrical signalling apparatus for railways. Els.

25560. Automatic controllers for electric motors. Boult. (Richards.)

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26340. Controllers for electric motors. British Thomson-Houston Company. Limited. (Holz.)

1902.

361. Contact boxes for electric railways. Brown.

380. Contact shoes for electric railways. Brown.

1224. Electromagnetic engine governor. Schmid.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	Feb. 15	534	522	+ 12	27,459	25,342
Birmingham Tramways	—	—	—	—	—	—
Blackburn Corporation	,, 20	556	541	+ 15	4,433	3,928
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 22	130	139	- 9	1,151	1,089
Bolton Corporation	,, 23	1,268	1,224	+ 44	11,201	10,417
Bradford Corporation	,, 22	107	103	+ 4	911	826
Bristol Tramways Company	,, 21	3,582	3,462	+ 120	—	—
Carlisle Tramways Company	,, 15	105	91	+ 14	803	722
Central London Railway	,, 22	6,636	5,941	+ 695	52,781	48,779
City and South London Railway	,, 23	3,024	2,055	+ 969	24,336	16,139
Cork E. T. and L. Company	,, 20	294	327	- 33	2,443	2,498
Darwen Corporation	,, 21	159	158	+ 1	1,280	1,164
Darwen-Hoddlesden	,, 21	22	—	—	—	—
Dover Corporation	,, 22	150	145	+ 5	1,273	1,214
Dublin & Lucan Electric Railway	,, 23	67	72	- 5	654	567
Dublin U. T., electric cars	,, 21	3,045	2,932	+ 113	—	—
Dublin S. District, Electric	,, 21	625	641	- 16	—	—
Dundee Tramways Company	,, 19	608	434	+ 174	—	—
Glasgow Corporation	,, 22	10,143	8,034	+ 2,109	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 22	1,539	1,445	+ 94	79,198	65,193
Liverpool Corporation	,, 15	7,843	7,576	+ 267	60,664	54,442
Liverpool Overhead Railway	,, 23	1,344	1,420	- 76	10,790	11,757
Newcastle-on-Tyne Corporation	,, 22	1,604	—	—	—	—
Portsmouth Corporation	,, 22	905	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 23	3,401	—	—	—	—
Southampton Corporation	,, 20	654	497	+ 156	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £438 decrease.
Barcelona Ensanche y Gracia, £27 increase. Barcelona, £586 increase.
Brisbane, £370 increase (month of Jan., £28 increase).
Buenos Ayres and Belgrano Electric, £88 decrease.
Calcutta, £20 decrease.
Cape Town (month of Jan.), receipts, £17,064; expenditure, £6,802.
La Capital Traction and Electric, Buenos Ayres (month of, Dec.), £1,394 increase.
Mexico Electric (month of Jan.), receipts, £17,000; expenditure, £10,600.
Perth Electric, £155 increase.
Port Elizabeth (month of Jan.), receipts, £3,898; expenditure, £1,898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Tramways.—	£	£
Anglo-Argentine, 1-260,007	5 ..	4¼-4⅜
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	124-127
Blackpool and Fleetwood Tramroad	10 ..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2⅜-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4½-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-105
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6¾-7¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9⅝
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13½-14½
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12½-12⅝
—— 5 per cent. Perpetual Debenture Stock	100 ..	126-129
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅜-1⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11-12
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	102-104
New General Traction, Ordinary	5 ..	2½-3½
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10⅞
—— 5 per cent. Cum. Pref.	10 ..	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	98-101
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	10½-11½
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	10s. ..	½
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	50 p.c. ..	50 p.c.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅜-⅞
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅛-⅜
—— Ordinary, 1-125,000	1 ..	⅜-⅝
British Insulated Wire, Ord., 1-70,000	5 ..	9½-10½
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5⅞-6¼
—— 5 per cent. Mortgage Debentures	100 ..	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5¼-6
Brush Electrical Engineering, Ordinary	2 ..	1⅜-1⅝
—— Nos. 90,001-105,731	2 ..	1⅜-1⅝
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	102-105
—— 4½ per cent. 2nd Debenture Stock	100 ..	97-100
Callender's Cable, Debentures	100 ..	111-115
—— Ordinary	5 ..	17-18
—— 5 per cent. Pref.	5 ..	5¼-6
Crompton and Co.	3 ..	3-3
—— 5 per cent. Debentures	— ..	99-104 p.c.
Edison and Swan United, Ordinary	3 ..	⅜-⅝
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	78-83
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	83-88
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1⅜-1⅞
—— 7 per cent. Cumulative Pref.	2 ..	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10½
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	18-19
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	112-116
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15½-16½
Telegraph Construction and Maintenance	12 ..	37-40
—— 5 per cent. Bonds	100 ..	102-104
Telegraph Manufacturing, Ordinary	5 ..	10¾-11½
—— 5 per cent. Cum. Pref.	5 ..	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	9¼-10¼
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-⅝
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	100-105
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9¾-10½
—— Debenture Stock, Red.	100 ..	102-105
Brompton and Kensington, Ordinary	5 ..	9¼-9⅝
—— 7 per cent. Preference	5 ..	9-9¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	8-9
—— Nos. 20,001-30,000	5 ..	7½-8¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10⅝ xd
Charing Cross and Strand	5 ..	8¼-9¼
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅝
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	103-105
Chelsea Electricity Supply	5 ..	5-5½
—— 40,501-50,936	5 ..	4¾-5¼
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	9¼-10¼
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	106-109
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6-6¼
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	105-108
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-5
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-6
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	11-12
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	95-100
Metropolitan, Ordinary	10 ..	15-16
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	15-16
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7½-8
—— £4½ Shares, New	4½ ..	6¾-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	98-101
River Plate Electric Light and Traction, Deb.	100 ..	65-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1¾-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-2½
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	98-101
Westminster, Ordinary	5 ..	12-13
Electric Railways.—		
Central London, Ordinary	100 ..	103-106
—— 4 per cent. Pref.	100 ..	103-106
—— ,, ,, deferred	100 ..	100-103
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-118
City and South London, Consolidated Ordinary	100 ..	65-68
—— Ordinary	10 ..	—
—— Nos. 60,001-70,000	10 ..	—
—— 4 per cent. Debenture Stock	100 ..	112-116
—— 5 per cent. Pref. Stock '91	100 ..	127-132
—— ,, ,, '96	100 ..	122-126
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-9 4
Telephones.—		
National Telephone, Ordinary	5 ..	—
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-5¼
—— 4 per cent. Deb. Stock, Red.	100 ..	93-96
—— 3½ per cent. Deb. Stock, Red.	100 ..	101-105
Oriental Telephone and Electric Company	1 ..	¾-1

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Supplement to "The Electrical Engineer,"

FEBRUARY 28, 1902.

ALLOA ELECTRIC LIGHTING.

The small Scotch town of Alloa with its 14,000 inhabitants has since the beginning of the year had a supply of electricity on somewhat novel lines. When the provisional order was obtained in 1899 it was proposed to drive the plant by gas-engines supplied from the Council's gasworks. Messrs. Buchan and Hogarth, of Edinburgh, then prepared a scheme on this basis, but in the autumn of that year the Council were approached by the British Electric Plant Company, who proposed to erect works near the town and to give a supply in bulk to the Council. This was ultimately arranged and the company charge at the following rates—*i.e.*, £9 per annum per kilowatt of maximum demand together with a charge of 1½d. per unit for all energy used. The consulting engineers above mentioned were instructed to draw up the plans for the distribution system, about which the following information will be of interest. The supply is on the three-wire system with continuous current at 220 volts on consumer's premises, and with 440 volts between the outer conductors.

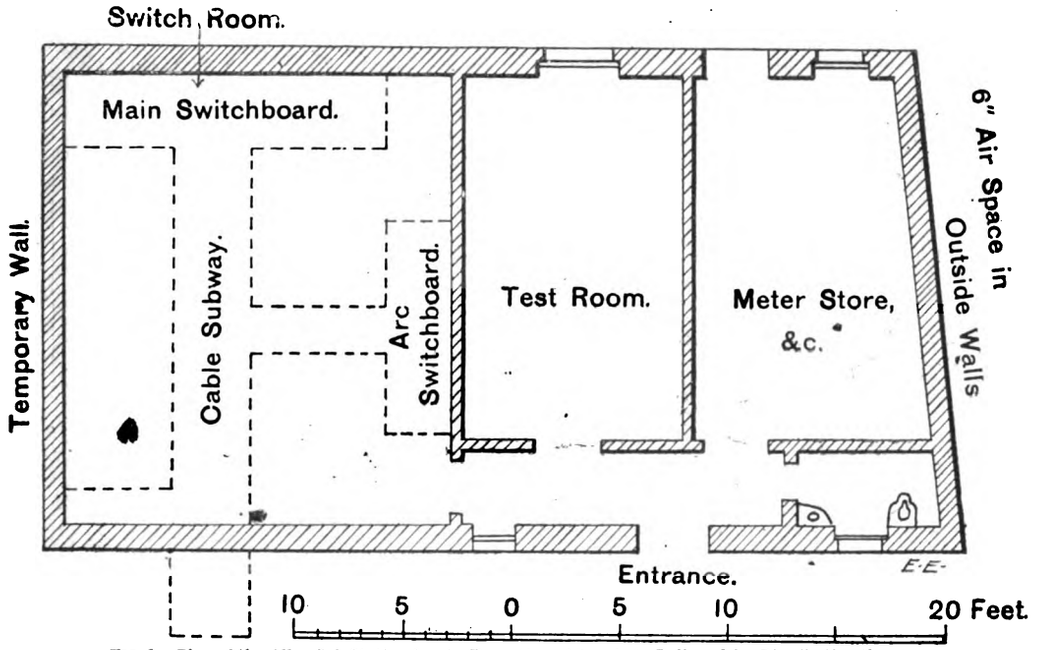

FIG. 1.—Plan of the Alloa Sub-Station for the Reception of Supply in Bulk and for Distributing the same.

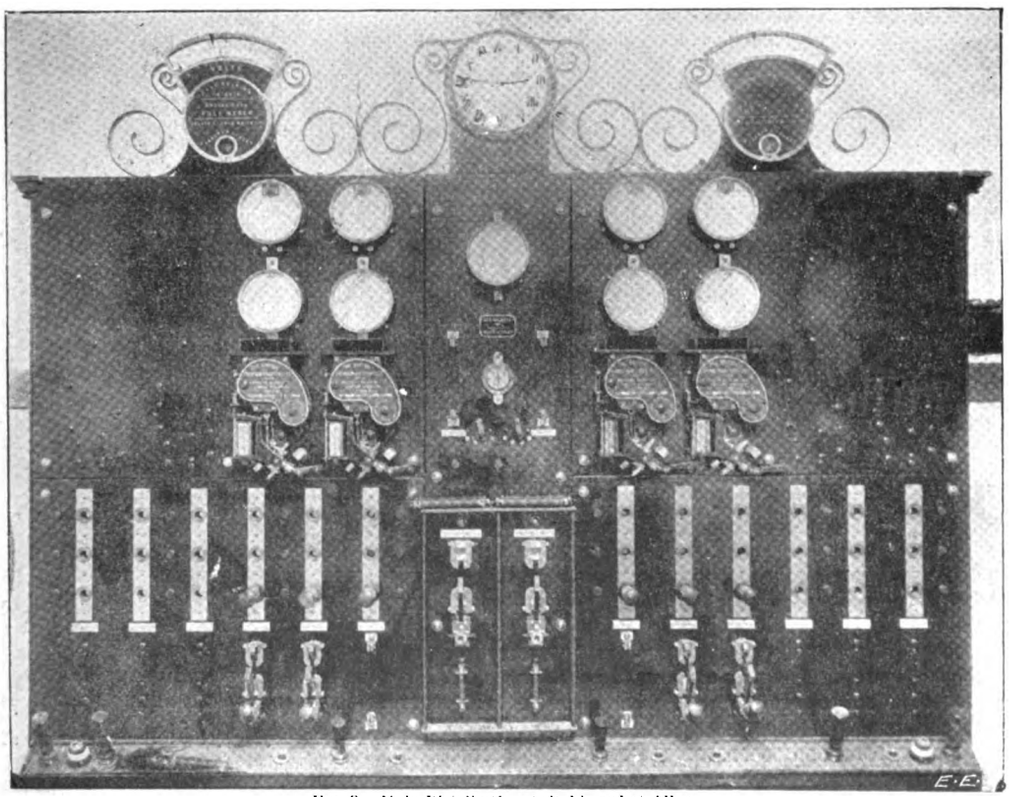

FIG. 2.—Main Distributing Switchboard at Alloa.

The current is brought from the company's works to the Corporation's distributing sub-station (Fig. 1) by trunk feeders. The positive and negative feeders each consist of three separate cores, each of ·25 square inch sectional area, and the neutral wire is a single ·30

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conductor. The supply is metered at the Corporation sub-station, which is located in a central portion of the town. The balancing and earthing is done at the company's switchroom. The distributing network consists almost entirely of ·10, ·06, ·10 cable, with the exception of two of the principal streets, where the section is ·125, ·06, ·125. The network is fed meantime by two sub-feeders of section ·15 and ·25 respectively, a feeder pillar being used to connect each of these to the network. The sub-station building consists of a switchroom (20ft. 6in. by 18ft., a test-room, and a store. In the switchroom is placed the main switchboard, which forms a connecting link between the trunk feeders and the sub-feeders, which convey current to the network. The board (Fig. 2) carries the usual complement of meters, switches, 'bus bars, plugs, etc., the pressure at the sub-station being shown on two illuminated-dial Kelvin voltmeters, that on the network being indicated by the usual pilot voltmeters. The arrangement of 'bus bars and plugs is such that any sub-feeder can be isolated, and these, as well as the design of the whole switchboard, are arranged so that additional sub-feeders can be added without disturbing the existing connections, and also that accumulators can at any time be added should it be considered desirable to do so. In each sub-feeder circuit there is a Thomson-Houston wattmeter and an automatic circuit breaker. From this switchboard connections are also taken to the arc lighting switchboard, and for lighting the sub-station and for a testing circuit.

The arc lighting switchboard is also located in the Corporation switchroom, and controls the 20 arc lamps which have been erected in the town. Both switchboards consist of enamelled slate set in iron frames, no combustible material being used in their construction. The arc lighting switchboard consists of six panels, five being in use and one spare. The arc lamps are switched in groups of four. Of the 20 lamps at present erected, 19 are on poles (Fig. 3) and one on a wall bracket. The lamps are of Crompton 10-ampere open type. The lamp pillars, which are of a graceful design, were made by the Alloa Iron Company, and erected by Messrs. Callender, the cable contractors. With the exception of the three core trunk feeders and pilots, single cable has throughout been used, these being laid solid in bitumen contained in iron troughs with tile covers, as shown in Fig. 4. Over 900 yards of Callender-Webber three-way casing has also been laid as spare cableways. The arc lighting cable is ·06 square inch size, laid along with the distributor, but quite separate therefrom.

The meters used for consumers are Bastian for the small sizes and Chamberlain and Hookham for the larger. Wright's indicators are also used. The prices charged are 7d. for the first hour's use of the maximum demand and 3d. for every subsequent hour. For power the rates are 7d. and 2d., or a special low flat rate for users who do not require their motors during the peak of the lighting load. In addition to the street arc lamps, the connections applied for already are approximately the equivalent of 3,500 8-c.p. lamps, representing some 24 consumers, which is quite a good beginning. Several applications for motors have also been received. No meter rents are charged, and there is no free wiring.

FIG. 3.—A Main Street in Alloa, showing Arc Lamp.

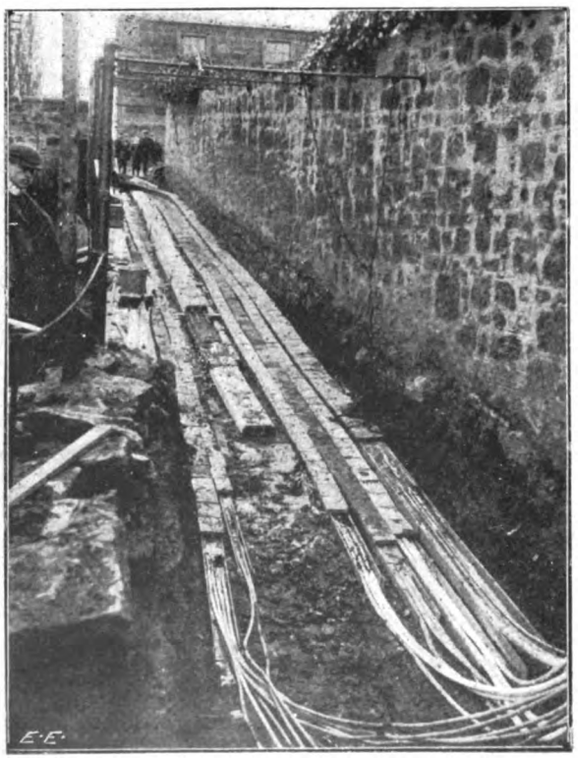

FIG. 4.—Cable Laying by the Callender Company at Alloa.

The total cost of the works has not exceeded £10,000, including the building of the sub-station, and it is claimed for the Alloa Council that they form the first instance of a municipality buying its whole supply of electrical energy in bulk and distributing itself. It has been claimed that a great advantage of the arrangement made is the lower capital outlay on the part of the Council, who, as they

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have not had to buy generating plant, can afford to spend more in mains. This has been done, but the real advantage is not so obvious, from the fact that the cost of the supply in bulk is, in our opinion, high, and the Council will have to pay for the distribution losses. A few years' experience will prove if it would not have been more advantageous to adopt Messrs. Buchan and Hogarth's original scheme, which would have kept the whole supply in the hands of the Council.

Mr. Yuill, the gas engineer, now has charge of the distribution system, and the merging of the two supplies will tend to keep down expenses.

BOILERS AND WATER SUPPLY.

BY F. G. ANSELL.

(Continued from Supplement, January 31.)

Treatment of Feed Water.

Most natural waters are alkaline to litmus because they contain carbonate of lime, or carbonate of soda, or carbonate of magnesia, and each of these salts is alkaline. Any boiler feed water which is not naturally alkaline should be made so by the addition of lime-water or carbonate of soda until the water is just able to change red litmus paper to a faint blue. More than a faint blue is not advisable, as we do not want to add to the mineral contents of the water more than we are obliged. Any soda added to the water cannot be extracted again, but lime, if added in proper quantity, will be precipitated by the carbonic acid present in the water, whether the water is cold or hot. Before attempting to decide which of the following processes for softening feed water is the best, we must ascertain what are the mineral constituents of the water, and what are the circumstances of the place where the boiler is situated. It would be useless to add quicklime to a water containing nothing but chlorides or sulphates of soda, lime, and magnesia. Such waters would not be improved by boiling—rather the reverse; but, on the other hand, adding carbonate of soda in proper quantity to such waters, and boiling, would materially improve them, whilst waters containing carbonates of lime and magnesia may be rendered fairly soft by the addition of quicklime in proper quantity to abstract the free carbonic acid from them. It must not be forgotten, however, that quicklime is sparingly soluble in cold water, and is thrown out of solution by boiling, so that lime-water can and does make a scale inside boilers. Soda never forms any scale under any circumstances. The first process I shall mention is simply to heat the water by means of waste heat to a temperature of at least 180deg. F., or to as near boiling as possible. In many places this can be done by turning the exhaust steam from an engine through a surface condenser fixed at the bottom of a tank in which the feed water is stored. This arrangement is often very economical, because it heats a great quantity of water, and if the water contains carbonates they will be decomposed by the heat, and so the water will be softened. It may be taken that 1lb. of steam—*i.e.*, the amount of steam generated by 1lb. of water in the boiler—will, after passing through the engine and pipes, heat about 5lb. of feed water from 32deg. F. to 212deg. F., but this supposes all the heat of the steam to be utilised. There is no difficulty in pumping this hot water into the boiler if it is raised so high above the pump that it flows by its own weight into the pump. Owing to the vapour tension of very hot water suction is impossible. Injectors also cannot deal with it, as it has no condensing power over the steam. Heating for about 20 minutes to a temperature of 212deg. F. will soften any alkaline water as far as it can possibly be softened, and therefore reduce its "scaling" power to a minimum; but in the case of waters containing sulphate of lime all the sulphate of lime might not be removed, especially if chloride of sodium were also present, and consequently the concentration caused by the evaporation of the water inside the boiler would produce a scale consisting of sulphate of lime.

The next simple treatment for an ordinary water is to put into it some carbonate of soda, and this is best done by allowing the water as it passes into the tank to flow over the carbonate of soda to dissolve it and to mix it well with the water, and so give it an opportunity to act upon the mineral matter dissolved in the water. [N.B.—Bicarbonate of soda will not do.] The carbonate of soda can be bought in two forms— viz., the dry and crystals, which are better known as washing soda. If these crystals are strongly heated they melt, boil and part with the water they naturally contain, and the residue left is called dry carbonate of soda; its weight is generally about 37 per cent. of the crystals before drying. As the dry soda is the only active material, it follows that if we use the dry form we shall want a correspondingly less amount to do the same amount of work in decomposing the mineral matter of the water. The price of the two about meets this difference in the effective value, but in places where carriage becomes a serious item the advantage lies with the dry form. It is a well-known fact to chemists that when carbonate of soda is boiled in solution with other mineral salts, the various acids leave the other bases to unite with the soda, and the carbonic acid of the carbonate of soda passes to such bodies as lime and magnesia. These carbonates, as previously explained, are not soluble in water, and are therefore precipitated in a harmless form either in the feed-water heating tank or in the boiler itself. The only difficulty presented by this process is that it produces a lot of soda salts in the boiler, and so necessitates frequent and copious blowing off of hot water whether the precipitation is performed in the heating tank or in the boiler. Of course, if the precipitation takes place in the boiler it also must be blown out. Besides this there is a tendency to add the soda wastefully to the water. To avoid waste, the best plan is to have the boiler feed water properly analysed, and to ask the chemist to state the proper amount of soda to add to each gallon. There is, however, another way of ascertaining this amount for those who have the necessary patience—viz., dissolve a known weight of the carbonate of soda in a known measure of distilled water—*e.g.*, suppose 1lb. of the soda dissolved so as to make exactly one quart—then we take a gallon of the feed water and boil it with a little of the soda solution, and allow the sediment to fall. Now take the clear liquid and boil it again with a little more of the quart of soda solution, and observe whether any further turbidity is produced. If so, the operation must be repeated until the addition of soda solution to the sample of feed water produces no further precipitation, when we notice how many ounces of our 1lb. of soda have been used in treating one gallon of the feed water. Obviously, if we have one pint of our original quart of soda solution left we have used one pint, and the soda being diffused throughout the whole of the quart equally, we have also used half the 1lb. of soda we dissolved in it, and so on in proportion for any amount of the soda solution we may have used. Those who do not like making the above quart of solution can add the soda to the feed water a few grains at a time in the dry state until no further precipitation or turbidity is produced, and if careful they will obtain the same result, but the water must be boiled, as in the other case, after each fresh addition of carbonate of soda.

Porter-Clarke's Process.—This process is about the best I have come across for waters containing carbonate of lime in solution, as it actually reduces the amount of mineral matter in the water, and the process is very elegant as well as continuous, and it does not involve the use of large tanks for storage or precipitation. It is founded on a simple chemical fact—viz., that when wet quicklime comes in contact with carbonic acid it unites with it to form carbonate of lime, which, as previously stated, is not soluble in water. It may be said that most natural waters contain in solution carbonic acid gas, and consequently they are able to dissolve carbonate of lime, the product thus formed being sometimes called bicarbonate of lime—that is to say, two molecules of carbonic acid united with one of lime. If to this solution we add quicklime, we take one of these molecules of carbonic acid and with it form one fresh molecule of carbonate of lime, while at the same time we reduce the "bicarbonate" naturally in the water to the state of carbonate by abstracting its second molecule of carbonic acid. There is, however, a rather simpler explanation of this—viz., water containing carbonic acid

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is able to dissolve carbonate of lime, but if we add quicklime, which is able to abstract the free carbonic acid from the water, it is no longer able to dissolve the carbonate of lime, and so the result of adding quicklime to the cold water is the same as boiling it—*i.e.*, it removes the free carbonic acid. It will be obvious that the precipitate thus formed will consist of the quicklime we put in and also the carbonate of lime we wished to remove, so that if carefully performed, this operation would remove all carbonate of lime from the water, but practically so complete a removal is not possible, because no water is perfectly uniform all the year round, and therefore more or less quicklime must be added as circumstances require. The best thing to do is to add a little quicklime in excess of the amount actually required, as this can be very easily determined by its action upon phenolphthalein, which is capable of showing a mere trace of quicklime, and so small a quantity is rapidly acted upon by the carbonic acid always being absorbed from the atmosphere. The most delicate and rapid way to apply this phenolphthalein test is to have the phenolphthalein on paper, and to float the piece of paper upon the surface of the water in a clear glass vessel, when, if an excess of lime is present, long streaks of pink will fall from the paper through the liquid, and may be easily seen. The accompanying sketch (Fig. 1) will make the apparatus and its working quite clear.

Quicklime is first well slaked, and then the proper quantity is put into the milk-of-lime tank, and water is run in until the tank is full, when the stirrer is set in motion, and the lime-water or milk of lime is pumped up to the top of the downfall tube, where it meets the hard water, which has to be softened, and the two streams fall together through the downfall tube, which is 15ft. or 20ft. long, to the bottom of the separating tank, where they spread out. Of course, the lime-water and the hard water are thoroughly mixed by this time, and the carbonic acid in the hard water is united with the quicklime, so that at the bottom of the separating tank we have water containing carbonate of lime in suspension only and not in solution. Obviously, the rate of fall is much greater in the downfall tube, which may be about 10in. to 12in. diameter, than the rate of rise in the separating tank, which may well be several feet in diameter, and the working capacity of this apparatus is only limited by the rate at which the sediment falls. Suppose we have a sediment which falls at the rate of 5ft. an hour in still water, then we can arrange our supply of hard water and lime-water at such a speed that the water in the separating tank shall rise at the rate of 4ft., or even 4ft. 6in., an hour, and all the water entering the collecting gallery will be soft and bright and the supply constant. The collecting gallery is best arranged as an octagon and the separating tank as a cylinder, so that the water is obliged to rise evenly, and to flow over the edge of the collecting gallery all round. This ensures the whole body of the water in the separating tank rising, and so avoids the use of unnecessary heights. As the sludge, which consists of carbonate of lime and any floating particles there may be in the water, accumulates rapidly, a sludge-stirring arrangement is advisable, so that the sludge may be thoroughly disturbed at the bottom of the separating tank and allowed to fall out at the valve as shown. This involves a slight loss of water, but not much. It should be done once or twice a week if the action is continuous and the water very hard. I have not been able to find anybody who makes a satisfactory use of this sludge, but in many soils it would be a distinct advantage to vegetation, especially those deficient in lime. In some places possibly it might be sold as whitening. The quantity of quicklime put into each milk-of-lime tank full must, of course, vary with the hardness of the water to be softened. A little experience, aided by the phenolphthalein test already explained, will enable most people to arrive at the proper proportion with very little trouble. It is best to arrange so that very little lime-water is wanted to a good lot of the hard water, and there is no objection to pumping the milk of lime up quite thick as shown, although, of course, if pumping can be avoided so much the better. It is, perhaps, a slight misfortune that the carbonate of magnesia, being rather a light precipitate, does not settle so quickly as the carbonate of lime, but for the purposes of boiler feed it is quite immaterial, as even if the precipitate gets into the boiler it is quite harmless.

With regard to the actual quantity of quicklime required to completely soften any sample of water, I may state that this can scarcely be inferred from the ordinary report of an analysis, because these reports do not usually state the amount of carbonic acid gas dissolved in the water, and, as stated previously, this gas must be combined with the quicklime before a complete deposition of the carbonates

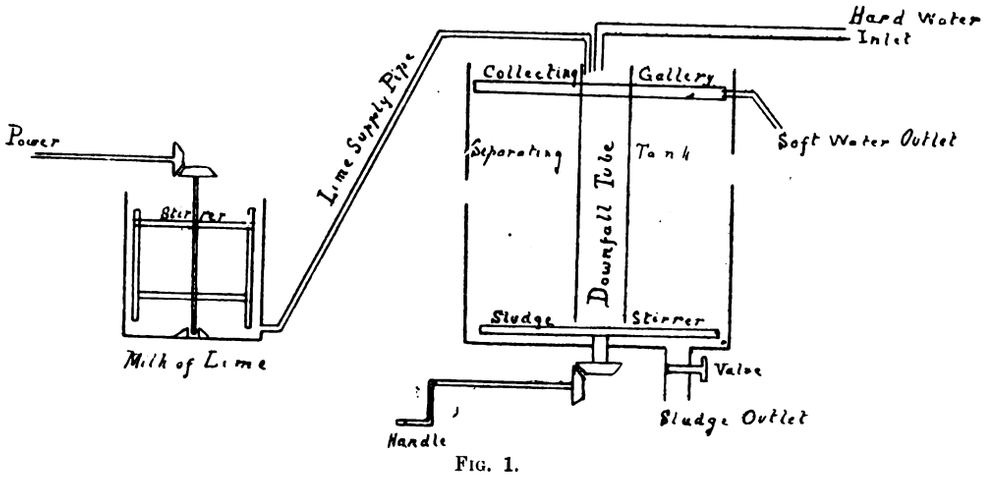

FIG. 1.

of lime and magnesia in the water can be effected, and, further, it would not be surprising to find that the amount of carbonic acid in many feed-water supplies varied considerably. Therefore, it is often most easy and simple to adopt the experimental test as suggested early in this section. In practice, this simple test should be applied daily, or at least as often as a fresh charge of quicklime is required. The phenolphthalein paper is very cheap, and a strip ½in. long and ¼in. wide is quite enough for each experiment.

The following analyses by myself may be interesting. The water is surface drainage from cultivated land, and varies considerably with the state of the weather:

	Before softening.		After softening.
Total lime	15·1	...	2·2
,, magnesia	4·6	...	4·5
Carbonates precipitated by boiling	26	...	1·0
Sulphuric acid	7·6	...	7·6
Chlorine	2·6	...	2·6
Total solids	40	...	11

	Before softening.		After softening.
Carbonate of lime	19	...	nil
,, ,, magnesia	5·8	...	nil
Sulphate of lime	6·2	...	6·2
,, ,, magnesia	1·2	...	1·2
Chloride of sodium	3·5	...	3·5
Total solids	35·7	...	10·9

These two separate analyses are taken from different places, and do not represent the same water. The reports are stated differently in order to give as much information

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as possible. In each case quicklime was added until it showed the faintest possible alkalinity to phenolphthalein in the water leaving the apparatus.

(To be continued.)

ELECTRIC LEGISLATION AND FINANCE.*

BY H. W. HANDCOCK.

When your genial chairman paid me the compliment of asking me to read a paper before you, the difficulty arose in my mind that there is no subject about which you cannot tell me quite as much as I can tell you. I finally ventured to suggest the subject of "Electric Legislation and Finance," or, perhaps, to be more correct, I should say legislation and finance as relating to the practical applications of electricity. There is a much closer relation between electrical matters and legislation and finance than is generally realised. The electrical engineer must in the long run be judged by the financial results of the undertakings with which he is associated, and he must always have before him the abilities and disabilities with which existing legislation has beset his path. I therefore hope that I shall at least succeed in giving rise to an interesting discussion on these matters, which are so closely allied with our own profession.

Under the present state of affairs, there is a sharply defined line between the engineer, the financier, and the legal adviser, and I fear that they have been up to the present so afraid of overlapping one another's interests that they have failed in many cases to get into sufficiently close touch with one another, the result naturally being to the detriment of the undertakings in which they are jointly interested. At the same time, I have to confess that, considering the extremely small acquaintance the legal mind has with electrical details, it is wonderful how well the Electric Lighting Acts of 1882 and 1888 have worked, more especially having regard to the state of knowledge at that time. They are, I venture to say, at the risk of a little unpopularity, a wonderful tribute to the foresight of the legal gentlemen who framed them and to their advisers, although I cannot defend the confusion in those Acts between electricity and electrical energy.

The chief demerit of the two Acts above referred to is that they have stood still while electrical engineering has moved forward by leaps and bounds. Although the Board of Trade has been much criticised for the way it has used those powers which the Acts vested in it, I venture to say that any one of us or of those in higher office could not have done better. We must bear in mind the simple fact that the honourable Board exists not merely for the benefit of the local authority or of the company promoted, but as an arbitrator which has had to follow definite rules set down for its guidance, doing its best for the public interest in so far as existing legislation permits it.

I often think that the Board of Trade has had many unjust remarks made about it, owing to the fact that its critics do not get into direct touch with its officers, for if they did so, I can say from personal experience that they would find them courteous officials, reasonable in every way, and only too willing to help one out of a difficult position if it is within their power to do so.

There is no doubt that we have to thank gas companies and similar undertakings for many of the provisions in the Electric Lighting Acts. There was a feeling at the date of these Acts that the great gas monopolists had studied their own interests, and had regarded the consumer merely as a channel through which to draw dividends. As an outcome of this the Legislature decided to put much more power into the hands of the local authorities as a check to such monopoly, and further than that to invite the local authorities, where they thought fit, to embark on these undertakings themselves. I do not say at this stage that it was wise or unwise to hold out this invitation to the local authorities; but who shall blame them if they have availed themselves of the power thus put into their hands?

In this case, as in many other electrical questions, we find two entirely opposite parties. The one regards the local authority as a very embodiment of sapience, a body that cannot err. The cry of the other party is, "Down with the local authorities"; in the eyes of this party whatever the authority may do is wrong. Is this not due to a great extent to the fact that each side fails to appreciate the very real difficulties of the other? If I may be pardoned for going back to elementary arguments, the local authority represents the ratepayers, and, therefore, the various interests of the district, and as such the local authority should know what is best for the district, and have supreme power there and the "yea" and "nay" in all things. In other words, it should be regarded as a small self-governing state, quite capable of looking after its own business, and possibly knowing better what is most suited to its requirements than those who know nothing of the district beyond the fact that there is money to be made out of it. But we shall find a flaw in this argument if we choose to argue by analogy, and take the position of larger and smaller states of the political world. Every state claims or aspires to claim to govern itself, but it is inevitably found that there are overlapping interests. The outcome is that every state has to recognise definite obligations to those beyond its borders, and to afford facilities for intercourse with them. It is quite true that it makes its own laws for internal administration, but the very fact that it has to receive the representatives of outside states makes it plain that outsiders have definite and distinct rights within its boundaries.

This may seem an unnecessary digression, but much the same argument holds good as regards our local authorities and matters with which they are called upon to deal. If it is simply a question of electric lighting and power, then they should certainly be in a position to deal with these commodities themselves as representatives of the population within their area, if they elect to do so. Some people may argue that they do not represent the views of the population within their area. If so, the obvious reply is that they are doing their best, and it is the fault of the inhabitants themselves for not taking sufficient interest in municipal affairs. Therefore, the ratepayer must not grumble if his interests suffer through his own indifference. To sit in one's armchair and criticise is an easy task, but, generally speaking, the critic is the very man who does not realise the self-sacrifice and expenditure of time that has to be made, and is made, by most members of local governing bodies.

When we come, however, to the subject of light railways and tramways, we must argue on an entirely different basis to that for electric light and power, unless energy for all three is supplied from the same source, when certain modifications must be made. At the present day the prosperity of any place, one may say, depends on its intercourse with the outer world; and in a similar way, to a certain degree, the prosperity of the surrounding places depends, as a general principle, on intercourse with that particular place and every other in the district. It may also happen that two places having very considerable intercommunity of interests are separated by a third through which it is necessary to pass before communication can be established between the two. In these cases, clearly, it should be out of the question to allow the local authorities of the intervening district to close their gates; it should be imperative that they should afford reasonable facilities for intercourse between their own district and the districts on all sides of them. It would be unfair to say that they might not have a tramway or light railway to deal with the traffic within their boundaries, but it should be an invariable rule that they should be bound to give facilities for through traffic between the places on either side of them. To this they would probably reply, "We would willingly do so, but our streets are already full with our own tramcars." This, however, presents no insuperable difficulty, for what is to prevent a certain number of local cars being replaced by a similar number of cars run through their district over the same route and to and from the districts beyond?

The great difficulty in starting electrical and possibly many other undertakings at the moment, is that application can only be made once a year for statutory powers to bring such undertakings into existence. The result is a great hindrance to enterprise, a sad loss of time, and that much of the work has to be hurriedly done and possibly improperly. I do not mean to say improperly done through any fault on the part of those concerned, but simply because a year's business has to be rushed through in a few weeks. The Local Government Board can be approached at any time of the year to ask for sanction to a loan, and although it is of course impossible to put Bills and provisional orders on exactly the same basis, proper provision might with advantage be made, enabling promoters to apply for statutory powers at least twice a year, if not more frequently. Our legislators will probably reply "Yes, but that would upset present procedure." My reply to that is, "Present procedure is exactly what we wish to upset; it has stood in the way of progress far too long."

We do not want panic legislation, for as a matter of fact the Tramway and Electric Lighting Acts only require a reasonable amount of amendment in themselves. It is true that the details calling for attention are numerous, too numerous to mention here, but the present groundwork might very well stand. What we do want is to do away with the present cumbersome methods of procedure, as the time lost under the existing arrangements is simply incalculable.

It may be well to refer to the position at the moment of electrical undertakings which are without statutory powers. The Board of Trade, doubtless through pressure of public opinion, exercises the rights it it has under the Electric Lighting Acts, and rarely sanctions the use by authorised undertakers of overhead wires. On the other hand, it is now established that any individual, not favoured with statutory powers, provided that he can obtain the wayleaves on each side of the road, may stretch a wire overhead. The only power that the Board of Trade have in the matter is to require him to take the necessary steps to avoid danger to the public. Similarly, as regards underground wires, it has been established that the right of the local authority only extends to what may be called the artificial surface of the roadway. If there are two persons on the opposite side of the street they may, with the sanction of the ground landlord, burrow underneath the street provided that they do not disturb the surface, and carry a cable from one side to the other. The authorised undertaker, if there be one, cannot interfere. One may go even further, and say that if an unauthorised undertaker broke up the surface and laid his cables, it is true that he would incur certain penalties from local authorities for breaking up the surface, but they could not make him remove the cables. The only persons who could do that would be the adjoining owners on either side of the road, as the natural ground that is below the artificial surface of the roadway is their property.

It is also well established that the possession of a provisional order does not confer any monopoly. It may safely be said that, apart from the fact that statutory electric lighting powers authorise the undertaker to break up the streets under certain conditions and also to secure and recover payments for supply, it imposes very definite and sometimes onerous obligations on him. These would render it very difficult to compete with unauthorised undertakings supplying electrical energy, for they can take their cables overhead with impunity, and give preferential rates of supply, and follow their own inclination generally.

This will raise in the near future a very important point with local authorities. A local authority is not justified in embarking on a speculation, and before it can undertake electrical work must obtain its provisional order and also the sanction of the Local Government Board to the loan. Now, if it is to be liable to competition from unauthorised parties with every advantage in their favour, then the undertaking of the local authority becomes a speculation, and although it may hold a provisional order, the Local Government Board will not be justified in

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, Feb. 10.

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sanctioning a loan for such purposes. Whether the undertakers be a company or a local authority, it should certainly be necessary to demonstrate that they are not doing their duty to the public before competition is permissible.

The question of overhead wires is a very big one, and much turns on it. We shall have to decide very shortly whether we will sacrifice æsthetic considerations for our prosperity, or *vice versa*. Now that electrical energy takes such an important part in industrial matters it has become indispensable to the manufacturer; by electrical energy I mean not merely electrical energy, but cheap electrical energy, and to have cheap electrical energy we must in certain cases have overhead lines. I do not wish to picture to you your city or any other in the garb of an American city, where daylight is clouded by the electrical cobweb overhead. There is reason in all things, but if we are going to prohibit overhead wires altogether, then we are going to sacrifice commonsense and prosperity to sentiment. It may be that overhead wires cannot be made absolutely as safe as underground wires—that is granted, but with proper precaution the risk need only be small. If absolute safety and freedom from danger to life and limb in all things is to be the order of the day, then let us begin at the right place, and remodel our railway systems, for instance, and the conditions under which railway servants work. When we have done that, then it will be quite time enough to talk about the risks in the supply of electrical energy.

In making the foregoing remarks I do not wish to be misunderstood as regards my attitude to overhead wires. I do not plead for their universal adoption—it would be folly to do so, but I do think that there are many cases where they are at present prohibited, and where they might with advantage be permitted. It is a very grave question as to whether it would be wise to take high-tension cables overhead, and there is room for discussion, but there can at least be no objection, with proper precautions, to carrying cables overhead for two-wire systems up to 500 volts, or three-wire systems up to 1,000 volts with the middle wire earthed, as we already have 500 volts on our trolley wires.

I will not detain you by discussing the Electric Lighting and Tramways Acts clause by clause, but provided that overhead wires for electric lighting and power have a proper status; that the purchase clause in the Tramways Act be definitely fixed at 42 years instead of 21; that the frontager distances are measured, not from the rail to the kerb, but from the car to the kerb; that matters relating to frontagers and their objections are reframed, and that the question of gauge be left to the Board of Trade, so as to render it possible to establish some uniformity in the latter respect, these Acts would probably be very workable. It would also be necessary to make suitable provisions as to running powers over existing lines.

I am by no means an advocate for the abolition of the necessity for the sanction of the local authority when electric lighting or tramway powers are sought. Companies must be subject to an authority of some kind, whether you call it a local authority or give it any other name. Companies and local authorities will have to exist in the future as they have done in the past, side by side. Sterling work has been done and will be done by both in their own sphere, but it is desirable that their relative positions should be somewhat more closely defined in many respects than at present. It is impossible to lay down any hard-and-fast line, for there are two sides to every question, and every question that crops up as between the local authority and the company must be decided after a certain point has been reached on its own merits. We do not want legislation that binds us hand and foot and lays down hard-and-fast rules, whether they are applicable or not; what we do want is a tribunal before which all sides can be heard, as at present, and the case decided; but it must be available at all times, not merely once a year. I trust the time is close at hand when our Institution will take a greater interest than at present in legislation relating to electrical matters. It is no use eternally crying for fresh legislation, unless when at last we catch the ear of our legislators we are prepared to tell them exactly what we want. I have to confess that although fierce strife has now been waged for some years past in the committee-rooms of both Houses, and great interests have been at stake, our Institution has been conspicuous only by its absence.

While on the question of expedition of transaction of business, I would like to refer to that overworked department, the Local Government Board. For years past it has suffered from a bad attack of indigestion, and it is a pity that local authorities cannot obtain sanction to their loans in a more expeditious manner than at present. The time has surely come when the business relating to one subject might be gathered together under one roof. At the present moment, in the matter of electric lighting, for instance, we have to deal with the Fisheries and Harbour Department of the Board of Trade when obtaining our provisional order. We have to get the sanction to the system we propose to adopt from the Engineering Department of the Board of Trade, and then we have to apply, if a local authority be the undertakers, to the Local Government Board to sanction the loan to carry out the work. They in turn have to satisfy themselves that the undertaking for which the funds are required has been approved by their colleagues at the Board of Trade, before they give their sanction to the loan.

This brings us to the consideration of the period for which loans are granted. In London the County Council sanctions loans for a period of 40 years, but the Local Government Board for the very same purpose only makes the period 25. The latter is probably the more accurate figure. At the same time they might very well extend the period when a certain amount of the money represents goodwill. Clearly they would not sanction the loan if the local authority proposed to pay too much for the goodwill when acquiring an undertaking from a company, and the fair inference is that goodwill is an increasing figure. Under these circumstances what objection can there be to spreading the repayment of the sum representing goodwill over, say, 50 years instead of 25? It is impossible to lay down hard-and-fast rules—every case must be judged on its own merits; but I feel that, to a great extent, a case can be made for the local authorities as regards undertaking the supply of electric light and power. For if we look through the returns of the last few years we shall find that on the whole energy is supplied by the local authority at something like 20 per cent. less cost than by the private undertaker. I do not mean by this that a company supplying five or six towns within reasonable touch of one another could not do better as regards price to the consumer than each local authority would do if it had its own station. If, however, the past is any criterion for the future, then I feel bound to say that for the same area current can be supplied by the local administrators at a figure about 20 per cent. below that at which it would be supplied by the private undertaker.

I always feel, when discussing the question of profit and loss in electric lighting and tramway matters, that the local authorities are placed at a disadvantage. A company, if it chooses, may write off nothing for depreciation, and may estimate its goodwill at a very considerable figure. A local authority, on the other hand, even when it pays its 6 per cent.—or, in other words, when it just meets its interest and sinking fund—is said to be making no profit, or possibly a loss, neither is it entitled to take any credit whatever to itself for goodwill.

As regards the charges made for electricity, which, of course, are greatly affected by questions we have just been discussing, it might appear as a first principle that everybody who takes it *under the same conditions*, whether in large or small quantities, should be supplied at the same price. I venture to think, at the risk of being considered guilty of heresy, that in practice this should not be so. If any argument used in favour of the same charges to all defeats its own object, it is the argument that if the large consumer were to have a reduction in price for a quantity, then the price would be increased for a small consumer; for this means, in other words, that the small consumer benefits at present to the detriment of the large consumer. I am not going to enter into an abstract argument here, but as long as electrical energy is bought and sold, the same arguments will have to hold good in connection with these transactions as have gradually framed themselves and been evolved since the time trading began—indeed, we may say that the basis of all commercial transactions to-day is that the greater the quantity the consumer takes the more favourable the price at which he gets the commodity. There is no doubt that everyone in this room, myself included, could immediately set to work and prove in the abstract that such a maxim is wrong, but there are many things which are indisputable in theory that do not work out in practice, and this is one of them. It may safely be said that there is not a company in existence, on whatever system it bases its charges, which does not legally or illegally hold itself open to give more favourable terms to very large consumers than it does to the smaller or ordinary consumers.

I have previously remarked that in some cases the local authority can supply current at a lower figure than a company, but I must not be unfair to the latter. The local authority is not justified in taking certain risks which a company may take. In many cases it is found that although a very low charge results in some loss in the first place, it is justified by increased revenue afterwards and extended uses of electricity in the district, and from that point of view a company is doubtless in a position, if it has a liberal policy, to do better for the consumer than the local authority can.

While I entirely differ from most of the harsh things that have been said about local authorities, I am bound to confess that I do consider it unfair when an attempt is made to introduce electrical enterprise within their boundaries to hamper it with toll in the shape of all sorts of conditions, which imperil its very existence. Provided that the local authority is not acting to the undue detriment of the neighbouring authorities and interests, it is certainly entitled to carry on its own affairs, by which I mean, among other things, to own its own electric lighting and tramway undertakings. Once, however, it has decided not to do so but to leave this to private enterprise, then private enterprise should certainly be left to grapple with the difficulties in its own way, and to make a reasonable return on the capital it has risked, subject only to such restrictions as are essential to the public interest and purchase afterwards by the local authority on equitable terms.

The local authority on their side naturally wish to do the best they can for the ratepayers, which is only reasonable, but if, for arguments sake, they wish to make a tramway company coming into the town improve the streets of the town, whether it be a necessity for tramway purposes or not, clearly the funds have to be found for this somewhere. The result is that the object originally in view is defeated, for higher fares have to be extracted from the travelling public for many years to come to compensate for the amount by which the capital is increased in possibly unnecessary road widenings, an expenditure that for all time is unremunerative to the company from the dividend-earning point of view. This remark is, of course, subject to the views I have previously expressed as to the duty of the local authority to protect what are purely public interests. There are two ways of taxing a company. One by insisting on reasonable charges for the commodity supplied, which is perfectly right and legitimate; the other by insisting on free public lighting, the free removal of refuse, and many other things which constitute indirect taxation, and are open to grave objection, as they tend to increase the price of the commodity and not to reduce it. It is one thing where a company may consider it worth while to make such an offer as this, but a local authority should never ask for it.

Turning to another aspect of the relation between authorities and companies, take, for instance, half a dozen towns, each some two or three miles apart, each with its separate tramway system, and each tramway system possibly a valuable undertaking by itself. What, however, is the aggregate value of these undertakings either financially or to the community as compared with what they would be if the whole were linked together? Clearly the capitalist is not going to step in merely to make the unremunerative connecting links if the authorities are going to close their gates against him when he seeks

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to enter the towns. In other words, tramway and light railway work if essentially work for the capitalist and not for the local authority, except in so far that the local authority may and should be permitted to construct the line within its own district and to run it provided that it affords reasonable facilities and terms to outside companies to enter the town with their cars and to pass through it.

Local authorities frequently ask promoters when they come to them for their consent, "Have you the money?" The question is a superfluous one, for but few promoters when they come to ask for such consent have the money available. With present-day finance, individuals and companies do not keep a quarter of a million idle on the chance of their being able to use it in such undertakings, and if they did, their position would be a far more independent one than it is at present. Such methods of finance are Utopian and impossible nowadays. When the promoter comes and makes an application to a local authority it means that he is well backed by people who are in close touch with the channels through which money comes, and who can obtain the necessary funds if the undertaking is likely to prove sufficiently remunerative. Care must be taken that by the time the negotiations are completed so many demands have not been made that it is impossible for the undertaking to bear the burden of them; if so, the scheme falls through. This accounts for the disappearance of many promising undertakings for reasons apparently unknown.

It is necessary to bear in mind that the preliminary expenses, more particularly with the present state of legislation, are heavy, and that the promoter is building up a new concern which involves many risks; and unless he can get a return of something more than 5 per cent., which many people seem to consider reasonable, he had far better to save himself years of work and anxiety, and avail himself of many existing channels already open in the form of 5 per cent. investments ready to hand at home and abroad. On the other hand, the undertaker must bear in mind when he comes in contact with the local authority that the local authority exists for a very definite purpose, and its chief object is to see that the public matters within its boundaries are conducted properly and in the best interests of the ratepayers; and if there be such things as public matters at all, then electric lighting and tramways must certainly be classed among them.

I have previously referred to the heavy preliminary expenses incurred in floating electrical undertakings, and described these expenses as being due to a great extent to legislative procedure. It is not, of course, to this alone that the preliminary costs are due. It is not for those outside the portals of the Stock Exchange and its connections to make suggestions, but we may safely say that it is of but little use reducing the cost of legislative procedure, unless a better and less expensive means can be devised than those at present in existence for providing the necessary funds when legal powers have been obtained. No one would deprive or wish to deprive the financier of his due, but I do wish to remind him that the work does not begin and end with financing; and many a concern which would pay handsomely on the basis of capital outlay for constructive purposes, is utterly wrecked by the inflation of capital which seems indispensable to the flotation of a company.

You will possibly be asking yourselves by this time whether I am an advocate for companies or local authorities. In reply, I tell you candidly I am an advocate for both in their proper place. Neither will succeed in sweeping the other away—there is room for both, but it cannot be said that under present legislation their spheres are properly defined. It will probably occur to you also that I am occupying a position which is commonly known as "sitting on the fence." That may be so, but I must remind you that the man who sits on the fence sees a great deal more than those on either side.

I feel that to do justice to my subject much more is necessary, in order to make it clear and convincing, than the mere sketch which I have given you, but the paper is already too long, and I must not trespass further on your patience. In closing, I beg that no one will take any criticisms that I have made as applying specially to himself or the interests with which he is identified. The observations in this paper are made entirely in a general sense, and if anyone takes them amiss I trust he will remember that there was never yet a rule but required the exception to prove it.

THE RAPID PROGRESS OF ELECTRICITY IN LIVERPOOL.

An interesting review of the progress of electricity for lighting and power purposes in Liverpool during recent years is contained in a report submitted by Mr. A. B. Holmes, M.I.C.E., the city electrical engineer, for the consideration of the Electricity Committee in connection with the draft estimates for 1902. We abstract the following particulars:

The output during the past year has been more than 20 million units, and has, the electrical engineer believes, exceeded that of any other electrical undertaking in the United Kingdom. The rapid growth of the supply from less than three million to over 20 million units during the past four years is shown in the following statement and diagram (No. 1):

Year.	Lighting and power.	Tramways.	Total units.
1898...	2,812,086 units	103,609 units	2,915,695
1899...	3,845,749 ,, ...	1,883,728 ,, ...	5,729,477
1900...	4,888,653 ,, ...	6,675,682 ,, ...	11,564,335
1901...	6,235,658 ,, ...	13,782,508 ,, ...	20,018,166

It will be noticed that the demand for lighting and power has steadily increased annually at an almost uniform rate. The demand for lighting expressed as the equivalent in 16-c.p. lamps connected to the mains was: on Jan. 1, 1901, 149,495 lamps; and on Jan. 1, 1902, 180,990 lamps. The demand for power expressed in horse-power of motors supplied was: on Jan 1, 1901, for 412 motors, 1,510 h.p.; and on Jan. 1, 1902, for 587 motors, 2,083 h.p. The number of tramcars now in service is more than 380, as against 250 at the commencement of the year.

Method of Supply.—Electrical energy is supplied throughout the city for lighting and power at a pressure of 230 volts, and over a considerable area the supply is given on the three-wire system, thus affording for large motors a supply from the outer conductors at a pressure of 460 volts. As the pressure of the tramway supply is 500 volts, each of the steam dynamos in the new stations can be used for either service. This fact enables each set of plant to be run approximately the same number of hours per annum, and the stand-by plant to be reduced to the minimum. Up to the present under the above arrangements it has been possible to generate electrical energy in the same form in which it is distributed and used—namely, as direct current at a pressure of 460 to 500 volts. But in dealing in the future with outlying districts which do not fall within a radius of economical distribution from the existing stations, it will be necessary to adopt a high-tension system of transmission, for which provision has been made in the design of the various distributing stations.

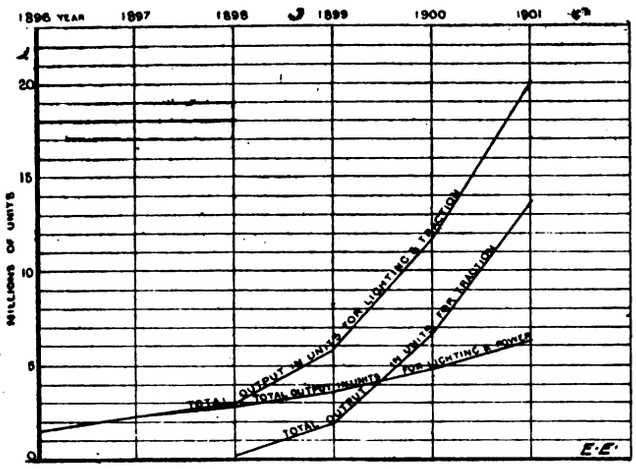

DIAGRAM 1.

Generating Stations.—The original generating stations at Highfield-street, Paradise-street, Oldham-place, and Lark-lane have been maintained in efficient condition, and worked to their full capacity during the winter season. The Paradise-street station is partially employed on the tramway long-hour service, and provision is made in the estimates for the addition of condensing plant, which will facilitate the economical working of this station. The auxiliary stations at the refuse destructors at Smithdown-road and Cobbs Quarry utilise a source of energy at the disposal of the Corporation which would otherwise be wasted, and are specially useful in the supply for the tramway service. It is expected in the course of the year that the similar stations in connection with the Charters-street and Lavrock Bank refuse destructors will be completed for work. The Lister-drive and Pumpfields stations are each divided into four sections, each section containing three steam dynamos. At Pumpfields two sections are completed and fully employed, and the third section which is required to meet the current year's demand is almost completed. Of the nine engines thus provided, seven have occasionally been in service at the same time. At Lister-drive two sections are in daily use, and it has been necessary to run five out of the six engines at times of maximum demand. There is, consequently, at the present time no sufficient reserve plant, but the machinery on order for the third section of this station will be delivered and fixed before the autumn demand commences.

Cable Tunnel, Pumpfields.—During the past year a cable tunnel has been constructed under the Leeds and Liverpool Canal by Messrs. Morrison and Sons.

Offices and Workshops.—The new buildings at Highfield-street are approaching completion, the workshops are already in operation, and the office extension will shortly be ready for occupation.

Underground Mains.—The estimates provide for additional feeders that are required for the tramway service; for supplementary mains where necessary to deal with the increased demand in certain parts of the city; and for the usual extensions to meet applications for supply in streets and districts where mains are not at present laid.

Variation in Output of Plant.—Diagram No. 2 shows the relative demand for lighting and power on an average summer day (Curve No. 1) and on an average winter day (Curve No. 2), and also for an average day's supply for the tramways (Curve No. 3). The height of each curve from the base line of the diagram shows the relative amount of plant necessary for each of the services specified. The two horizontal lines show the reduced amount of plant that would be required for the lighting service (line L L) and for the tramway service (line T T) respectively if the work required for these services could be uniformly spread over all the hours of the year. It will be noticed that whilst the plant required to meet the demand for lighting in winter is eight times that necessary to meet the average demand throughout the year, the plant for the maximum demand for tramways

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is less than twice that required for the average demand; or, to state the fact in another way, four times the plant is required to produce a given annual output for lighting that would be necessary for a similar output for tramways. At the same time attention must be called to the peak in the tramway diagram about 7 p.m., which is caused by the additional cars which it is necessary to put in service at this hour. Such a peak makes the tramway load less desirable from the power station point of view than it otherwise would be.

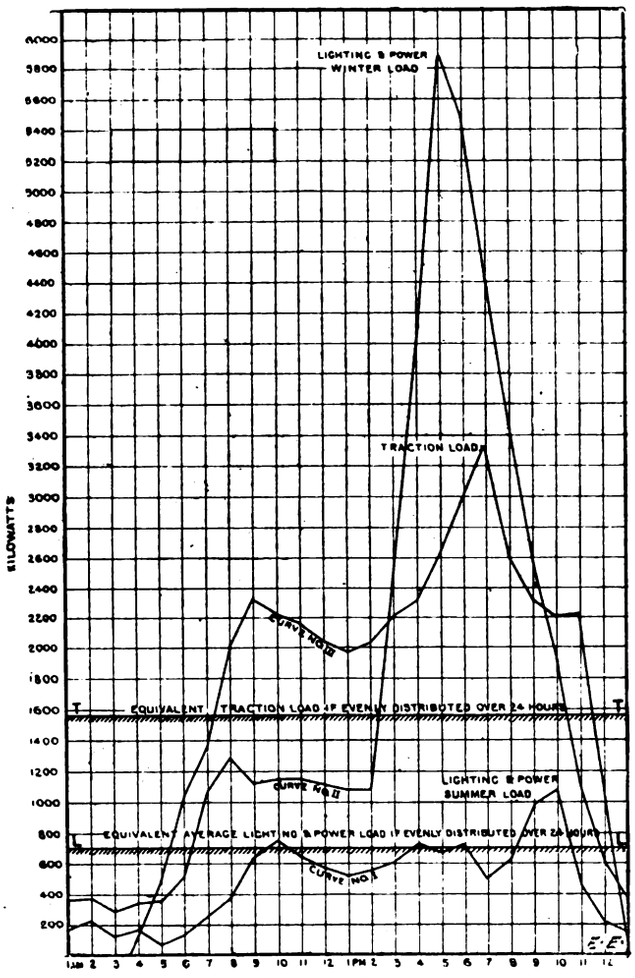

DIAGRAM 2.

Working Costs and Price Obtained.—Diagram No. 3 shows how the working costs per unit have been reduced from the year 1896 to the present time. The lower line on diagram shows the costs exclusive of capital charges, the middle line shows the costs inclusive of capital charges, and the upper line shows the average price obtained for electrical energy supplied for all purposes during the corresponding periods. The space between the upper and the middle line on the diagram obviously represents the margin between receipts and expenditure available for reserve and renewal fund, or for other purposes.

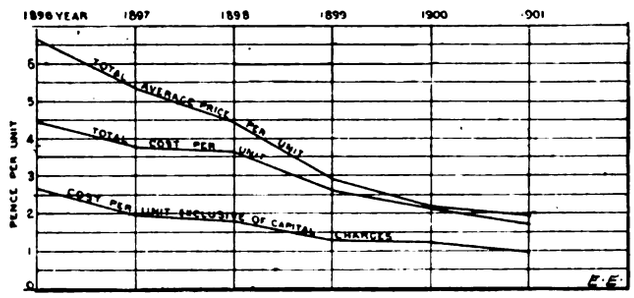

DIAGRAM 3.

Future Demand and Plant Required.—The annual increase in demand for lighting and power requires the provision each year of at least three sets of plant of the 1,200-h.p. standard size. The fourth section of the Pumpfields station will provide accommodation for the plant to be installed in the year 1903. The order for this plant must be placed in the current year, but as it will not be delivered till 1903, it is not necessary to include any provision for it in the estimates for 1902. The fourth section of the Lister-drive station will be used for the plant required to supply the eastern and southern districts of the city, a considerable portion of which lies beyond the distance at which the supply can be economically given at 500 volts pressure, and it will consequently be necessary to employ high-tension plant. Very careful consideration has been given to the type of plant to be employed for this purpose, and the adoption of generators giving an alternating three-phase current at a pressure of 6,000 volts is recommended by the electrical engineer, the current to be transmitted to the sub-stations at this pressure, and there transformed down to the ordinary pressure of distribution. As the first portion of the high-tension plant will be required by the end of the present year, the electrical engineer advises that tenders should be invited for the same forthwith, and provision has been made in the estimates for the payments that may be required this year on this account. It will be noticed that the proposals submitted in this report complete all the plant that can be installed in the Lister-drive and Pumpfields engine-rooms, and cover all that will be necessary as regards engines and dynamos up to the end of the year 1903, although the estimates now submitted only provide for the expenditure of the current year. In considering the most advantageous system to adopt for the outlying districts, the electrical engineer has given special attention to recent developments in the generation and distribution of electrical energy. He is of opinion that the time may be approaching when fuel will cease to be brought into such cities as Liverpool in the present form. It seems possible that before very long the energy contained in the fuel will be brought from the colliery to the city either in the form of a cheap gas or in the form of electricity at high pressure. A gas-engine is a more efficient heat engine than a steam-engine to an extent which would double the useful work contained in a given weight of coal, but against this possible saving must be put the cost incidental to the manufacture of the gas and of its transmission from the colliery. At present gas-engines have only been made of comparatively small sizes, up to, say, 600 h.p., though larger engines, it is stated, are now in course of construction. The transmission of energy from the colliery to the city by high-tension electricity is probably a more promising method for such distances as have to be dealt with in Lancashire, but for this method of transmission there are also many practical difficulties to be overcome. It will be noted that the existing power stations will meet the requirements of the city for the next two years, during which time much experience will be gained in this country as to the transmission of power over long distances, and it is not necessary to decide at the present moment whether the future power stations for Liverpool should be constructed in the city or at the colliery. The high-tension plant recommended for the Lister-drive station is of a type that will work satisfactorily in combination with a high-pressure supply from a distance, should such supply be available at a future date.

Prices for Electrical Energy.—Taking as a basis the principle adopted by the Council that the electric power stations should be worked in the joint interests of the lighting and tramways undertakings, and that the working expenses and capital charges should be equitably divided, having due regard to the special circumstances of each case, the electrical engineer is of opinion that the ratio of the rates now in force for the various services does not require any alteration. The results of the business for the past year show that the prices obtained are sufficient to meet all charges and to leave a surplus for an adequate addition to the renewal and reserve funds. The amounts required for interest and sinking fund for the current year show an increase of more than £10,000. It is assumed that the rate of increase in the demand for electrical energy for lighting and power will be maintained, but the demand for the tramway service is not likely to be more than 6 or 7 per cent. greater than last year. As against the increased capital charges an approximately equivalent saving may be anticipated in the cost of fuel. The prices for electrical energy at present in operation compare not unfavourably with those charged by similar undertakings, but with the view of encouraging an increased demand in directions in which experience shows such encouragement to be necessary, the electrical engineer begs to make the following recommendations: (1) that the charges for service lines up to the meter be reduced on a scale (to be submitted) varying with the size of service line required; (2) that the price for electrical energy for lighting be reduced from 4d. to 3d. per unit for any energy in excess of 3,000 units per quarter supplied to a consumer in any one establishment.

Estimates, 1902.

On Capital Account.	
Work done and goods delivered in 1901, or in course of delivery, but not paid for	£33,372
Buildings—	
Power station construction at Lister-drive	10,531
Extension of offices and workshops, Highfield-street	5,678
Office and stores, Fairclough-lane	450
Plant—	
Engines, dynamos, boilers, etc., on order for Lister-drive and Charters-street stations	34,030
Other plant and apparatus, including meters	19,650
Plant for southern district destructor station	5,000
Alternating-current high-pressure plant	20,000
Mains—	
Mains for lighting and power, including reinstatement of roads	44,500
Mains for tramways ditto	10,500
On Revenue Account.	
Goods delivered and work executed in 1901, but not paid for	9,045
Goods and wages, supply department	80,000
Goods and wages, fitting department	27,000
General expenses	18,000
Interest and Sinking Fund.	
Interest	41,000
Sinking fund	28,300

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NOTES.

Telegraph Experiments.—The Indo-European Telegraph Company state that owing to the press of work they are maintaining their attempts to work the Wheatstone apparatus from London to Teheran, in Persia. The results of the recent trials are said to be good. Signals at the rate of 350 words a minute were received from Emden.

Dielectric Constant of Paraffins.—By means of an electric wave method, says an abstract in the current number of the *Journal* of the Chemical Society, W. G. Hormell has found that the higher the melting point of the paraffin under observation, the greater is the dielectric constant. As the wave-length diminishes, the dielectric constant increases. It is to be noted that Cauchy's formula for calculating the index of refraction for infinitely long waves gives results inconsistent with experiment.

Discharge Potential of Hydrogen.—The difference between the discharge potential of hydrogen at a platinum and at a mercury cathode at − 85deg. is nearly the same as the difference at 18deg. From this Messrs. A. Coehn and E. Neumann have concluded that since in one case the mercury is solid and in the other case it is liquid, the discharge potential of hydrogen at metal cathodes is dependent, not on accidental properties of the metal, such as the form and nature of the surface, but on the chemical individuality of the metal.

Telephone to Brussels.—We understand that the authorities at the General Post Office, in conjunction with the Belgian Government, are arranging to lay a new telephone cable between England and the Continent in a few weeks, which will allow of through telephonic communication between London and Brussels and Antwerp. The new cable, which is now practically ready for delivery, will run from St. Margaret's Bay, near Dover, to La Paune, a point close to Ostend. The distance between these two landing places is 56 miles.

Shocks at 500 Volts.—As the measurements of resistance of members of the audience after the reading of Mr. Trotter's paper on Thursday week were made under disadvantageous circumstances, it is proposed to make further measurements on Tuesday next, 11th inst., on any persons belonging to scientific institutions or societies at the Electrical Standards Laboratory, 8, Richmond-terrace, Whitehall. From 1 to 2.30 and from 5 to 6.45 p.m. will be reserved for these measurements, but visitors will be measured at any time on the 11th inst. between 11 a.m. and 6.45 p.m. so far as the work of the laboratory permits.

Continuous Current.—The introduction and spread of electric traction has given a great advantage to continuous-current systems of electric distribution. In fact, since the corporations in this country have taken up electric traction, a fair number of supply stations have gone over from alternating current to direct. One of the most recent of these is Cardiff, where a decision has been come to that in future the whole of the centre of the town shall be supplied by means of direct current on the three-wire system. The great advantage, apart from the convenience in distribution, is that the voltage between the outers of the three-wire system is so nearly that required for tramway practice, that the same machines can be used for both services.

Institution of Junior Engineers.—The members of this institution recently paid a visit to the new baths and wash-houses of the metropolitan borough of Fulham, shortly to be opened, and situated in Melmoth-place, Fulham-road. The architect, Mr. H. Dighton Pearson, A.R.I.B.A., showed the party over, and fully explained the numerous features of interest. There are 84 private baths; a swimming-pond, 60ft. by 20ft.; one 100ft. by 30ft.; and another 125ft. by 33ft. The chimney is 80ft. high, and there is a water storage tank for 41,000 gallons. At the meeting of the institution on Friday, March 14, a paper is to be read on the subject of "The Uses of Engineering Models" by the chairman. On the following evening the annual conversazione takes place.

Electricity and Lampblack.—As is well known, lampblack is made by the incomplete combustion of hydrocarbons, and is deposited in flues and settling chambers. According to our French contemporary, *L'Electricien*, an engineer, Mr. Irnine, has introduced an arrangement for reducing the length of flues and number of depositing chambers hitherto required in order to secure the whole of the lampblack produced. For this purpose he uses two metal plates with a number of points projecting from them fixed one on each side of a glass receptacle 5ft. 5in. long and 5ft. wide. These two plates are charged up by means of a small dynamo, and by electrification the lampblack is quickly deposited on the same. The description of the apparatus we have before us does not mention what the voltage employed is, or if it is a continuous one, as would seem to us not to be the case.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on the 3rd inst., Sir James Crichton-Browne, treasurer and vice-president, in the chair. It was announced that his Royal Highness the Prince of Wales had graciously consented to become vice-president of the institution. Several members having been elected, the special thanks of the members were returned to "An Old Member" for a donation of £50 to the fund for the promotion of experimental research at low temperatures. The Friday evening discourse on March 14 will be given by Prof. Silvanus P. Thompson, his subject being "Magnetism in Transitu." The succeeding discourse on March 21 will be delivered by Geheimrath Professor Otto N. Witt, of Berlin, on "Recent Developments in Colouring Matters" in English. There will be no evening meetings on March 28 and April 4.

Proposed Institution Visit to Italy.—An important announcement was made by President Langdon at the meeting of the Institution last week to the effect that it is proposed to visit Italy in the spring of next year. He explained that the Council of the Institution had at first considered the desirability of arranging a visit to some foreign part during the present year, but that the proposal had been abandoned in favour of a visit to Italy in 1903, where it was thought there would be works and electrical installations of very great interest to members of the Institution. The secretary had been in communication with Signor Colombo, of Milan, who had offered them the warmest and heartiest welcome. Signor Colombo had also promised to carry out all the necessary arrangements for the tour. Mr. Langdon further announced that details of the proposed visit would be published in due course.

Lord Rayleigh's Lectures.—Lord Rayleigh continued his course of lectures on "Some Electrical Developments" at the Royal Institution last Saturday afternoon. His first experiments on this occasion dealt with the magnetisation of iron, and it was shown that with direct currents of feeble intensity the magnetisation was proportional to the amount of current employed. Lord Rayleigh next considered the question of the magnetisation of iron with reference to its bearings on the telephone, and explained that the original estimates as to the sensitiveness of the telephone receiver were not quite borne out by recent investigations on the subject, which showed that the sensitiveness was not so great as had previously been imagined. A few

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experiments on the Ruhmkorf induction coil followed. A large glass sphere was filled with phosphorescent smoke, and when oscillatory currents were passed through it the sphere was cleared of the mist.

World's Fair at St. Louis.—It is promised that the forthcoming exhibition at St. Louis will be on a larger scale than any ever before attempted. We understand that the authorities have just placed a large contract with the Westinghouse Companies for power generating plant having a rated output of 4,000 kw. The main units are four Westinghouse-Corliss steam-engines, each direct-coupled to a 2,000-kw. Westinghouse three-phase alternator. Other electrical plant to be installed will consist of three direct-coupled exciters, transformers, rotary converters, synchronous and induction motors, switchboards, etc. The boiler-house plant, auxiliary machinery, steam system, and, in fact, the whole of the power arrangements, have been placed in the hands of the Westinghouse Companies. The entire installation will thus be carried out under one responsibility, a fact which should go a long way towards assuring its successful working.

The Arco-Slaby Wireless System.—It is announced that the Allgemeine Elektricitäts-Gesellschaft have received an order from the United States Naval Department for two complete installations of the Arco-Slaby wireless telegraphy apparatus. According to the news received, this system is shortly to be worked by the United States authorities in competition with the Marconi apparatus between Annapolis and Washington. During the recent competitive trials in the presence of naval authorities in Kiel Harbour, the Arco-Slaby system is reported to have given satisfactory results over a distance of 83 miles, as against 57 miles by the Marconi system. The Arco-Slaby method is being largely adopted in Germany at the present time, and the Reichstag lately granted a subsidy of £15,000. Some 40 German warships are already fitted with the apparatus, and it is stated that the system will shortly be used in connection with the establishment of wireless telegraphy stations on the German coast.

The Future of British Canals.—Mr. George Cawley, consulting engineer, of Westminster, sends us a little pamphlet on the subject of "The Future of British Canals." The articles originally appeared in the *Manchester Guardian*, from which they have been reprinted in this more convenient form. The subject is not an unimportant one as opening up the question of the cheapening of inland transport in this country. The author pleads for immediate parliamentary action in respect of our canals. His opinion is that if this means of transport were improved and firmly established on business and engineering lines, it would provide a healthy and effective competition with the railways, to the great advantage of manufacturers and traders generally. New methods of haulage are most required in order to bring about a reduction of expenditure and a greater freedom of traffic. He points to what the owners of canals in other countries are doing in the development of their waterways, and urges that we in this country should follow the lead thus given and establish our canal system on a basis that would be compatible with the best modern methods of working.

Manufacture of Aluminium.—Messrs Haber and Geipert have recently published an account of an experimental investigation of the manufacture of aluminium by electrolysis of a molten solution of alumina in cryolite. It seems that pure aluminium can easily be obtained at a pressure of seven to ten volts with a cathode current density of about three amperes per square centimetre in a carbon crucible with carbon anodes. Regarding the properties of the aluminium obtained, it is very important to use pure materials. The electrolysis takes place in an easy and uniform way, like an electro-analytic deposition of a metal, if the dimensions of the bath and of the electrodes are properly chosen, and if the anode is so adjusted that during electrolysis it can be easily raised in a systematic way. The electrolyte from which the pure metal was obtained consisted of about one-third sodium fluoride, one-third aluminium fluoride, and one-third alumina. The high percentage of aluminium fluoride is favourable because it lowers the melting point. The temperature of the bath is that of a light-red heat. The experimenters believe that the progress which has taken place in the last 10 years in the industrial manufacture of aluminium is not due to secret modifications of the electrolytic process, but to the use of pure materials.

A French Wireless Telegraphy Company.—We understand from the last issue of our Parisian contemporary, *L'Electricien*, that a limited liability company is being formed in Paris for the development of wireless telegraphy and for telephoning without wires. The objects of the company are, of course, numerous, but we see that the first is the establishment of a line of wireless telegraphy between Paris, Rouen, and Havre. The sixth object of the company is to make investigations and experiments for the establishment of wireless telegraphy between Marseilles and Algiers, between Brest and the Azores, and between Newfoundland and New York. It is not quite clear from our contemporary's reference to the company how much capital they are to have in the first instance, but we believe we are correct in stating that 80,000 shares, at £1. 4s. each, are to be issued. The real object of the company seems to be the exploitation of a system of wireless telegraphy invented by a Russian engineer called Pilsoudsky. A description of the system has been given in the Press before, but we have considerable doubts as to how far the results which have been obtained up to the present are equal to or in advance of those realised by other inventors; in fact, our contemporary goes so far as to say that the experiments made up to the present have only succeeded in transmitting signals over some 4½ miles. The company hardly calls for the investment of English capital.

Cable Rates.—Mr. J. Henniker Heaton writes to the *Times* of Monday's date with reference to the reduction in the cable rate to India from 4s. to 2s. 6d. a word, which came into force on Saturday. He complains that even this charge is far too high, and asserts that the public will not be satisfied until the rates are reduced to India to 6d. and to Australia to 1s. per word—the rate now charged for Press messages. The present charge for an ordinary cable message to Australia is 3s. per word. In the course of his letter, Mr. Heaton refers to an article he contributed to the *Times* in 1899, in which he advocated the use of land lines wherever possible in preference to cables. Land lines, he contends, could be constructed at a fifth of the cost, and carry at least four or five times more messages than cables. As an example he quotes the case of Australia, where a telegraphic message is carried across the Continent, over 3,000 miles of wire, for less than 1d. per word. From here to India overland it is 3,600 miles. In these days, he argues, we never shall have Imperial federation until we make telegraphic communication between London and Vancouver and London and New Zealand as cheap as between London and Ireland—until by the use of electricity we annihilate time and distance. Mr. Heaton also objects to the monopolist and "octopus of Old Broad-street being the only purveyors of electricity in the British Empire." After referring to the attitude of the Eastern Telegraph Company in the matter, Mr. Heaton

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concludes with the wish that the Government will give their full support in the battle for cheap telegraphic communication to all parts of the Empire.

Dusseldorf Exhibition.—Particulars are now available of the forthcoming exhibition to be held at Dusseldorf in the summer of this year. As an exhibition town, Dusseldorf offers peculiar attractions, not only on account of the beauty of its surroundings, situate, as it is, on the shores of the Rhine, but also because it is the chief centre in Germany of the engineering and electrical industries. We hear that at this year's exhibition electricity will reign everywhere. In the machinery hall an electric generating plant of a capacity of over 3,000 h.p. is being installed, and this will supply the current for the thousands of electric lights in the different buildings and in the grounds of the exhibition, besides furnishing electric power for driving machinery. A special feature in electric traction will be a circular electric railway which will run round the grounds, measuring over three miles in circumference. The exhibition covers about 150 acres, and occupies one of the best positions in Dusseldorf, being bounded on the one side by the Rhine and on the other by the Hofgarten, a large portion of which has been included in its grounds. The buildings are now nearly complete, and everything points to a successful opening on May 1 next. During the run of the exhibition, which is dated to close its doors on Oct. 20, a number of professional and scientific societies have arranged to visit Dusseldorf, and the British Iron and Steel Institute has decided to hold its summer gathering there. The exhibition will be held under the patronage of the Crown Prince of Germany.

Economy of Isolated Electric Plants.—A careful examination of the relative advantages of isolated plants and electricity supply from central stations, from actual records of cost, has led Mr. Parsons to the conclusion that in some cases the isolated plant is the more economic. From an abstract of an account of his research which appears in the *Electrical World* for last month, it seems that over 250 buildings with isolated plants in New York were visited, but only 17 were found where reliable information in every particular was available. Only these, therefore, were considered in the analysis of the cost records. Those of five office buildings are analysed in detail, and as they include one of the largest office buildings in New York, one of the smallest, and three buildings of average size, they cover the field fairly well; they indicate as a rule the marked superiority in economy of the isolated plant, but in one case it is shown that a slight error of installation combined with unfavourable load conditions may, even in the very largest buildings, render the isolated plant of doubtful economy. The next class of buildings considered is the loft buildings; from the figures given for three buildings of this sort it appears that the installation of a plant in a building of this class and the sale of current to the tenants at central-station rates, or in very large loft buildings, at 10 to 25 per cent. reduction from those rates, would in most cases prove very profitable. Figures are then given regarding a department store, showing a very great advantage in the installation of the isolated plant, and with the two important points in its favour, that the average load factor is quite high and that a steam plant is a necessity whether the electric plant is installed or not.

The Sheffield Accident.—It is a curious coincidence that the fatal accident at Sheffield should occur just one day after the three papers on "Electric Shocks" had been read before the Institution of Electrical Engineers. The paper by Mr. A. P. Trotter, and also the experiments performed by him on himself, showed how exceptional the circumstances must be for death to be caused by 500 volts. Even standing on the rails and holding a live trolley wire was not sufficient, although wet boots were worn. The facts of the fatal accident by which Mr. W. R. Hind met his death, as revealed at the inquest, are as follows: The deceased was at the Alhambra Theatre, Attercliffe, and entering a lavatory behind the dress circle, tried to pull down a disused bracket which was wired for electric lighting on a 200-volt alternate-current circuit. The bracket was 7ft. from the floor, and the evidence showed that the deceased on touching it was at once drawn up with his feet at least a foot from the floor. He expired soon after he was pulled off the bracket by a friend. The verdict brought in was one of accidental death, but it seems to us that the case calls for expert investigation. Thus, the Corporation did not have any representative to give information at the inquest, and, from the report we have seen, there was nothing to show the actual voltage of the shock received. This should have been investigated, seeing that the supply is on the alternate-current system, and it would be only fair to the profession as a whole that a doctor's opinion as to the real cause of death should be ascertained. The evidence clearly shows that the deceased hung from the bracket after he had broken the circuit to earth, by lifting his feet from the floor. It is surely not to the interest of the electric lighting department of the city of Sheffield that a statement should be circulated to the effect that, if the meter were defective, more that 200 volts might be obtained.

Telephone Office Location.—The exact determination of the best point in a town at which to establish a central telephone exchange is one which is exceedingly difficult to settle on theoretical lines. It is the more so in this country because the streets of the towns are not laid down on a rectangular plan, as in the States, and the routes to be taken by the cables are often exceedingly devious. We notice in the *American Electrician* for last month an interesting communication by Mr. F. J. Dommerque on this question, in which he not only indicates the best position of several exchanges in one town, but also shows what should be the dividing lines between them as far as connections to subscribers are concerned. He recommends in the first instance that squared tracing papers should be laid over the town, on which the positions of the subscribers could be marked. It then resolves itself, when only one exchange is concerned, into finding the centre of gravity of a system of small weights placed one on each of the dots. The author suggests that this should be done by means of a ruler, which should be moved down the sheet until one-half of the dots is visible. A line should then be drawn. After this the ruler should be turned to a right angle, and again turned down until the half of the dots is visible This, he presumes, would give at the intersection of the lines the correct point for the location of the station. It is not, however, a correct means of solving the problem, as it assumes an equal density of subscribers. What should be done, if time allowed, would be to find the centre of gravity of the system as mentioned above. When the position of two exchanges has been found in the way described, the author shows that in laying out the dividing lines correctly between subscribers on the one station and those on the other, the route of the cable between the stations has to be considered. The dividing lines should, of course, pass through equidistant points, so far as line wires are concerned, from the two stations. When all has been done correctly, the condition will be arrived at that a minimum length of subscriber line wire will be required. Unfortunately, like accurate calculations of electric lighting mains, the true conditions as to distribution cannot be

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presumed, and are only ascertained after the works have been in operation for some years. What is wanted, therefore, is a knowledge of theory and practical experience in predicting what will be the density of the subscribers in the various districts.

Telegraphs of the Empire.—Sir Edward Sassoon, M.P., who has always shown the greatest activity in all telegraphic and telephonic affairs in the House of Commons, delivered a lecture at the Fishmongers' Hall on the evening of the 27th ult., his subject being "The Telegraphic Lines of the Empire." In the course of his remarks the lecturer maintained that the present system of telegraphic intercourse was inefficient. We were so much accustomed to leave the ordering of matters telegraphic in the hands of private companies, who now had the control of them, that we had come to accept with unquestioning gratitude any small concession which might be granted by those companies; and he contended that until the utmost pressure was put on private companies we had not been on the side of progress. The cable system, as it existed at present, was not in hands from which the telegraphic community might hope to derive great benefits. The natural remedy to look to was free and open competition, but owing to the advantages and financial assistance the telegraph companies had received from the various Governments, they had been placed in an almost unassailable position. We were, therefore, compelled to look for a remedy at the hands of the State. An efficient and sufficient telegraphic service, uniting together all the British possessions, at a charge within the reach of the most modest purse, was much to be desired, and would shortly be regarded as an absolute necessity. It seemed to be of vital importance that in any engagement which his Majesty's Government might enter into with the cable union companies in future, every provision should be made to secure to the Government complete control over the working of the cables in question. But what was more important still was that in every fresh agreement a clause should be inserted reserving to the Government the right to purchase such cables on equitable terms. In conclusion, he admitted that there might be some difficulty in arranging for the ultimate acquisition of such of the existing cables as it might be thought desirable that the State should buy; but that was all the more reason why the Government should not delay in establishing the principle of possible ultimate purchase.

Manchester Local Section Dinner.—The first annual dinner of this section of the parent Institution took place at the Queen's Hotel, Manchester, on the 28th ult. Over 100 members were present, Mr. C. H. Wordingham occupying the chair. The loyal toasts having been proposed by the Chairman and duly honoured, Mr. S. Z. de Ferranti proposed the toast of "The Institution and the Chairman." He impressed on members the necessity for bringing in those outside the "tabernacle," and referred to a youth who had told him that day that he was going in for a B.Sc. examination, and would not require any electrical knowledge to pass. This was surely a state of barbarism. He would be pleased to report the great progress made by the Manchester branch to the Council of the Institution. Mr. Wordingham's remarks in reply were greeted with loud applause. He thought the amalgamation of the Northern Society with the Institution was a benefit both to themselves and to the Institution. He suggested that the Council, being chronically blocked with work, might pass on some of the matters for the councils of the local sections to settle, and especially decried the idea of the Institution being dragged into political questions such as municipalisation. Mr. Browett, in the course of a very humorous speech, proposed "The Health of Our Guests," and explained that he was a stopgap on account of Mr. Fawcus being absent, whose place he could not pretend to fill—either mentally or physically. Dr. Bowman and Mr. Stromeyer replied to the toast. The latter suggested that a crest should be designed for the Institution, and proposed that a certain Venus should be made the tutelar deity of the profession on account of her being born from the head of Jupiter after a headache occasioned by deep thought. Mr Wordingham then proposed "The Manchester Engineering and Scientific Institutions," and referred to the text of his inaugural address regarding a common assembly house and library for the various engineering societies in Manchester, which city he described as the centre of English engineering. The matter, he said, was now in course of negotiation. Mr. E. G. Constantine having said a few words, Dr. Schuster, in further reply, blamed Mr. Ferranti for it being possible for people to pass for B.Sc. without electrical knowledge. If he had given such good advice to the professors 10 years ago as he had given that night, this could not have happened. Professors were always ready to accept advice and willing to learn. The proceedings were enlivened throughout by a very engaging musical programme. It may be mentioned that Mr. P. C. Pope's comic songs were genuinely musical as well as being "funny," and were accordingly hugely appreciated. Mr. E. W. Cowan, the hon. secretary of the section, is to be congratulated on the success of this function, for which he was mainly responsible.

Electro-Therapeutics.—Dr. H. Lewis Jones dealt with the subject of the present and the future of electro-therapeutics in a paper which he presented at a meeting of the British Electro-Therapeutic Society last month. In many ways, he thought, the general introduction of public electric lighting supplies had been responsible for the extension in the practice of medical electricity, and it had also provided the profession with a new and valuable agent in the sinusoidal current. As regards electrical testing, the author considered there was still need for a method of measuring induction-coil currents, and the difficulties of doing this might be evaded by the substitution of condenser discharges in place of them. Chemical batteries, with the troublesome preparation of exciting fluids, were being rapidly discarded by the profession, and the modern dry battery or the portable accumulator was superseding them, with the result of greater simplicity in working and greater confidence in the instruments used. The static machine had begun to return to favour, and seemed likely to achieve great things in the near future. The author next turned his attention to the use of the X-rays in the treatment of lupus and of rodent ulcer. This form of treatment seemed to be assuming an established position. He mentioned in particular one case in which the patient when admitted to St. Bartholomew's Hospital had a large, open ulcerated wound of the right breast, measuring 4in. in one diameter and 5in. in the other. Treatment with the X-rays was commenced on Nov. 14, and an exposure of 10 minutes was given four times a week until Jan. 17. During this time the healing process continued to advance steadily, and since the suspension of the treatment on the date given a firm and healthy scar had covered the whole surface of the wound, except about one square inch in the centre. Thus, nineteen-twentieths of the area of a cancerous ulcer had healed in three months as a consequence of X-ray applications, and the author regarded this result as obviously a most significant one. The rays, however, had no effect upon the spread of the disease in the remote parts of the body, and the opportunity must be looked for of treating some cases of cancer in the early stage, when the disease

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was still limited to the superficial part. When the disease was no longer local, but had implicated distant and deep-seated organs, it was too late to apply X-ray treatment to the original site of the disease. The concluding part of Dr. Lewis Jones's paper explained the scope and aim of the British Electro-Therapeutic Society. Among other things it was sought to bring about uniformity in apparatus, and it was the duty of the members to inform scientific men as to the instruments which they could usefully employ in investigations. The encroachment of unqualified persons upon the field of work of the society was a very serious matter. The treatment of lupus by any irresponsible person who happened to have an induction coil should not be countenanced by any medical man, and with the possibility of the use of the X-rays in the treatment of cancer the danger became greater. This was one of the matters which would shortly engage the attention of the society.

Telpherage.—In an article contributed to the current number of *Cassier's Magazine*, Mr. A. S. Clift adds some useful information to what has already been published on the subject of telpherage. The system cannot be better described than in the words of the late Prof. Fleeming Jenkin, who has said that telpherage is the "transmission of vehicles by electricity to a distance independent of control from the vehicle." Some of the earliest investigations and experiments were made by him in 1882, and it was the late Prof. Jenkin who coined the word "telpherage." Much pioneer work on the subject has, however, also been done by Profs. John Perry and W. E. Ayrton. It is only comparatively recently that the subject has been revived and brought to what the author terms a successful status. Aerial telpher lines may be of either cable or rail construction, the former, however, being the more common. The spacing of the poles is an important matter, and varies with the load, a distance between poles of 100ft. being generally adopted for light lines, while for heavy loads a lower cost and increased stability are secured by setting the poles closer together and having fewer intermediate points of support for the cable. The trolley wire is run a short distance above the running cable, and in long lines is supplied with current at several points in the usual manner by means of feeders. The telpher, or electrically-driven carrier, which runs along the cable, is of the simplest construction. There is no gearing, the grooved wheel which runs upon the cable being fixed directly upon the motor shaft, which is made large in diameter and runs in amply proportional bearings adjacent to the wheel, to sustain the total weight of the motor and load. One advantage of the line being overhead in this system is that there is little chance of obstruction, and an occasional dead branch of a tree is almost the sole cause of trouble. The extremely important problem of the control of the telpher upon grades has, we are pleased to hear, been satisfactorily solved by the use of an electric braking device, which acts automatically, with varying degrees of force, depending upon the grade and the speed at which the carrier is run. The author further asserts that the surmounting of moderately steep grades presents no difficulties, for the tractive power of telphers of the ordinary construction, running upon a flexible cable, is remarkably high. Accompanying the article are several interesting illustrations of the system at work in engineering and other workshops. In one case, in which a two-phase power plant was already in use, it was decided to use the same system on the telpher line. Accordingly, two-phase induction motors were employed, which necessitated the use of two trolley wires, the connections of the circuit being two-phase, three-wire, the running cable acting as a common return. The working speeds attainable with the system are said to be high, a rate of 12 miles an hour on straight sections having been found entirely satisfactory in practice. It is thought probable that there would be no difficulty in the way of attaining far higher speeds where the conditions are such as to make them of advantage.

Mr. Marconi's Success.—There can no longer be any doubt that Mr. Marconi's claims to establish a line of wireless telegraphy across the Atlantic are not without foundation. His latest success is certainly one which entitles him to every congratulation. The fact that he has received readable messages at a distance of 1,551 miles and the signal "S" 2,099 miles away from the Cornwall station, is most encouraging. The reports on the subject which have reached this country from New York all agree in the essential details, and they are, moreover, confirmed by an official statement issued by Marconi's Wireless Telegraph Company with reference to Mr. Marconi's success. It seems that the first message was received when the "Philadelphia," the steamship which took Mr. Marconi to New York, was 250 miles away from Poldhu, his station in Cornwall. This was on Feb. 23, in the early morning, and at night another message was received when the vessel was 500 miles out. The next day, at a distance of 1,032 miles, a further message was recorded, and also on the 25th, when some 1,163 miles were between the "Philadelphia" and the station in Cornwall. The last readable message was received at a distance of 1,551 miles. It was as follows; "All in order. Sign. Do you understand?" Finally, at midnight on Feb. 26, when the "Philadelphia" was 2,099 miles away from the Lizard, the letter "S" was received. All the messages were read off the tape. It will be noticed that communication was only maintained one way—*i.e.*, from the station to the ship—but Mr. Marconi explained on his arrival in New York that while the apparatus on the "Philadelphia" admitted of the reception of the telegrams, it was not sufficiently powerful to send them such a distance as the better-equipped Cornwall station accomplished. Mr. Marconi is also reported to have said that the curvature of the earth does not in the least affect the waves, and he mentioned that during the voyage he carried out a number of important experiments, the character of which, however, he declined to disclose. The news of Mr. Marconi's success prompted a question in the House of Lords on Tuesday, put by Lord Lamington, as to the attitude of the Post Office towards the development of wireless telegraphy. Lord Londonderry, replying merely as the head of his own department, and not on behalf of the Government as a whole, said the Post Office regarded the matter as of enormous importance. The owners of the patent could do what they liked, and required no authorisation from his Majesty's Government so far as communication between ships at sea was concerned; but as to communication between ships at sea and signalling stations, anything in any way interfering with that would be an absolute infringement of the rights of the Postmaster-General imposed upon him by Parliament, and which it was his duty to carry out. At the present moment it might be that wireless telegraphy in the hands of private companies might interfere seriously with the experiments and working of the Admiralty, and until those doubts were dissolved he should not consider himself at liberty to give a license. It might be that in the course of time wireless telegraphy might be worked at a profit, and then he might give it the support of the Post Office, but at the present time they were simply watching keenly all that was done.

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THE BERLIN ELEVATED AND UNDERGROUND ELECTRIC RAILWAY.

Last week witnessed the formal opening of Berlin's new elevated and underground electric railway, which has been under construction for some years past. A description of the undertaking from the pen of Mr. Gisbert Kapp appeared in the *Elektrotechnische Zeitschrift* for Feb. 13 last, of which we venture to give the following abstract:

The route of the new line lies to the south of the Berlin Metropolitan Railway, and forms an almost straight connection between the Warschauer Brücke (east) and Zoologischer Garten (west) Stations of the latter system. Central-Viehhof, as shown on the accompanying plan (Fig. 1). One of the most interesting portions of the line is the so-called junction triangle (Anschlussdreieck) to the east of the Potsdam Goods Station (Fig. 2 and 3). In this triangle level crossings are avoided by carrying the up and down lines at different levels—one above the other—where the crossings occur. There are no level crossings at all over the inner tracks. By this arrangement not only are three sources of possible danger avoided, but a much quicker succession of trains also rendered possible. The succession of trains in the triangle must necessarily be rapid, since it negotiates the traffic for three lines—namely, from the Potsdam Station eastward, from the same station westward, and the through traffic between

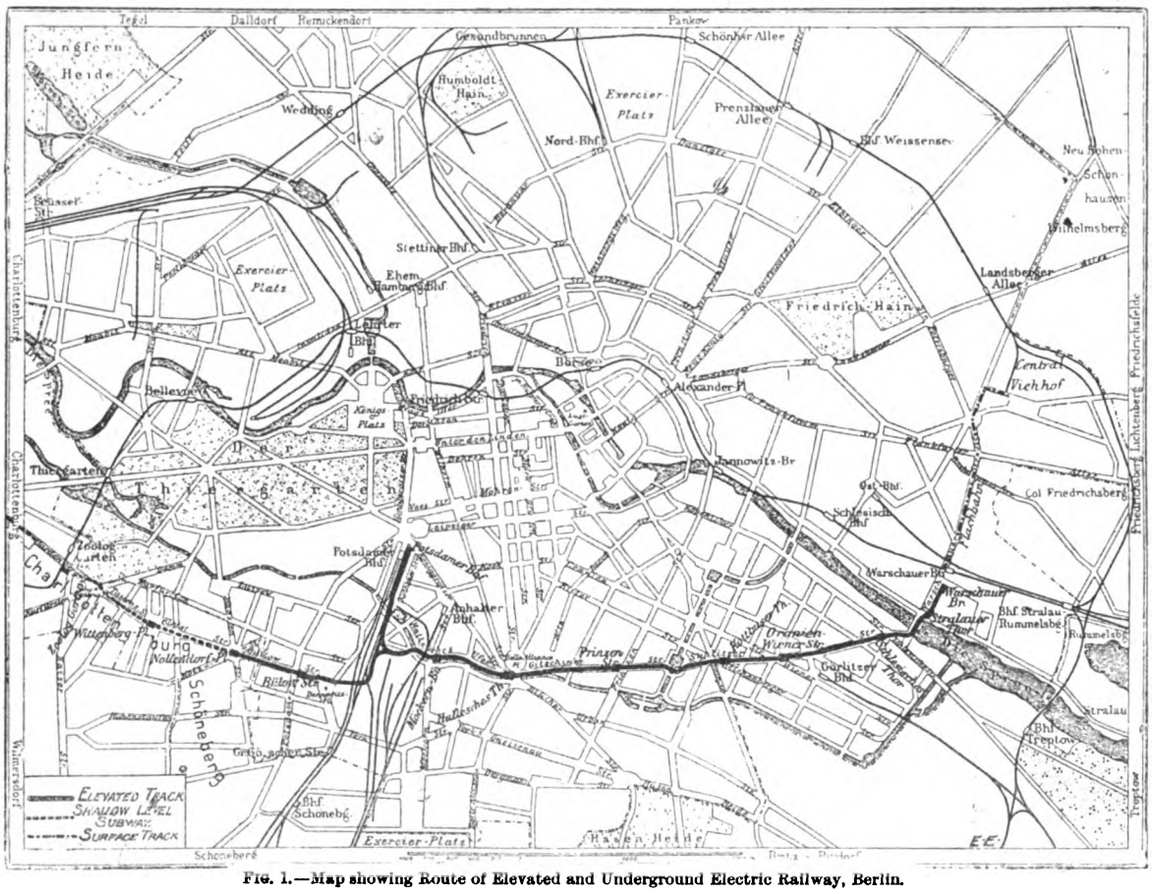

FIG. 1.—Map showing Route of Elevated and Underground Electric Railway, Berlin.

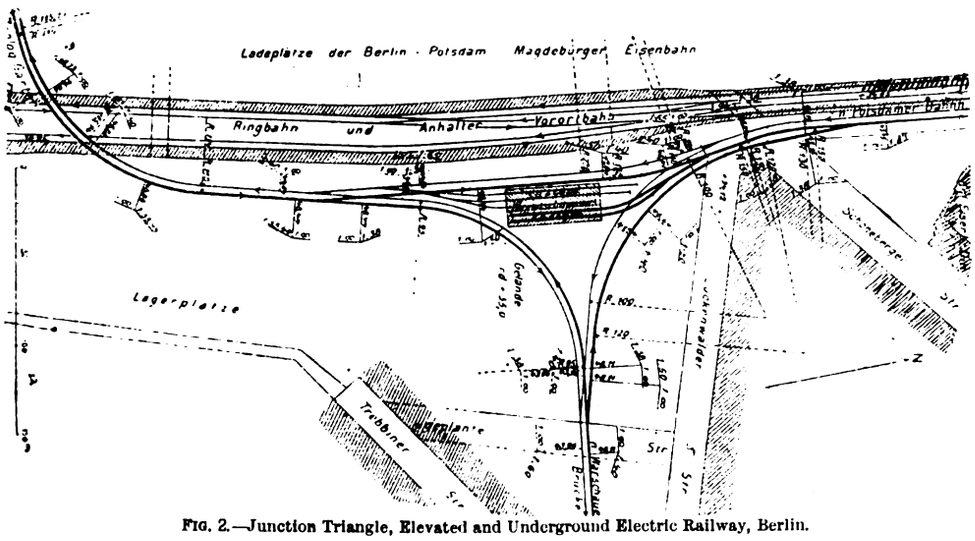

FIG. 2.—Junction Triangle, Elevated and Underground Electric Railway, Berlin.

Plans for the new line were prepared in 1891 by Messrs. Siemens and Halske, and to these plans, with some slight modifications, the work has been carried out. The greater part of the track is elevated, a comparatively short section to the south of the Potsdam Station, and another at the western extremity of the line, being constructed in a cut-and-cover, or shallow-level subway, while a surface-level link connects the east end of the elevated track with the east and west ends of the main section. At two points—namely, south of the Potsdam Station and to the west of the Nollendorfplatz—the line dips into a shallow level subway, the gradient at these transition points being 3·15 per cent. A cross-section through the shallow-level subway is shown in Fig. 4. In this figure the conductor rails are also shown. They are placed outside the two tracks at a height of 9in. above the upper surface level of

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the running rails. On the elevated track the conductor rails are placed between the up and down tracks at a height of 7in. above the upper surface level of the running rails. The difference in the height at which the conductor

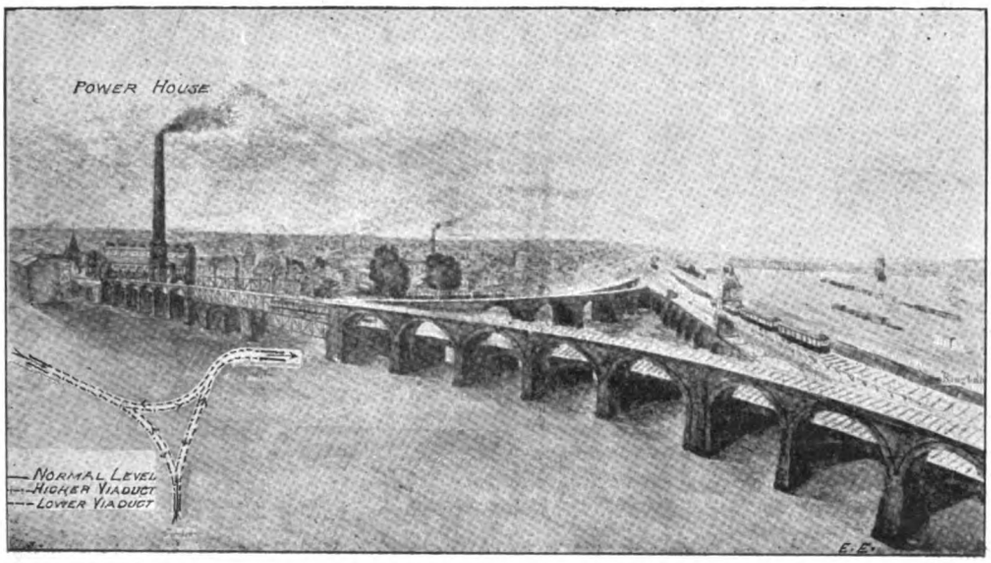

FIG. 3.—View of Junction Triangle.

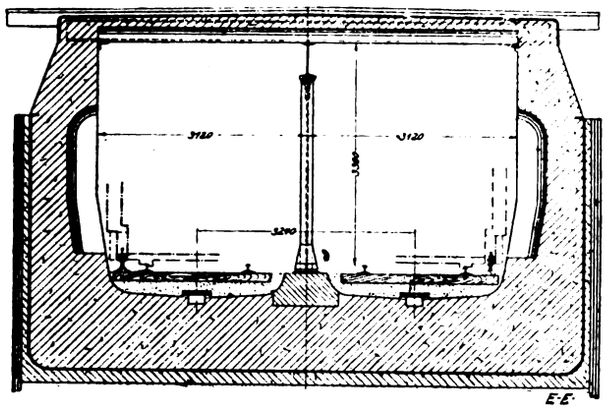

FIG. 4.—Cross-Section through Shallow Level Subway, Elevated and Underground Electric Railway, Berlin.

rails are placed serves to effect the automatic contact of the slide through which the lighting circuit of the car is completed in the subway. The arrangement of the conductor rails on the open track is shown in Figs. 5 and 6.

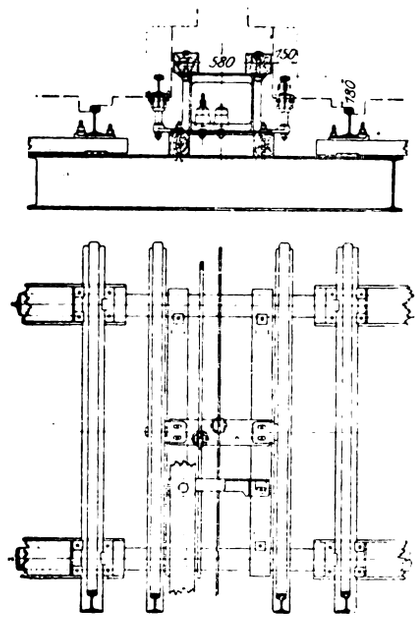

FIG. 5.—Arrangement of Conductor Rails on Open Track, Elevated and Underground Electric Railway, Berlin.

In all, there are the following systems of conductors: (1) for the supply of current for working the trains; (2) for the lighting of the stopping stations, the block and point signals, the car-sheds and workshops; (3) for the safety signal installation; (4) for the telephones; (5) for the electrical working of the signals and points in the junction triangle.

The conductor rail is situated 3ft. 7in. from the centre of the track. It consists of railway metals of 5½ square inches cross-section and 39ft. 6in. length, copper-bonded at the joints. This conductor also carries the current for lighting and heating the cars. It is placed outside the track at a height of 7in. above the upper surface level of the running rails on the open track, and at 9in. above the corresponding level in the subway, as already mentioned. On the sections between the power station, which is in close proximity to the junction triangle, and Kottbuser Thor, on the one hand, and the power station and Nollendorfplatz, on the other, there are also laid bare feeders consisting of copper bars well bonded at the joints. The feeder conductor has a rectangular cross-section of 1·5 to 2·3 square inches area. The lighting main for the stopping stations and subways is likewise bare, being laid beside the feeder conductor. Both the conductor rails, feeders, and lighting mains are supported on insulators, the attachment of which to the track differs according to the construction of the permanent way. On the section from where the line crosses over the Anhalter Railway to

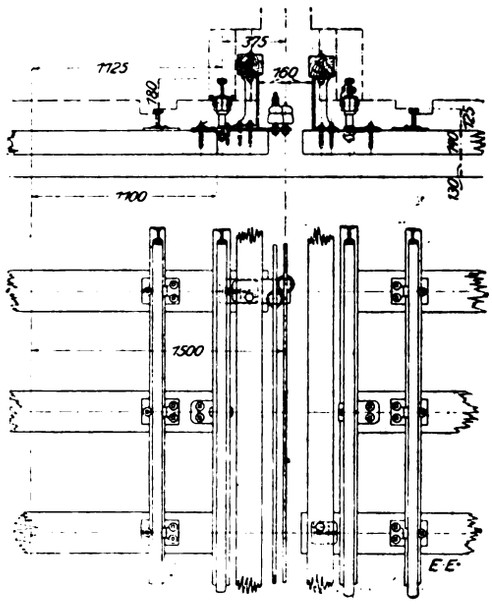

FIG. 6.—Arrangement of Conductor Rails on the Bülowstrasse Viaduct, Elevated and Underground Electric Railway, Berlin.

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Oberbaumbrücke the sleepers rest direct on the transverse girders of the permanent way, as shown in Fig. 5. At a distance of about 20ft. apart wood beams are attached longitudinally in pairs to two adjoining transverse girders, these beams carrying in turn cast-iron trestles, the openings through the frame-like trestles serving for the feeder and lighting mains. The insulators which carry these mains

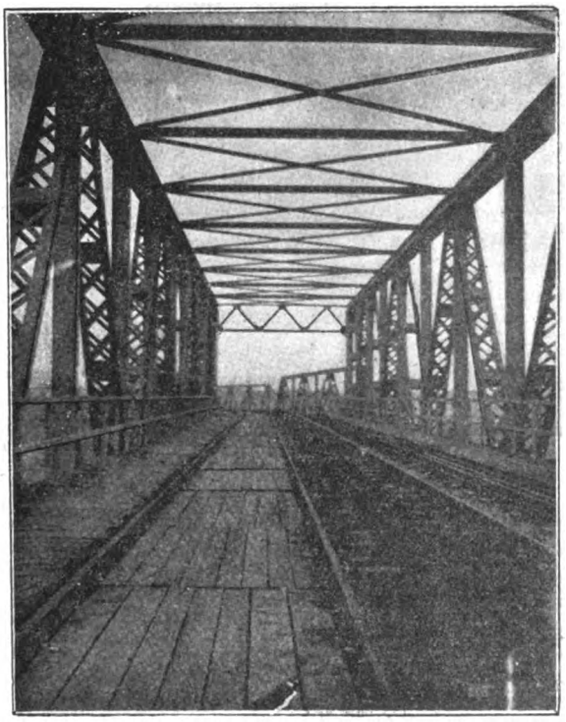

FIG. 7.—View of Elevated Track, looking towards Power House, Elevated and Underground Electric Railway, Berlin.

are attached by means of screws to an iron plate, which rests transversely on the wood beams, while the insulators for the conductor rails are supported directly by the longitudinal beams. To the cast-iron trestle pieces are attached two guard beams of wood parallel to the conductor rails, but about 5in. above their upper surface level, which allow the conductor to be crossed at any point without danger. At those points where telephone wires cross the elevated track, wires of 8mm. diameter are fixed along the outside upper edge of the guard beams, and connected direct with the rail return—that is, to say, earthed—thus providing an efficient protection for the telephone apparaus should the telephone wires break. A slightly modified arrangement (see Fig. 6) has been adopted for the viaduct in the Bülowstrasse. The trestles are here mounted upon longitudinal sleepers, and the conductor rail on iron traverses. On the Oberbaumbrücke, where the track itself is laid on longitudinal sleepers in troughs, the arrangement of the conductors differs from the normal, in that the timbers to which the cast-iron trestles and insulators are attached are fastened to the floor beams of the bridge by means of screw clamps, perpendicular to the axis of the track.

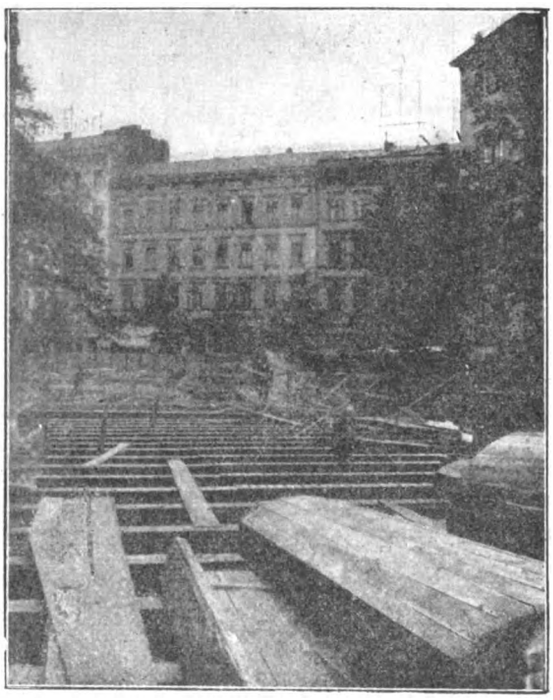

FIG. 8.—Subway in course of Construction, Elevated and Underground Electric Railway, Berlin.

At the termini and junctions it has been impossible, owing to the arrangement of points, to make the conductor rails continuous. They are laid, therefore, in isolated sections between the different point connections. A continuous feed to the motors is, nevertheless, obtained, as the trains running over the elevated way are provided with four contact shoes per side, of which two are situated on each

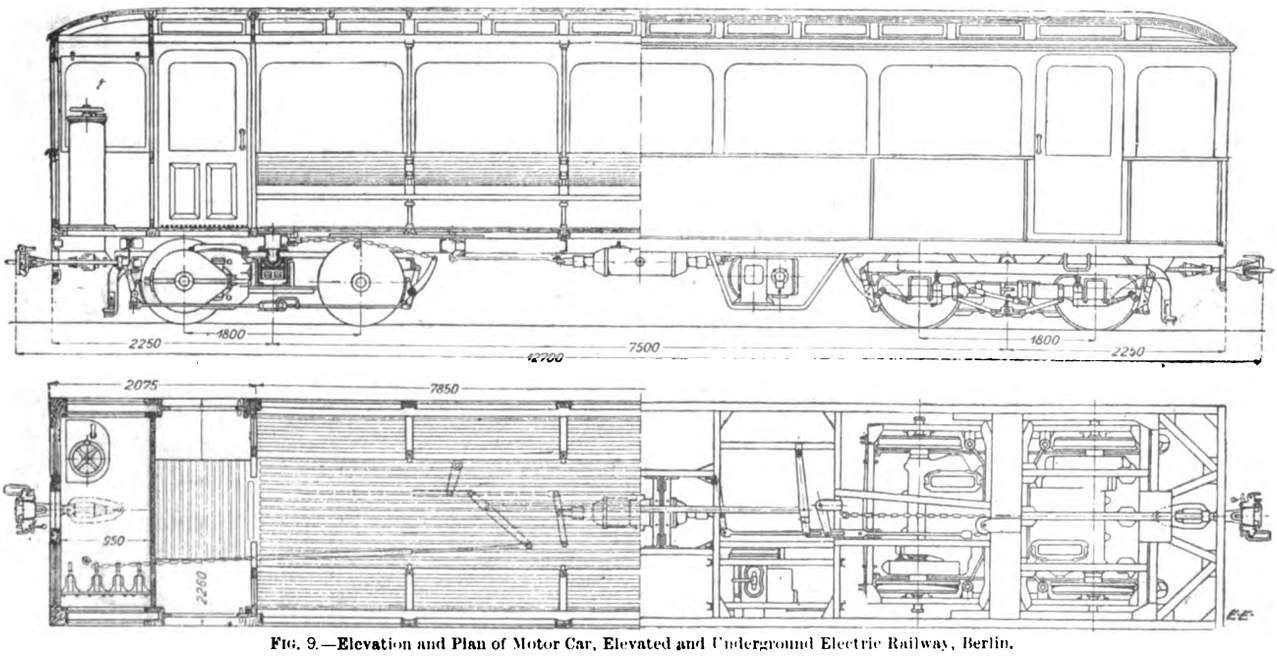

FIG. 9.—Elevation and Plan of Motor Car, Elevated and Underground Electric Railway, Berlin.

side of each motorcar, so that when the contact shoes at the front end of the train break contact, the circuit to the motors is continued through the shoes attached to the rear car. The different isolated lengths of conductor rail are interconnected electrically by means of cables. The insulators for the conductor rails at the terminus at Warschauer Brücke are attached to the ends of the sleepers. This arrangement of the conductor rail is also provided on the section

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from Oberbaumbrücke to the terminus at Warschauer Brücke. In the stopping station at Warschauer Brücke the insulators for the conductor rail are attached to the walls of the platform cutting. In the car-sheds the conductor rail is arranged over the side of the track. It consists of L-iron, which is protected from accidental contact by an ⊓-shaped wood guard. On those sections of the junction triangle where the up and down lines are at different levels relative to each other, the arrangement of the feeder and lighting mains is as follows. The insulators for the conductor rail are throughout attached to the ends of the sleepers. The feeder and lighting mains on those sections of the junction triangle where the sleepers are bedded in gravel are arranged by placing lengthened sleepers at intervals of 20ft., which carry cast-iron trestles for the guard timbers and wrought-iron plates, to which latter the insulators for the lighting and feeder mains are attached. From the junction triangle to the entrance of the subway near Courbièrestrasse lengthened sleepers are provided at intervals of about 20ft., which carry cast-iron trestles, below which are fixed wrought-iron plates for carrying the insulators. At those points where the up and down lines resume a common level, the same arrangement of the conductors is again resorted to as occurs on the western section of the elevated track, and, indeed, this arrangement extends along the section towards Potsdamer Platz, up to the subway entrance, and along the section towards Möckernbrücke, until the normal conditions of the track are reached—that is to say, up to and including the bridge over the Anhalter Railway. It may be mentioned also that at those points where junctions occur between the up and down lines, the feeder and lighting mains are continued by means of cables. Fig. 7 is a view of the elevated track looking towards the power-house, while one of the subways is seen in course of construction in Fig. 8

Contrary to the arrangement on the open track, the conductor rail in the subways is not placed between the tracks, but outside the same, as shown in Fig. 4. The conductor rails in the subway sections are placed 2in. higher than on the elevated track, solely in order to facilitate the automatic completion of the lighting circuit of a car as it enters the subway. The insulators for the conductor rails are screwed to lengthened sleepers, placed at intervals of 20ft.

regulating arrangement which is provided. The regulation is effected from the power-house as shown requisite by pilot wires. At the several points of consumption along the lighting circuit provision is made for connecting to the conductor rail, so that in case of necessity the individual installations of lamps may be switched over to the power circuit. The running rails serve as a return both for the current which works the service of trains and for the lighting current. In order to make the return as perfect as possible, the rails are not only electrically connected at the joints by means of copper bonds, but the rails of each track are also cross-connected by means of copper rods.

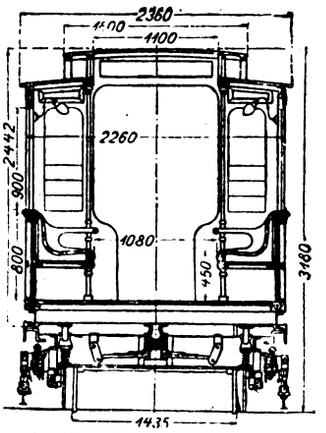

FIG. 10.—End Section through Motor Car, Elevated and Underground Electric Railway, Berlin.

Cables are laid for the purposes of the signal and telephone installations, the returns for these consisting of special wires. Each stopping station is in immediate telephonic connection with the two neighbouring stations, and can also communicate with any other of the stations through the exchange at the power-house. Current for the working of the signals and points in the junction triangle is likewise conveyed through cables. These cables, as also the telephone cables, are attached to the timbers which guard the conductor rails.

The insulators for the conductor rails have cast-iron caps constructed in two pieces, which when screwed up grip the

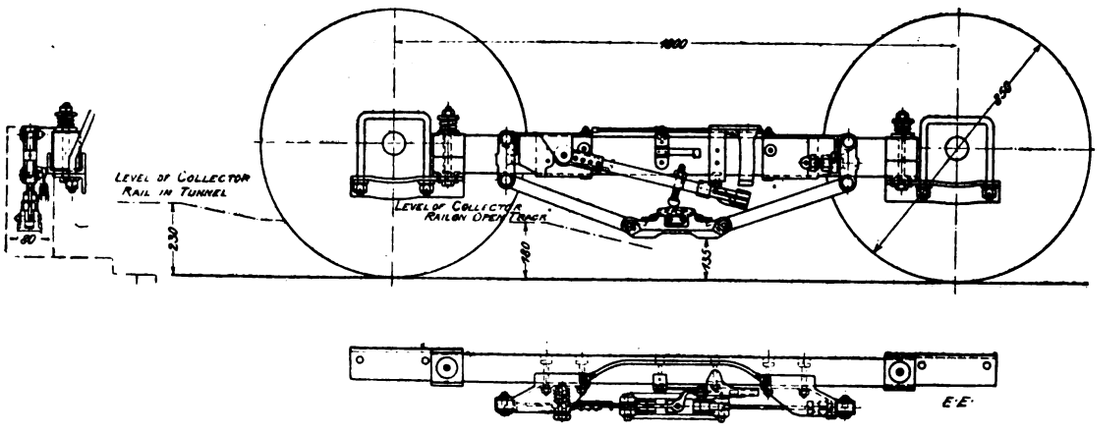

FIG. 11.—Details of Contact Shoe, Elevated and Underground Electric Railway, Berlin.

As already mentioned, the lighting main is run in the same manner as the feeder. The section of the lighting main is proportioned to maintain a pressure of 660 volts at the Warschauer Brücke stopping station when the lamps at all the stopping stations are burning, and the initial pressure of the supply from the generating station is 750 volts. At the stopping stations between the power-house and Warschauer Brücke the pressure of the lighting current is reduced to 660 volts by means of suitable resistances. With this pressure the arc lamps are supplied in series circuits of 12. Three 220-volt incandescent lamps are connected in series where incandescent lighting is required. When at the end of a working day, or in winter during the early hours of the morning, the lighting circuits of individual stations are cut out, the pressure in the lighting main would rise correspondingly were it not for a vulcanite centre parts of the insulators. To each length of metal composing the conductor rail an insulator with a flange is provided, so designed as to prevent movement of the conductor. The insulators for the feeders are of the double-bell type, the outer portion being of porcelain and the inner of vulcanite. The feeder itself is fastened to the insulators by means of tin caps. For the lighting main single porcelain insulators are employed.

Each train is to consist for the present of two motorcars, with an ordinary car sandwiched between. The motorcars have each a driving cab at one end, the cars composing a train being arranged so that there is a driving cab at either end. The construction of the motorcar is shown in Figs. 9 and 10, and that of the contact shoe in Fig. 11. The train is driven by the driver, who actuates the controllers and brakes from the front cab. The motors of each car are

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connected permanently in parallel. In starting ahead, the motors of the two motorcars are connected in series through suitable starting resistances. In starting backwards, the motors of the leading car only are used, likewise in braking, which is done by short-circuiting the motors.

(To be continued.)

ELECTRIC LIGHT AND POWER AT A DRAPERY WAREHOUSE.

A large installation, consisting of electric lifts, pumps, fans, incandescent and arc lighting, has just been completed at the new premises of Messrs. Jeremiah Rotherham and Co., Limited, 79-91, Shoreditch, N.E., the current being taken from the mains of the Shoreditch Corporation at a pressure of 150 volts. The power service mains are kept separate from the lighting service mains, and after passing through the Corporation fuses and meters are connected to two main switch and fuse distribution boards for power and lighting respectively. The power service board is arranged for five circuits, supplying three electric lifts, one electric pump, and one sub-distribution board controlling the 16 fans throughout the building. Each main circuit is controlled from a double-pole quick-break switch and double-pole fuse, and on the power service board is mounted an Evershed dead-beat ampere gauge and volt gauge.

The three electric lifts, one of which is for passengers and two for goods, are of Messrs. R. Waygood and Co.'s latest type. They consist generally of a worm gear running in oil, directly connected to an enclosed motor running at about 600 revolutions per minute. The worm gear is directly keyed on to the drum, which winds up the hoisting ropes, giving a speed, in the case of the passenger lift, of 160ft. per minute, and in the case of the goods lifts 100ft. per minute. The motor-controlling switch is fitted with a device to prevent the operator cutting out the resistance too quickly, and automatic overload and no-voltage circuit breakers are also provided. A further safety device is fitted so that if for any reason the distance between car and counterweight be varied, or should the rope slacken or break, a switch immediately opens, cutting off the supply of current to the motor, and should this fail to stop the car, it is immediately afterwards brought to a standstill mechanically by means of safety jaws brought into action upon the sides of the runner backings.

The electric pump was installed by the General Electric Company (1900), Limited, of London and Manchester, and consists of a 2-h.p. shunt-wound motor running at 1,000 revolutions per minute, driving, by means of a belt, a three-throw pump capable of pumping 1,140 gallons of water per hour against a head of 16ft. The pump runs at a speed of 45 revolutions per minute, and is geared down from the belt-driven pulley by a machine-cut spur wheel and pinion. A complete duplicate set is provided, together with a double-pole change-over switch, so that should one set get out of order, the other can be started immediately. The starting and stopping of the pump is automatically controlled by means of a copper float in the tanks, which puts a quick-acting double-pole switch on or off as the tanks are empty or full by means of a lever. This switch controls a General Electric Company patent solenoid motor-starter in the pump-room. The electric fans are of the well-known Blackman type.

The lighting service board is divided into three portions—for arc lighting, incandescent lighting, and house service respectively, the latter being metered separately from the rest. These circuits are further subdivided by means of switch and fuse distribution boards, of which there are two on every floor, from which the sub-circuits are run to supply the various arc and incandescent lamps. The maximum number of incandescent lamps supplied by any sub-circuit is eight, and each sub-circuit is controlled by a double-pole bridge-type fuse and single-pole tumbler switch. With few exceptions every lamp is furnished with a separate switch, and in large rooms the switches are grouped together on boards at convenient points. The arc lamps are of the Gilbert open single-carbon type, capable of running for about 18 hours without requiring retrimming. They are of five-ampere size, and are arranged in groups of three in series for 150 volts. Each lamp is fitted with a substitutional resistance for series running.

The total number of lamps installed in the new premises is about 850 incandescent and 36 arc lamps. The electrical installation was designed and superintended by Mr Reginald J. Wallis-Jones, M.I.E.E., A.M.I.C.E, of Messrs Wallis-Jones and Dent, 36, Great George-street, Westminster, in his capacity of consulting engineer, and the contractors for the work were Messrs. Simpson Bros., of Hapton, near Burnley, who also made and supplied the whole of the switch and fuse distribution boards.

THE EQUIPMENT OF A MODERN TELEPHONE EXCHANGE.

BY F. A. S. WORMULL, ASSOCIATE.

Telephone exchanges have already formed the subject of several interesting papers which have been read before our society in London, but as telephony, like all other branches of electrical science, is progressive, I trust that this paper of mine will not be a case of "bringing coals to Newcastle."

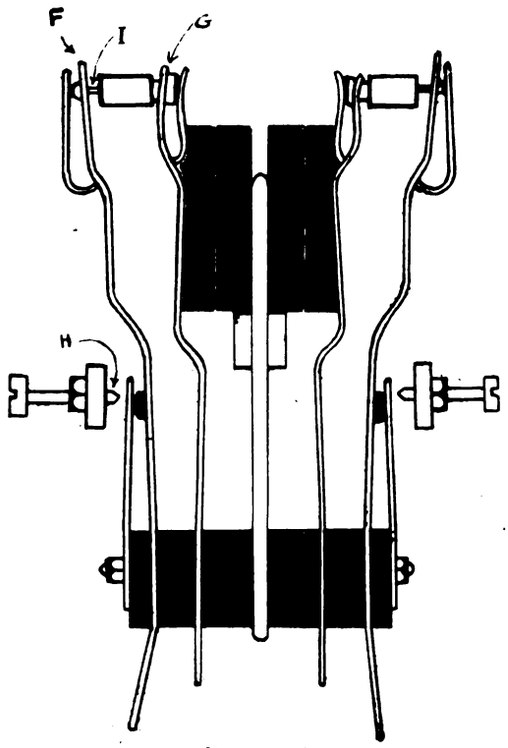

DIAGRAM 1.

The three systems I have selected for description may be taken as representative of the most recently built exchanges in this country. I will avoid, as far as possible, an expression of preference for either,* but will describe the merits of each, and will give the number of movements an operator has to make in each case to effect a connection or a disconnection. This must not, however, be taken as a sole test of merit, for although the question of operating is one of the most important the telephone engineer has to consider when designing a switchboard, he must also take into consideration simplicity of apparatus, for, other things being equal, the simpler the switchboard and attendant apparatus the better. If complicated apparatus is to be introduced, in order to reduce the work of the operator, or to give additional facilities to the subscriber, the amount of the reduction of work, or the value of the additional facilities, must be weighed against the increased liability to faults through any complication of the apparatus. As the majority of the apparatus used in a telephone exchange is well known to most of you, I have not attempted to explain it in detail, but I have samples here for your inspection, and will be pleased to give a description of any particular part, should anyone desire it.

The first of the three exchanges I have selected is fitted with series jacks and hand-restored indicators. The line connecting the subscriber's office with the exchanges is led into the testroom and connected to a device for protecting the exchange apparatus from lightning, or heavy power currents, which may, through an accident, find their way over the subscriber's line. This device is designed to

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, Feb. 17.

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protect both lines, but a description of one side is all that will be needed. The lightning protector (Diagram 1) consists of two blocks of carbon, separated from each other by a thin sheet of mica, in one of which a small hole has been drilled, and filled with fusible alloy. These are held in position, and against the frame plate, by springs, G.

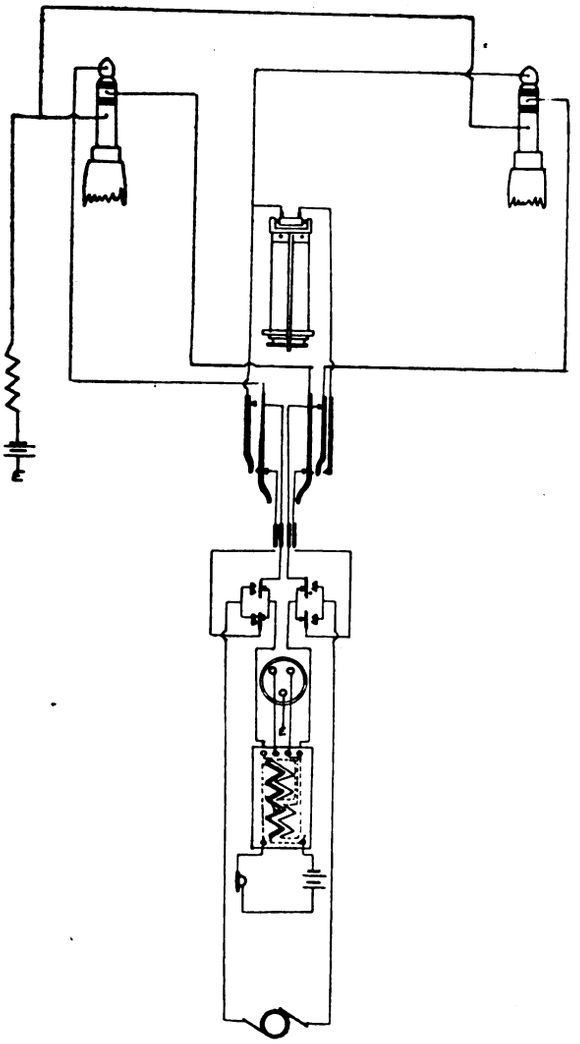

DIAGRAM 2.

For a protection against the power current, a small coil of German-silver wire is wound round a thin tube filled with fusible alloy, into which is inserted a pin with a somewhat enlarged head. This coil fits into slots provided in the springs G and F, the spring G, to which the outside wire is connected, holding the base of the coil, which is insulated from the frame, but in connection with one end of the German-silver wire, the other end of which is connected to frame of bobbin, and the pin shown on diagram as I is held under tension by the spring F, to which the line leading to the exchange is connected. Should the outside line be struck by lightning, a discharge will take place between the two carbon blocks, which will soften the fusible alloy, and put the line direct to earth by short-circuiting the two carbon blocks. Should a contact occur between the line wire and, say, the trolley wire of the tramways, the current will find a path through the German-silver wire on coil and heat the cup in which the pin is held, soften the fusible alloy, and the tension on spring F will cause the pin to be withdrawn, thus breaking the circuit between the inside and outside lines. At the same time the releasing of the spring F will close a circuit through the contact at H, and indicates to the inspector in charge that trouble has occurred on that particular section of the protection board. The bobbin and the fusible alloy are so adjusted as to allow a current of one-half ampere to pass without operating the device.

From the protecting device the lines are carried by means of separate leads to the test jacks, which consist of rows of springs arranged in groups of four, each four forming one subscriber's test point, the line wires being connected to the two top springs, and the exchange cables to the lower. This will enable the inspector, by means of a suitable plug and test set, to ascertain the condition of either of the four wires separately. Covering the aperture in front of each set of test springs is a small metal flap, which automatically opens or closes on the insertion or withdrawal of the test plug, thus protecting the contacts from the dust, which in earlier patterns of test jacks was a source of considerable trouble. From the test jacks the lines are led to the line springs on the switchboard proper (Diagram 3), first to the Post Office junction section, thence in series through the National junction board to the subscribers' sections, and, lastly, to the home section jack, or jack in front of the operator, whose duty it is to attend to that particular subscriber's wants, thence to the indicator, the latter consisting of an electromagnet, wound to a resistance of 100 ohms, controlling the shutter or indicating disc. On the face of each jack is a metal ring, connected to each similar ring on every other jack of the same subscriber's number in the exchange, the circuit being totally separated from the speaking circuit. This is for the purpose of enabling any operator in the room to ascertain whether the line is in use on any other part of the switchboard. The operator's set and connecting-cord circuits (Diagram 2) are equally simple, three-point plugs and three-conductor cords are used in conjunction with a listening key for each pair of cords, and a double ringing key common to the pairs of cords forming an operator's position.

The speaking circuit, when the listening key is in the through position, is as follows: The tips and rings of the two plugs are joined together through the listening key, and an indicator wound to a resistance of about 1,000 ohms, and sheathed with iron, so as to give it high impedance, is bridged across the circuit. The body of the plug, which makes contact with the ring in front of each jack, does not come through the listening key, but is connected to a wire common to the whole of the exchange, which, in turn, is connected to a battery and earth through a resistance coil. It will be noticed from the diagram that this circuit is entirely independent from the speaking circuit, and necessarily so, otherwise the earth would cause a noise to appear in the speaking circuit.

In the operator's instrument set, the only apparatus that needs any description is the differentially-wound induction coil and receiver. These are necessary, so as to enable the operator to go into circuit of two subscribers talking without upsetting the balance of the lines, which the earth on her instrument would otherwise do, and to enable her to ascertain whether the line wanted is engaged at any other section of the board. When the listening key is down, the operator's instrument is bridged across the cords, and the indicator cut out. The circuit is then from the tips of the plugs to the contact of the listening key, through the ringing key, to the outer end of one half of the induction coil, through the receiver to the inner end of the second half of the coil, thence back to the rings of the plugs. The test signal is given to the operator by a noise in her receiver, caused by the earth current put on to the ring of the jack by the body of the engaging plug passing from the tip of the testing plug, through the listening key, through the ringing key, through one half of the differentially-wound induction coil, through one half of the receiver, to earth.

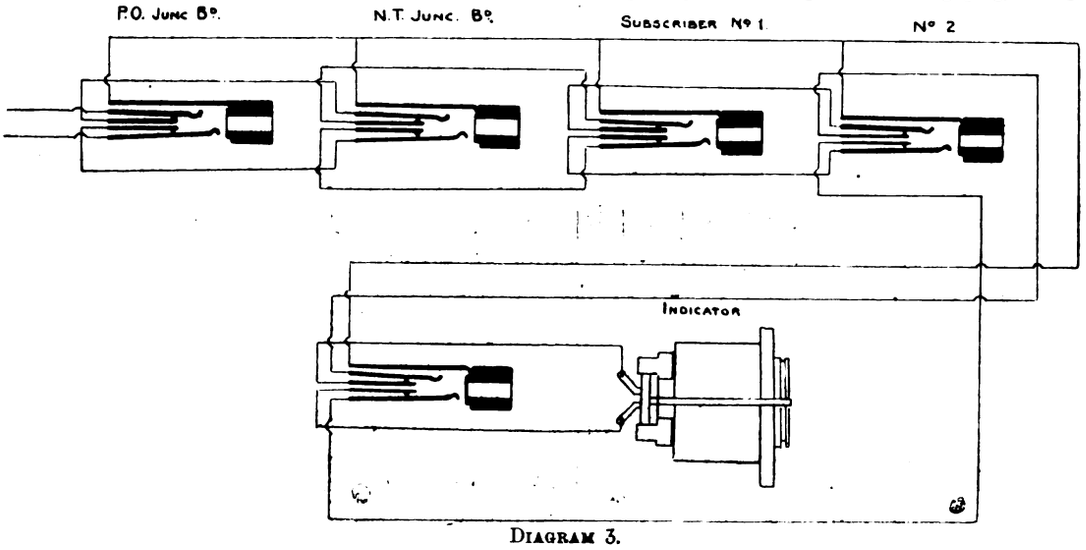

DIAGRAM 3.

The number of movements an operator has to make on this system to effect connection is five, as follows: (1) insert plug and answer; (2) insert corresponding plug into number wanted; (3) ring wanted subscriber; (4) restore listening key; (5) restore indicator; and for disconnection, four: (1) pull down key; (2) challenge line; [(3) pull out plugs; (4) replace ring-off indicator.

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With the relay calling and clearing system, the lines, after passing through the test-room, are brought to the jacks in the exchange in a manner similar to that described in the series system, the only difference being that the two inner contacts of the home section jack are joined together and connected to a 250-ohm relay to battery and earth. The test circuit shown on Diagram 5 is also somewhat different, the line being engaged by means of an extra spring and contact provided on the jack instead of by the body of the plug and the third conductor of the cord. I might mention that the system of engaging the line is not an essential part of the relay calling system. I have

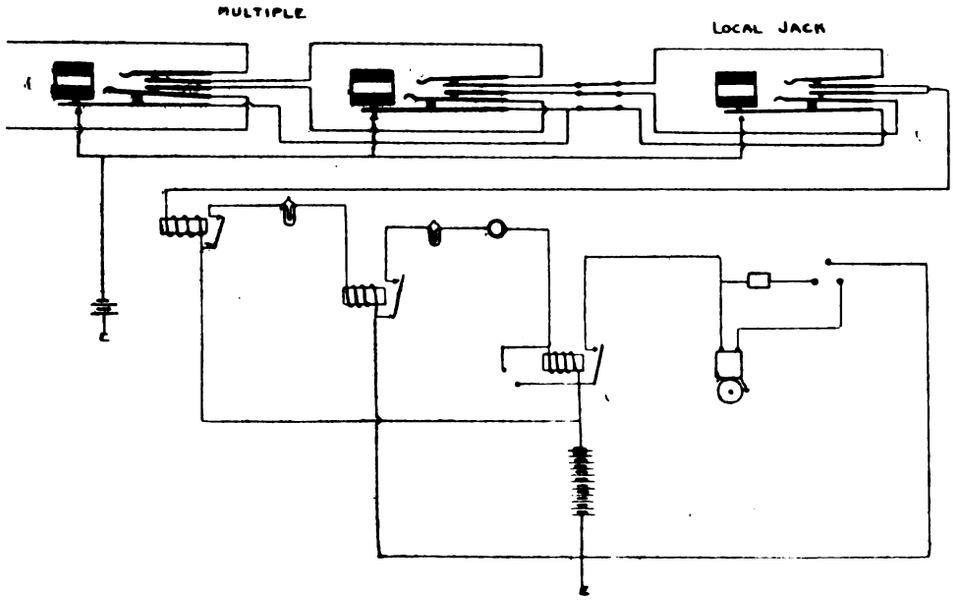

DIAGRAM 5.

selected to describe this method as an alternative to the method given on the series system. You will notice that on the insertion of the plug the line springs are lifted from the inner contacts, thus cutting off the relay and battery, and the test spring is also lifted from contact with the test ring, and pushed outwards, and forced in contact with a stud, connected to which is an earth battery. The test springs of each jack of the same number in the exchange being joined together, and in their normal position in contact with the test rings, the current of the earth battery will be on the test ring of each jack in the exchange, corresponding with the number of the engaged line, except the test ring of the jack into which the plug is inserted.

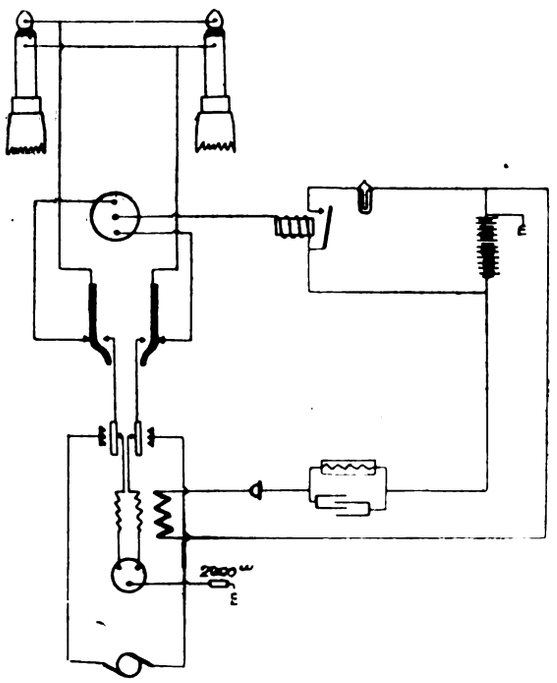

DIAGRAM 6.

The armature of the 250-ohm calling relay is connected to one side of the battery, and a contact to which the calling lamp is brought is provided in such a position that on the relay being energised the armature will close the circuit through the calling lamp, and for each operator's position a second relay of very low resistance—about two ohms—is provided, connected in the return wire common to the bank of calling lamps forming that position. The armature of this relay is connected to the positive side of the battery, and the contact joined to the pilot lamp and supervisory lamp on chief operator's table in series, this relay, being in series with all the line relays for the operator's position, will respond simultaneously with any one of them. From the supervisory lamp the circuit is carried through the night-bell switch to the negative pole of the battery; or if the night-bell switch is to the night position, through another two-ohm relay, the contact on the night-bell relay being through bell to battery. The night-bell relay is, as its name denotes, for the purpose of giving an audible signal, in addition to the visual signal, after the busy hours of the day.

The operator's connecting-cord circuit is shown in detail on Diagram 6. The two tips and two bodies of the plugs are joined together, and connections are taken through the listening key, through the ringing key, and differentially-wound secondary of the induction coil to the receiver, the centre point of which is to earth, through a 2,000-ohm simple resistance: the object of this resistance being to reduce the amount of current passing through the receiver, and consequently the click, which might otherwise be detrimental to the operator's hearing. It will be noticed from the diagrams that the operator's receiver in this, as in the series system, is in the middle of the secondary of the induction coil. With the listening key in the through position the instrument is cut out, and the line is bridged by a differentially-wound retardation coil, the centre point of which is connected to a 250-ohm relay, thence to negative pole of the earthed battery. The armature of the clearing relay is also connected to the same pole, and the relay contact to the clearing lamp and earthed side of the battery. The microphone circuit is also interesting, for, as it works off the common battery of 24 volts, it requires to be specially dealt with to protect the microphone from the excessive current, and for this purpose a 160-ohm retardation coil is placed in circuit shunted by a condenser of two microfarads capacity.

The subscribers' instruments, although not properly within the scope of this paper, require a little description, for, in addition to the magneto ringer necessary in the series system, a special calling-key relay has to be provided (this relay is shown on Diagram 7). One end of the relay coil is connected to the subscriber's line wire, and the

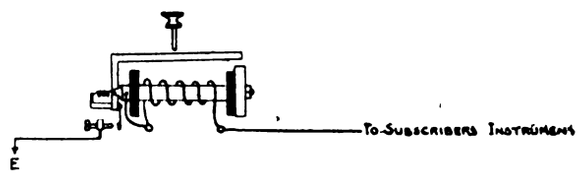

DIAGRAM 7.

other end to the frame of the relay; a special stud with adjustable contact is connected to earth, and so placed that on the armature being depressed by means of the call button, the subscriber's line is earthed through the coil of the relay.

The operation of the system is as follows: A subscriber desiring to initiate a call, presses the call button, thus earthing his line as previously described. This draws a current from the central battery, through his line relay, over both lines, through the call-key relay. Both relays being thus energised, the calling relay is held down, the line signal relay being also in operation, causes the lamp in the exchange to light, signifying that the subscriber requires attention, the lamp remaining alight until the current is removed by the insertion of the operator's plug. The cutting off of the current at the exchange, releases the armature of the line signal relay, and extinguishes the lamp. It also allows the calling-key relay to return to its normal position, thus signifying to the caller that the operator is on the line. After the number has been taken and the connection made, the listening key is put up, and the clearing relay is then in circuit. On completion of the conversation either subscriber can give the clearing signal by pressing his calling key, which earths the line and draws current from the central battery through the clearing relay, through the differentially-wound retardation coil to lines, and calling-key relay to earth, thus bringing both the clearing relay and calling-

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key relay into operation, lights the clearing lamp at the exchange. This remains alight until the operator pulls down her key, cutting off the central battery, extinguishing the lamp, and causing the button of the subscriber's calling key to return to normal, thus giving him a visual indication that his line has been cleared. With this system it is possible for any two subscribers to convert their exchange line into a private line—that is to say, after obtaining communication with the desired number, they can ring one another by means of their magneto-generators without actuating the clearing lamp at the exchange, but either of them can obtain the attention of the exchange by pressing their call button.

The number of movements necessary on the part of the operator to effect connection by this system is four—viz.: (1) insert plug and answer; (2) insert corresponding plug in number wanted; (3) press button to ring subscriber; (4) put up listening key; and for a disconnection, two: (1) pull down listening key, thus putting out the lamp; (2) pull out cords. The current necessary for working this system is obtained from a battery of 11-cell accumulator, charged by preference by a motor-generator working off the town mains. It is, necessary, of course, to duplicate both the battery and the motor-generators, so as to avoid the possibility of a failure of current due to breakdown of the generators or accident to the batteries.

The third system is what is generally known as the Western electric common battery relay switchboard, in which system both the signalling and speaking current is supplied from the central source of energy, thus removing from the distant station one of the most fruitful sources of trouble—viz., the battery for working the transmitter. The lines, after passing through the test-room, are brought to a distribution

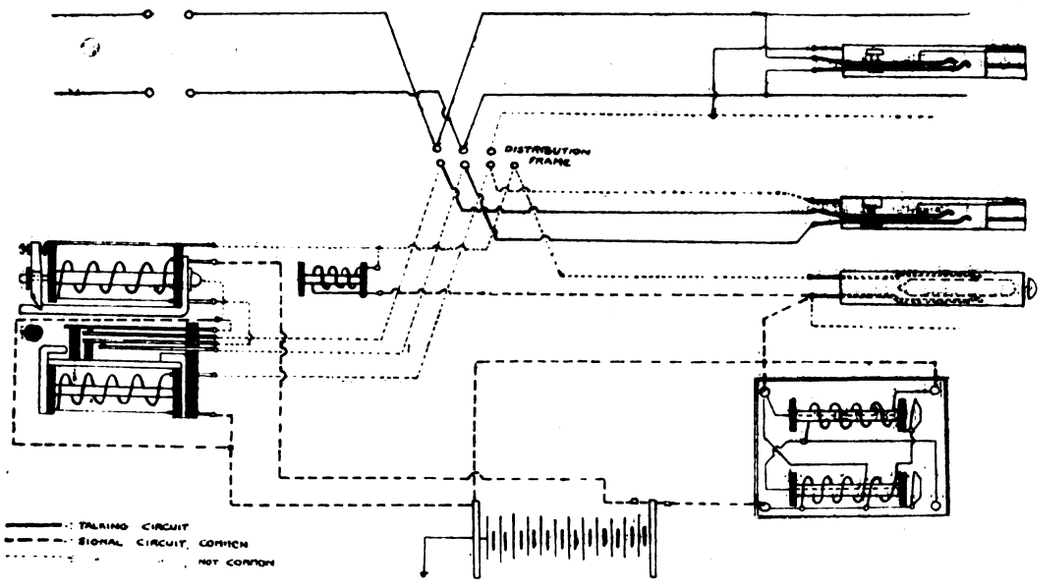

DIAGRAM 9.

frame This consists of a series of double tabs, arranged in groups of three in blocks of 60 on the one side and in groups of four double tabs in blocks of 80 on the other. These blocks are supported on an iron frame, one side in horizontal rows and the others vertically. The two sets of tabs are held about 3ft. 6in. apart, and insulated rings are provided midway between them. The lines from the test jacks are brought to the horizontal side of the frame, and cables from the multiple of the switchboard are brought to the same set of tabs and soldered to one side, the cable from the switchboard containing 63 wires laid up in threes, the odd wire being that in connection with the test circuit. From the four-way double tabs on the vertical side cables are led to the home section jacks and calling lamps, and also to the relays controlling same, four wires for each subscriber's circuit being taken to the switchboard—viz., two to the line springs of the home section jack, one to the test circuit, and a fourth to the calling lamp. Four wires are also carried to the relay frame, two from the line tabs to the cut-out springs of the cut-off relay, one from the test tab to the winding of the cut-off relay, and the fourth to the calling-lamp contact on the line relay. It will thus be seen that the lines on the horizontal side of the distribution frame are arranged in numerical order, or similar to that of the multiple of the switchboard, and on the vertical side in order of the home section jacks and calling lamps. The object of this distribution frame is to enable the work of each operator's position to be equalised by distributing the very busy subscribers equally between the operators' positions. This is done without disturbing the numerical arrangement of the subscribers over the multiple. The fact of the subscribers not being in numerical order on their calling lamps is not important, as the calling lamp of each subscriber is placed adjacent to his home section jack, and all connections with the numbers wanted are made on the multiple.

The second use of the frame is to provide a convenient point at which the wires between the home section lamps and the relays and the lines from the testboard and the multiple can be joined. The distribution of the lines over the operators' positions is made by three-conductor cable, each wire being separately insulated, and the whole covered with an asbestos braidlng. The three wires are coloured green, pink, and purple respectively, the green and pink being soldered to the line tabs, and the purple to the test tabs on the horizontal side of the frame. They are then passed through the insulating rings corresponding with the operator's position on which the subscriber's calling lamp is situated, and soldered on to the first three tabs, which are connected to the two lines and test of the home section jack. The relays are fixed on an iron frame in the same room, and arranged in bays and in rows of 10, the line and cut-off relays being fitted on the

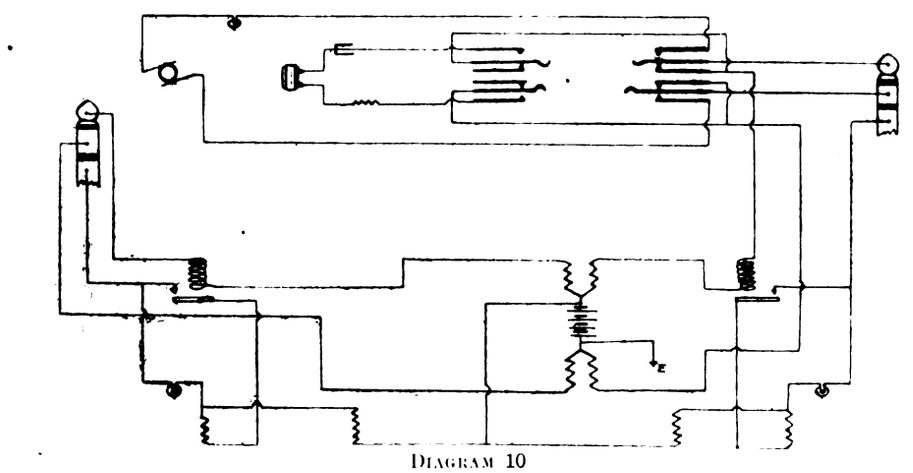

DIAGRAM 10.

same base plates. These are arranged in the same order as the vertical tabs on the distribution frame—viz., in the order of the home section jacks on the operators' positions. I have a sample of the line and cut-off relays here, but perhaps they deserve a short escription.

The line relay consists of a single coil wound to a resistance of 83 ohms, and in front of the free end of which is a disc armature, turned to a knife-edge, and balanced in a slot in a piece of iron, which forms an extension to the pole of the relay nearest the base plate, the disc being controlled by a regulating screw through the centre. In the front of the relay a contact point is provided, to which the calling lamp is connected, and in such a position as when the armature is attracted a circuit is formed through the disc armature and the contact point referred to.

The cut-off relay is slightly more complicated. It consists of an electromagnet wound to a resistance of 37 ohms. The pole-piece of the

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free end of the magnet is extended, and bent at right angles, so as to be parallel with the core, and overlapping the outside of the bobbin. A flat armature is supported on a pole-piece fixed to the base-plate end of the magnet. Parallel with the armature, four spring contacts are fixed normally in contact in pairs. The outer springs are controlled by insulated studs on the armature, so that when the relay is energised, the two pairs of springs are lifted apart and the line signal circuit broken.

The repeater coil, which is placed between the battery and the connecting cords of the operator's set, consists of four coils of equal resistance (37 ohms) wound in pairs round an iron core, the two coils to the positive side of the battery to which the tips of the cords are connected being wound on the right-hand side of the core, as shown on Diagram 8, and the two negative coils, or those connected to the rings, on the left. The two wires of each pair, being wound on together, are equal in the number of turns, and also equidistant from the core. The object of this repeater is to divide the cord circuit into two parts for signalling purpose, without interfering with the efficiency of the speaking circuit. The 63-wire cable from the horizontal side of the distribution frame is carried through multiple of the switch-board, first to the jacks on the junction section, then on to the subscribers' sections, in a manner similar to that described in the series system. The jacks, however, in this system differ from those previously described, the lines being carried through the board in parallel, so that the insertion of a plug in the first jack of the multiple will not disconnect the remainder of the board. The advantage claimed for the parallel jacks over the series jacks is that the number of loose contacts in the circuit is reduced. The test circuit in this pattern jack, as in the former, is completely insulated from the line springs, and extended so as to pass through the winding of the cut-off relay. The home section jacks and lamps are arranged in groups of 100, each group forming an operator's position, and immediately in front of which the operator's connecting cords and supervisory lamps are placed. The operator's set and connecting-cord circuits are very much more complicated in this system than in either of those previously described. Three-point plugs are used in conjunction with three-conductor cords, a combined ringing and speaking key, special repeating coil and relays for controlling the clearing lamps.

The connecting-cord circuit is as follows: From the tip of the answering plug connection is taken through the coil of the relay controlling the supervisory or clearing lamp of the answering plug, through one-half of the repeater coil to the relay controlling the clearing lamp of the calling plug, thence through listening key to tip of calling plug, from the ring of the answering plug through the other half of the repeating coil, through listening key back to ring of calling plug, from the body of the answering plug through the answering plug clearing lamp, to an 83-ohm simple resistance coil, thence to negative side of battery; from the body of the calling plug, through the calling plug clearing lamp, through 83-ohm coil to battery. There is an alternative path for the current from the battery to body of plugs through a 40-ohm simple resistance, this path being controlled by the armature of the supervisory relays.

In order that the calling circuit may be followed, a short description of the subscribers' instruments must be given. These consist of a specially-wound induction coil, having a ratio of 1 to 2, transmitter, receiver, switch-hook, magneto bell, and a two-microfarad condenser, joined up as shown on Diagram 11. It will be seen that when the receiver is on the hook the circuit is open as far as continuous currents are concerned, but a circuit is available for alternating currents through the condenser and magneto bell. When the receiver is off the hook, the two lines are short-circuited through the 15-ohm primary and transmitter.

A subscriber's calling circuit is as follows: From the "A" line through cut-off springs on the cut-off relay, to winding of signal relay, to negative side of battery. From the "B" wire to cut-off springs on cut-out relay to positive side of the battery. A subscriber removing his telephone from the hook closes the circuit through the low resistance of his primary, thus energising the signal relay, which closes the local circuit in which his signal lamp is connected, indicating to the operator that he requires attention. On the operator inserting the answering plug the cut-off relay is energised by the current from the body of her plug, passing through ring of calling jack, through the winding of cut-off relay, to positive side of battery. The lifting of the armature of the cut-off relay forces the cut-off springs apart, thus breaking the circuit between the subscriber's line

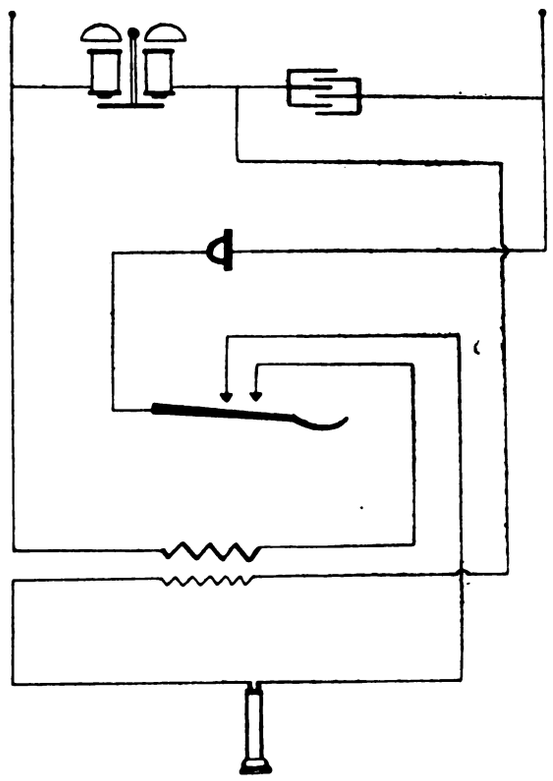

DIAGRAM 11.

and calling relay and extinguishing the signal lamp. The number wanted being ascertained the operator takes the corresponding calling plug, and taps on to the ring of the jack of the number asked for, and if her receiver remains silent inserts the plug. The current on the body of the calling plug causes the supervisory lamp to light, which remains alight until the wanted subscriber removes his telephone from the hook. The supervisory lamp of the calling plug is extinguished when the supervisory relay becomes energised by the current drawn from the battery through the ring of the plug, through the primary of the subscriber's instrument, back to the tip of the plug and battery. This shunts the current from the supervisory lamp through the alternative path before mentioned; or, in other words, the insertion of the answering plug cuts the line relay out of circuit, and inserts the supervisory relay for the reception of any subsequent signal from the calling subscriber. The insertion of the calling plug cuts the circuit of the line relay of the wanted subscriber, thus preventing a call being given on the home section lamp, when he removes the receiver from the hook to reply to the call. The

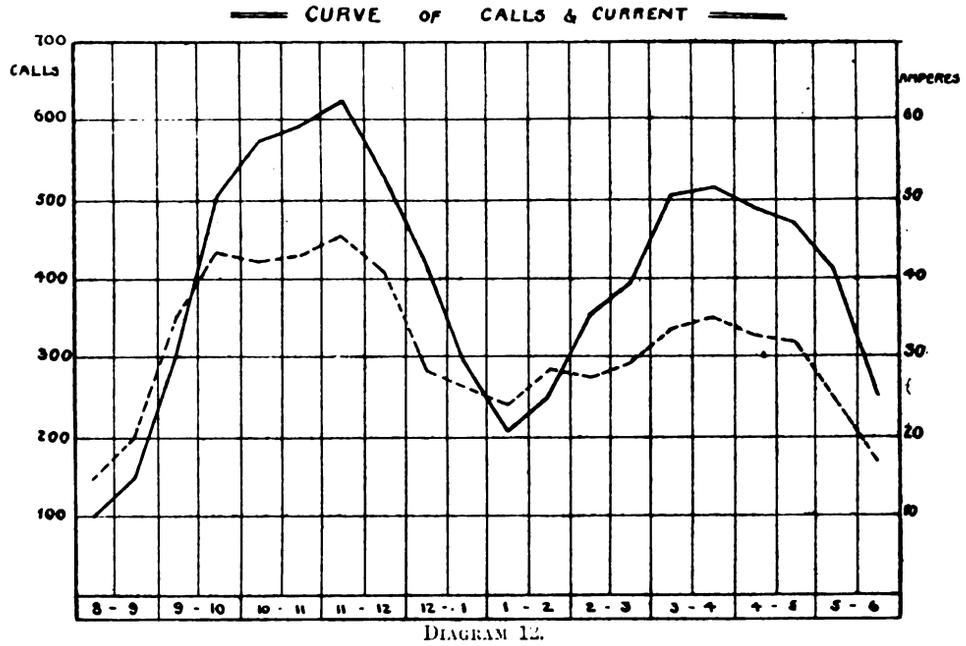

DIAGRAM 12.

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supervisory lamp of the cord circuit now becomes his means of signalling with the exchange. On a connection being completed, and both supervisory lamps extinguished, the operator knows that the two subscribers are in communication; the hanging up of either of the subscribers' receivers will cause the lamps to light, and when both lamps are alight the operator knows that the conversation is completed, and proceeds to withdraw both plugs without challenging the line, which restores the line calling relays to their normal position.

The number of movements to effect a connection in this system is four—viz.: (1) insert plug and answer; (2) insert corresponding plug in number wanted; (3) ring subscriber wanted; (4) replace listening key; and for a disconnection, two: (1) pull out plugs; (2) pull over listening key.

The current for working this system, although normally taken from a set of 11-cell accumulators, is actually, during the busy hours of the day, taken direct from a specially-wound dynamo, with the accumulators bridged across the discharge mains, the unutilised current from the dynamo being absorbed by the cells. The dynamo is a six-pole shunt-wound machine, driven at 1,100 revolutions per minute, capable of giving a current of 200 amperes at 30 volts, and is coupled direct to a 12-h.p. four-pole shunt-wound motor, running off the town mains.

In this system it is not essential that a duplicate battery should be provided, but duplicate motor-generators are necessary in order to avoid a breakdown. This system, as previously mentioned, works equally well without the accumulators being bridged across the discharge mains, but in order to work economically, and avoid the necessity of running the machines during the quiet hours, the accumulators are provided, so that they may be switched into circuit to replace the dynamo when the current curve falls to a low figure. The power circuits do not call for any special description; the leads from the machines are carried to the power switchboard, fitted with the necessary starting and controlling switches, a voltmeter for taking the condition of each cell, and ammeters to the various discharge 'bus bars, so that the inspector in charge may keep a record of the current taken by the various circuits. From the power switchboard discharge mains are led to main fuse board, as shown on Diagram 14, from which the various circuits of the switchboard are fed through suitable fuses. A main is also taken to the 'bus bars of the coil and relay rack fuse board, supplying the current to line relays and repeater coils. Diagram 12 is a curve of calls and current, the figures on the left being the number of calls in hundreds, those on the right the number of amperes, and the vertical lines the half-hours of the day. The black line is the curve of calls taken in half-hours, and the dotted line the amperes over a similar period.

EARTH CURRENTS DERIVED FROM DISTRIBUTING SYSTEMS.*

BY E. BASIL WEDMORE, ASSOCIATE MEMBER.

(*Concluded from page 305.*)

In the light of the above we are amply justified in concluding that we know the distribution of magnetic force in the neighbourhood of a traction system, and that we know the direction of the current streams near the surface of the earth, but further information is required before we can calculate their strength, for if the current flows in a plane of relatively small thickness the current density at any point will be *inversely as the distance* between the lines of current (see Fig. 4), while if the current flow through the body of the earth the current density at any point will be *inversely as the square of the distance* between the current lines at that point. At Stockton we have seen that the horizontal component of the magnetic disturbance at a point 0·8 mile from the line was 15×10^{-6} absolute units. If the earth is a solid conductor, the fall of potential along the current stream must have been at the rate of about one volt per 60,000 yards. If the current sheet be 250ft. deep, the voltage drop must have been about one volt per 1,000 yards. At greater distances from the line the difference between the two results will be largely increased. In calculating these values the specific resistance of the earth has had to be considered. I shall how shortly how this was arrived at.

Meanwhile, let us continue the examination of the point at issue. When the bonded rails for the track of the London United Tramways Company were laid, it was found by experiments on some 2½ miles of track that there was a variation of potential occurring along the rail such as would be caused by traction systems, and such as would correspond to a flow of + or − 15 amperes along the rails. The current alternated in direction. The mere fact of the rails collecting such a large current would show that the conductivity of the return path in the neighbourhood was considerably improved by the rails, so that the voltage drop before the rails were introduced must have been still higher. The voltage drop was as high as about 0·2 volt per mile, which, considering the distance of the nearest traction system, points to a current sheet. Fall of potential tests made at divers places by divers persons give values at least as high as the figure given for a 250ft. current sheet, which makes it probable that often, if not always, the currents return in a sheet of comparatively small depth. In light of these considerations additional interest will be attached in future to such tests.

Let us now consider the conditions holding in the immediate neighbourhood of the track where the current densities are greatest. In a paper previously alluded to, Mr. Evan Parry has shown that there is an apparent resistance between the rail and the body of the earth of about 740,000 ohms over a square inch. This is equivalent to about 5,000 ohms over a square foot, so that if the rail was at a potential of five volts above that of the earth, the maximum current density would be less than one-thousandth of an ampere per square foot, and this would rapidly decrease as the distance from the rail increases. I have already shown how to estimate the paths of the current streams through the earth. Consider the path of any portion of the current flux. The current leaves the rails, enters the earth, spreads out into a larger and larger stream as it leaves the track, curves round towards the point of return, converges on to a distant part of the rail and enters the same again. Now, on its path it meets with certain resistance offered by its earth path, possibly certain resistance offered at the contacts between rail and earth, and possibly with certain electrolytic E.M.F.'s. We know the total apparent resistance of the whole path. If we assume that the whole of the resistance is that offered by the earth, and with that as basis calculate the specific resistance of the earth, we shall be over-estimating rather than under-estimating the value of the same. On several occasions since March, 1900, I have approached this question, having estimated as accurately as possible the dimensions throughout of one or more current paths through the earth, based on measurements made in England and Ireland, and again on Mr. Parry's published data. Given the dimensions, the calculation of the specific resistance is easy. The values obtained have always been in the neighbourhood of 75 ohms per yard cube. We may compare this with the values of 50 ohms per yard cube for clay containing about 60 per cent. of moisture and 35 ohms for sand containing about 8½ per cent. given by Herrick.

Dr. Fleming, in an important paper read at the meeting of the British Association, at Bristol, in 1898, gives a value of 17 ohms per yard cube for clay, based on laboratory measurements, and one ohm per yard cube for sand wetted with salt water—a figure which is interesting in connection with Mr. Trotter's experiments on voltage drop near the sea in Cape Colony. Dr. Fleming gives reference to experiments made in 1896 by Dr. St. Lindeck at Berlin, in which the following results were found:

Cement in normal condition	50	ohms per yard cube.
Cement after 22 hours soaking in water	15	,, ,,
Cement artificially dried at 100deg. C. for 5½ hours	270	,, ,,
Concrete, one part cement, five parts gravel, minimum value	25	,, ,,
Concrete after drying	500,000	,, ,,

We may apply the value of the earth's specific resistance to the estimation of the current that would flow into a pipe of a given diameter, given the potential difference between the pipe and the body of the earth.

Let r_1 = radius of the external circumference of the pipe, in inches;
r_2 = a larger radius measured from the axis of the pipe into the earth, in inches;
K = specific resistance of the earth = 2,700 ohms per inch cube;

then R, the apparent resistance of the earth over a square inch of pipe surface, is given by the following:

$$R = 2{\cdot}303\ K\ r_1\ (\log r_2 - \log r_1),$$

from which we may calculate the current density for a given voltage. If we allow, taking into account the spreading of the current as it leaves the pipe in a direction parallel to the axis of the pipe, that the whole resistance will be practically equal to that reached at a radius of 1,000in. without spreading, then inserting 2,700 for K, we have

$$R = 6{,}000\ r_1\ (3 - \log r_1).$$

For a 10in. pipe we have R = 69,000, while for a 2in. pipe R = 18,000 ohms—that is to say, the smaller the pipe the less the resistance over a square inch of surface. This is, perhaps, an unexpected result. In estimating the value for K, it was found that one-fifth of the resistance to the earth currents is encountered in the first 10ft. of ground, and about half in the first 100ft. The value obtained, therefore, is not materially affected by any considerations as to whether the currents penetrate below a depth of a few hundred feet or so. It might be thought that the presence of pipes in the surface layers of the earth would so materially improve the conductivity near the surface that return currents would be almost confined to that region. Were this the case, however, the conductivity would be largely dependent on the state of the weather. So far as I can discover, all experiments on a large scale have shown the contrary to be the case. I have attempted to discover traces of electrolytic E.M.F.'s by a careful comparison of the theoretical curves given by Mr. Parry with curves obtained in practice, but have been unable to obtain any positive evidence. In general, the agreement and general reliability of the curves in cases where the E.M.F. is both below and above that necessary to decompose water would seem to be additional evidence that the conductivity of the earth did not depend much on electrolytic actions. Experiments made by Mr. George Claude, and communicated to the Société des Electriciens in July, 1900, showed that if a current was passed between lead plates buried in the earth with a potential difference of 23 volts, the amount of decomposition produced was as though only 40 per cent. of the current had been flowing, and this figure was reduced to 4 per cent. if the voltage was reduced to one volt. Herrick has given a figure corresponding to the latter for iron plates.

Recent observations tend to show that in the past electrolytic troubles have been very much overrated, and that in many cases corrosion not due to earth return currents, but to the usual taxies levied by Nature from the users of inferior metal, have been attributed to the return current. Cast iron has been found more free from corrosion than wrought iron, and oxides produced at the seat of electrolysis increase the resistance and reduce the electrolytic current. It is quite a different matter when one comes to consider the effects due to leakage in connection with the earthed middle wire of a three-wire lighting system. In this connection, the formulæ developed above for the current density in the surface of small pipes will be found of interest. To

* Paper read before the Institution of Electrical Engineers.

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those who are not accustomed to figuring the insulation resistance of thick dielectrics on thin wires, some of the deductions which may be made from the formulæ referred to may prove curious. For instance, in the limit where the wire is very small it will be seen that the current density is inversely proportional to the radius of the wire. Now, the current density is a measure of the rate of change of potential through the dielectric. For a given E.M.F. we may increase the dielectric strain up to any limit we please, even above the breaking limit, if only we make the wire small enough. The notion that there is a practically constant resistance between tramrails and the body of the earth, now well proven, serves to simplify the consideration of many problems depending on the nature of the earth return. As an example a brief consideration will be given to the question of bonding water-pipes to the rail in the neighbourhood of the traction station—a question in which some difference of opinion has already arisen in at least one quarter. The primary object is to reduce both the *area* of pipe *out* of which current is flowing, and to reduce the *density* of the outward flowing current. If there is no connection between the pipes and the rail, the current flowing into the surface of the pipes must equal the current flowing out of the surface of the pipes, and when either is a minimum both will be a minimum. The rail being disconnected from the pipes, its potential will be such that the sum of the resistances to the inward and outward flowing currents will be a minimum. A point about the middle of the rail will be at zero potential, the further end + and the station end −. The earth current will also be a minimum. If, now, the + or further end of the rail be connected to the pipes, the area over which the current leaves the pipes will be considerably augmented, but the area of rail − to the earth will also be considerably augmented, thus increasing the total leakage current. If, however, the − end of the rail be connected to the pipes, the rail as a whole will be positive to the earth and the pipes as a whole will be negative to the earth, the amount of current leaving the pipe surfaces being a minimum. The pipes may now be considered as an extension of the rail, and the best protection will be obtained when the point of junction is at the earth's potential, other things being equal. The currents entering and leaving the pipes must be equal, *but no current now leaves the pipe surface.*

We have now, however, very largely increased the currents carried by the pipes. While this may be to the advantage of the current user, it may not be so to the pipe owner. At each bad joint the current will leave the pipe over a limited area at a high density and return again further on. The smaller the pipe, the higher the current density. If, moreover, the pipes are conveying electrolysable liquids internal as well as external, damage may ensue. If one had it in one's power to lay both pipes and track in the best possible manner, it would seem best where metal pipes are used to use cast iron, to introduce resistance at every joint, to introduce any possible surface resistance, and to avoid all connections with the rails, leaving the rails to take their own potential.

In conclusion, may I express the hope that this paper will serve to at least draw attention to the lack of information on this important subject, and that in the discussion that follows will be found the key for future investigations?

Discussion.

Dr. R. T. Glazebrook sent a communication on the above paper, which was read by the Secretary, as follows: "Mr. Wedmore has referred to papers on the same subject published in the *Phil. Mag.* for last April by Prof. Rücker and myself. Prof. Rücker developed his theory, as Mr. Wedmore points out, on the assumption that the track is uniformly grounded, and that leakage, according to Fourier's law, goes on along its length. I stated in my paper, however, that the application of this to practical problems is somewhat complex, and that it suffices to suppose that all the leakage current leaves the track at the car and returns to it at the power station. Thus, Prof. Rücker's equations are simplified, and those which I have used (pp. 433 and 441 *loc. cit.*) are identical with the equations developed by Mr. Wedmore. For C, the leak current, I have used symbols $I\,k$, I being the current in the trolley wire, and k a leakage coefficient, which, as Mr. Parry showed, depends on the length of the line and on the conductivities involved, while my two fractions $(a+b)/r_2$ and b/r_1, are cos θ_2 and cos θ_1 of Mr. Wedmore's expression. It may be of interest, also, to repeat a table from my paper giving the comparison between Dr. Edler's experiments and the theory in a rather different form from that on which it is given by Mr. Wedmore. The table gives the values of the calculated and observed vertical disturbing force, and is based on the assumption that in the line in question, about three miles long, the proportion of leakage current to current in the trolley wire is 25 per cent.:

Distance from line in kilometres.	Vertical disturbing forces. — Calculated.	Observed.
0·38	12·8	23·17*
0·64	7·3	10·6
0·79	5·8	5·6
0·92	4·9	4·3
3·01	0·99	0·95
7·48	0·21	0·24
1·54	1·5	1·04

* This corresponds to the 25·2 of Mr. Wedmore's paper, but in my copy of Mr. Edler's work the figure is 23, not 25.

The amount of leakage assumed is rather in excess of Mr. Parry's number from a line three miles long, but agrees fairly with some other experiments. It will be noticed that at the two shortest distances the calculated disturbance falls greatly short of that observed. This probably might have been anticipated; the distances, about ½ km., are too small to allow the approximate theory to be considered trustworthy. Then from 0·79 km. to 7·48 km. the agreement is excellent. In the case of the last observation, at a distance of 1·54 km. the River Havel passed between the line and the observing station. Since the theory assumes earth of uniform conductivity, it clearly ought not to be pressed too far in this case, and a discrepancy was to be expected. The agreement between the theory and the observations is much less good in the case of the horizontal disturbance."

Mr. A. P. Trotter spoke at considerable length. He said the paper before them contained many problems, some of a fascinating interest, and others of very considerable commercial importance. But those who had not studied the subject before would hardly be convinced by the very brief manner in which the author had put forward the source-and-sink theory. He (himself) had only accepted the theory on the authority of others, who knew more about the subject than he. An interesting point was alluded to in the paper of a large conducting system lying in a current stream—a problem which was still in a very immature state. It had been stated, when the tramway lines were first laid down in the west of Middlesex, that there were apparently 15 amperes + or − flowing up and down. He would very much like to see that experiment repeated, because it was alleged that these currents were leakage currents from existing lines concentrated into this path of low resistance, and appeared as very considerable currents flowing up and down the rails. But normally the earth currents known to telegraph engineers obtained very considerable values. It was stated in the paper that "if the current sheet be 250ft. deep the voltage drop must have been about one volt per 1,000 yards," but he (the speaker) had found differences of $\frac{1}{10}$ volt per 100 yards miles away from any tramway, and by changing the electrodes to eliminate local action had had this figure repeated. He had a mass of undigested observations in connection with experiments made in Cape Town with Mr. Bayly, and Mr. Wilkinson, who had worked a good deal with him out there, also had much information, which he hoped one day would be published. He had found that by driving steel rods one yard long and ½in. diameter into the ground, sometimes near the tramway and sometimes at a distance, he got these tramway currents. The soil being rather dry, the emptying of a bucket of water into the neighbourhood of the electrode completely upset the direction of the current, and two buckets at the opposite end again altered the direction. From the fact that the currents he had mentioned were measured over very small distances, they might imagine that the paths of the current flow were straight, whereas the earth currents measured over many miles by telegraph people might flow in loops. Mr. Trotter went on to refer to the practical conclusions at the end of the paper, in which he was not prepared to agree with the author. With regard to the question of the advisability of connecting pipes deliberately to the rails, the author said that the best protection was obtained when the point of junction was at earth's potential; but it was very difficult to know what was meant by the earth's potential anywhere near a tramway. With the moderate currents found in this country, Mr. Trotter thought that the stray currents would enter the pipes if so connected, and he was not prepared to agree with the author on this point. Referring to another part of the paper, he mentioned that he had been very much interested in the question of earth currents with regard to observatories, and not being able to calculate how they would go he set to work to make some experiments, and had followed precisely the method adopted by Prof. W. G. Adams, who showed how to draw equipotential lines by putting a current into a sheet of tinfoil and exploring with wires from a galvanometer. He himself took some sheets of tin and soldered 20 pieces of wire along the edge at 1in. intervals, each wire being about one yard long, the total current put into the wires being 20 amperes, and all of it was taken out at one or more points. He then used an ordinary Weston instrument with no added resistance, and explored, and had obtained a considerable number of curves by drawing the equipotential lines, and afterwards drawing lines of current flow at right angles to the lines found by experiment. The conductance of the rails was omitted. No current, therefore, re-entered the rails, but all passed through the sheet. The experiment, which might be made in three dimensions, was a most fascinating one, but he had not been able to follow it up, and was much indebted to Mr. Wedmore for his assistance in it. Mr. Trotter, in conclusion, showed two solid models which he had constructed showing how the fall of potential was represented as a slope, and the relation of this slope to the undisturbed potential of the earth.

Mr. E. Parry said the theory to which Mr. Wedmore alluded in his paper was called upon to account for a great number of facts which had accumulated in the course of several years. The facts as they presented themselves to him as the result of experiments were these. He found, in the first place, that the amount of leakage was independent of weather conditions, that being contrary to the preconceived notion; in the second place, he found that the leakage was independent of the locality; and, thirdly, that the presence of metal pipes, etc., in the earth had no particular influence on the amount of stray current. The conclusion he was forced to was that the earth acted as a solid homogeneous conductor for all practical tramway purposes, and that the stray currents did not make for or confine themselves to any pipes in the earth. With regard to what was the earth's potential, to which Mr. Trotter had alluded, he thought a very simple definition of this was that that point of the rail was at the earth's potential at which the current ceased to flow into the rail and began to flow out of it. The method the author put forward of measuring stray currents was extremely simple. The method which the speaker adopted was the direct method of measuring the current at any point in the rail by means of a potentiometer, and comparing this with the potential put into the rail. Another method was used of connecting potential wires to the track, and so obtaining the potential at several points. Mr. Wedmore's method was to place a magnetometer at a known distance from the line and to obtain the force acting on the instrument. The only objection the speaker had to that method was the necessity for housing the instrument. He

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knew that Mr. Wedmore did not countenance Dr. Edler's theory, that the return currents were carried by a layer of damp ground a small depth below the surface. That theory seemed to be untenable. The contact between two layers of earth was enormously greater and more intimate than between the rail and the surface. Thus, if current passed in the latter case, it would do so in the former, and so on; the argument might be extended from layer to layer indefinitely. At this point Mr. Parry was asked to communicate any further remarks he had to make on the subject.

Mr. E. O. Walker remarked that in all the experiments he had made with regard to earth connections it was found that the surface layers to a depth of certainly 4ft. or 5ft. were comparatively non-conducting, but 30ft. or 40ft. down good conducting layers were obtained, which probably represented the water-bearing strata. So that if pipes such as gas and water pipes were near the surface of the ground, it was not likely that they would be subject to all the corrosions which had been anticipated. He thought that the ordinary chemical agency of the soil was much more an element of damage to such pipes than were stray electrical currents. With regard to the disturbance which had been noticed laterally to the tramway track, he thought that if one went five miles away one would find there was a disturbance due to the want of balancing of the system. In telephones the effect was felt very decidedly at a distance of five miles owing to the want of balance.

Mr. S. F. Walker attacked the solution given by Mr. Parry, that the earth was to be considered as one homogeneous conductor, and that practically it did not matter where the track was laid so far as the metal pipes in the ground were concerned. He thought that if one took either theoretical considerations or practical considerations, one could not help questioning that statement. For instance, what had they in the ground to conduct apart from the rails? There was an aggregation of minute particles of a substance which in itself was a high resistance, and these particles were arranged together in such a manner as to offer a very high resistance. It followed from this, that for practical purposes the conductivity of the earth was by way of the moisture which was held in the ground. Moisture in the ground was partly a question of the weather. It was quite correct that the surface of the ground sometimes merely got wet temporarily, and that the ground lower down held the moisture, but wherever it was, it was the moisture that conducted, plus any conductors you might have embedded in the ground and which could be reached by the currents. All gas and water pipes were connected to masses of metal above the ground, and there was no doubt that they took part in conducting any stray currents. The question whether the pipes could get hold of the currents, and how far this occurred, would depend entirely on the surface resistance. He was very pleased to see that the question had been tackled as to what was the earth's potential. He did not think anyone could say what it was. You might say that the earth's potential was when the potential was at a particular spot of rail at a particular instant, but you could not say it would remain the same. Therefore you were dealing with a constantly varying quantity, and the problem accordingly became very much more complicated. Then there was the question of electrolytic action of the current in the pipes. The corrosion of gas and water pipes was certainly a difficult problem, and if stray electrical currents got into pipes they would very much assist the chemical action of the soil.

Mr. H. M. Sayers said they were compelled in this country by a paternal Board to bury earth-plates, and to record the current flowing back to the negative bus bar at the station from these earth-plates. Obviously that current was only an exceedingly rough indication of the true leakage from the rails. The true leakage current from the rails, where a simple system was in use, must be at the maximum somewhere about the potential middle of the rails. He should like to know how the magnetometer method would be affected in a case such as frequently occurs where feeders were taken across country, and not parallel with the trolley wires. It appeared to him that the current in these feeders would be very much out-balanced, and that the effects would become so subject to difficult corrosions that the results with the magnetometer would not be trustworthy. However, it was something to find that in simple cases the measured results did correspond to the calculations. He had had one case of a tramway which showed a marked difference between the temperature of the track in dry and in wet weather. On a thoroughly wet day the amount of earth current returned was distinctly lower than in dry weather. This pointed to the fact that a thorough wetting increased the temperature of the track as a whole. It also indicated that the principal leakage into the earth was in a vertical direction, which bore out the statement of the comparatively poor conductivity of the upper surface. As regards the electrolytic action on gas and water pipes, Mr. Claud had shown in a paper which had probably been read by many of the members present that the earth was in the nature of a solid conductor. He had had an opportunity of examining some rails which had been in use for nearly nine years under Board of Trade regulations, but in which the volts were not limited to seven. The rails had been used at the positive extremity of the tramway, and he could not see any signs of pitting on them caused by electrical corrosion. They were certainly rather rusty, but this was due rather to the ordinary impression of oxide rather than to electrolytic action. The question as to connecting pipes to the rails was a very important one. Mr. Claud's experiments showed that pipes were on the whole safer when not connected to the tramway track, and, in the speaker's opinion, it was a counsel of safety not to connect the pipes. He also advocated the use of cast-iron pipes for laying the feeders in. He was quite aware that the pipes might suffer in some cases from connection with the track, but he felt that the lead sheathing of the cables would be protected as long as cast iron was around them.

Mr. A. J. S. Adams objected to the title of the paper for the reason that the use of the term "earth currents" had always hitherto been confined to the currents which were of cosmic origin. He expressed the hope that the next time stray currents from tramways were dealt with, it would be under some other and more appropriate title. He also mentioned that the true earth current at Greenwich was found to be wholly masked during the hours that the City and South London Railway was in operation. Nothing could be picked up in the daytime except the electric railway.

Mr. W. M. Mordey reminded telegraph engineers that the single-needle instruments were made with movable dials, so that they could be shifted round to correspond to the earth current deflector, and he mentioned a case where he had found as many as 40 Daniells necessary to reverse the earth current in 17 miles of wire. He also thought that the gas and water companies had a substantial grievance against Nature on account of these earth currents. If electrolysis followed from the existence of such currents, then there ought not to be a gas-pipe left in existence. He wished Prof. Ayrton and Prof. Perry had been present that evening to hear the words which had fallen from practical engineers on this matter.

Mr. Wedmore, in reply, first referred to Dr. Glazebrook's communication. He noted that that gentleman had calculated his figures on vertical disturbances, and omitted the figures on horizontal disturbances. It appeared to him that, in order to get an agreement in his figures, Dr. Glazebrook was bound to choose the points at the two extremities of the line. These were not, in his opinion, the points at which the real conditions were represented. He also thought that the leakage currents which Dr. Glazebrook had assumed from the only data apparently available, might really be much larger than he put them at. The principal justification of the calculations he (the author) had given, was the agreement between the horizontal and vertical disturbances. Mr. Trotter had referred to the experiments made on the London United Tramways. He should like to add a few remarks to those in the paper on this matter. In the first place, the curves plotted, as the result of readings taken over a few sections, represented accurately the sort of curves one took on a recording ammeter. He thought there was pretty strong evidence that the currents were not merely earth currents, but were due to the traction system. With regard to Mr. Trotter's point, in distinguishing between the measurement of potential difference and taking that measurement as a basis for calculating the current, he thought the measurements made on the London United Tramway Company's track before the generators were running over a line of 2½ miles were of a kind which were fairly reliable. Mr. Wedmore went on to disclaim any intention of advocating in his paper the use of a magnetometer for measuring. His object in introducing the matter was to show the agreement between this method and other methods of measuring. With reference to the specific resistance of the earth, given as 75 ohms per yard cube, if the resistances did not flow through sheets or through low bodies of the rails, then the resistance of the earth must be very much lower than he had figured it at—one speaker had mentioned the figure 1,600 ohms per square foot. It seemed to him that the expression "ohms per square foot" was incorrect. Resistance was not proportional to the area; it was inversely proportional to the area.

On the motion of the **President,** a vote of thanks was warmly tendered the author for his paper.

NEW COMPANIES REGISTERED.

Pioneer Manufacturing Company, Limited.—Capital, £1,000. Object: to carry on the business of manufacturers of and contractors for the sale, purchase, and supply of electrical novelties, motors, etc.

Electric Landaulet Co., Limited.—Capital, £50,000. Object: to manufacture, deal in or with cycles, carts, cabs, carriages, and other vehicles driven by human, animal, electric, hydraulic, or other power, etc.

Colombo Electric Tramways and Lighting Company, Limited. Capital, £150,000. Object: to purchase, lease, construct, or otherwise acquire any tramway or tramways in the island of Ceylon, or in any other country, etc.

Salsbury and Sons, Limited.—Capital, £22,500. Object: to acquire the business carried on at Green-street, Blackfriars, S.E., and 124, Long-acre, W.C., as Salsbury and Son, and to carry on the business of manufacturers of and dealers in lamps, producers of and dealers in electricity, etc.

Pathe Freres (London), Limited.—Capital, £10,000. Object: to adopt an agreement between A. Soury et Compagnie and this company, and generally to carry on business as manufacturers of, agents for and dealers in cinematographs, phonographs, gramaphones, phonoscopes, telephones, telegraphs, and other similar instruments, etc.

Rothschild's Motors, Limited.—Capital, £1,000. Object: to acquire the benefit of and carry on the agencies for the sale in this country of the motors and motorcars of the Deutsche Automobil-Industrie (Friedrich Hering), of Gera-Unterm Haus, in the German Empire, and of the Lux'schen Industriewerken Motorfahrzeug Abtheilung, of Ludwigshafen-on-Rhine, and to carry on the general business of motorcar, motor cycle, and vehicle agents, manufacturers, and merchants, etc.

Greville Electric Inventions, Limited.—Capital, £25,000. Object: to acquire the British patents in respect of the electric inventions of A. E. Greville, as specified in an agreement with the said vendor, to acquire the business carried on at 46, Farringdon-street, E.C., as the Greville Engineering Works, and at 4, Holborn-bars, E.C., as the Greville Electric Inventions, and to carry on the business of electricians, marine and mechanical engineers, suppliers of electricity, cycle and motorcar manufacturers, etc.

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TO CORRESPONDENTS.

All Rights Reserved. *Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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LONDON COUNTY COUNCIL CONTRACTS.

At the meeting of the London County Council on Tuesday last it was decided to accept a Belgian contract for some six thousand tons of steel track rails, slot rails, and conductor rails required in connection with the conversion of the Council tramways for electric traction. This is the second contract which has been let for such steelwork, and in the first, which comprised the materials required for the Tooting line, it was decided only to accept tenders for British-made material. In this instance the tenders were left open for foreign competition, and the lowest offer received was from English agents of a Belgian firm, and amounted to £41,742. 4s. 4d. The next two tenders in order of price were respectively from a German and a Belgian firm, the amount of the third tender being £42,935. This shows that the foreign firms were exceedingly near each other in their tenders, and hence makes the wide difference between them and the lowest English offer more marked. This lowest tender for English-made rails amounted to £50,463. 15s., and thus was some 18 per cent. higher than the lowest Belgian offer. The same remark, however, as regards the small variation between the three foreign tenders applies to the three lowest for English steel, and at first sight the conclusion would be that steel rails can now be obtained from the Continent at from 18 to 20 per cent. below English prices. The result, if this were always so, would be that the English steelworks would rapidly have to be shut down, and the numerous allied interests would also fall to the ground for want of work. When the matter came up for discussion before the London County Council, the chairman of the Highways Committee stated that he had discovered a ring amongst English steelmakers, and that as a result the prices for English steel rails were 20 per cent. higher than those of the Belgian firms. In spite of this, a labour member was found to advocate the placing of the orders in this country. It seems to us that there is another explanation of the matter which is worthy of attention, as it is by no means pleasing to find that public contracts of this magnitude should go out of the country. This explanation lies in the general policy of the London County Council both with respect to contractors in general, and to the labour clauses which they insert in all their specifications. In this instance the first cause is hardly operative, as the Council have not yet reached the stage of seriously considering the laying down of steelworks for the production of steel rails, etc., for its tramways. It by no means follows, however, that this will not in the future be suggested as a legitimate section of the Works Department's business. We come, then, to the labour clauses. In these the Council has thrown in its lot wholly with the trades unions, and recognises the decision only of these unions as to the proper rates of wages which shall be paid on all work carried out for the Council. It frequently happens, therefore, that the taking of a small order for work to be supplied to the London County Council would result in the firm accepting the work giving way to a labour organisation which it has successfully resisted for years, and which, in consequence of the same resistance, has by no means secured the support of the majority of the operators it claims to represent. We know of one instance in point in electrical works. The firm who was asked to tender for a large County Council contract paid trade union rate of wages in all but one department. The men in that department were trained labourers, as the firm had found that a training of from a month to six weeks was quite sufficient to make an intelligent labourer capable of doing the work in question. As a consequence of this training, the men received from 15 to 30 per cent. increase in wages, and were content. If,

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however, a County Council contract had been accepted, the rates of wages in this department would have to be again raised to the limit fixed by a small society which claimed to have the representation of the trades union for that class of work. The firm accordingly refused to tender, as did a good many other English electrical firms. The result was most amusing. The work was given to some agents of an American firm, who found that it would not pay them to manufacture the machines in question, as they were not of their standard type. The agents accordingly sublet the contract to an English firm, with the labour condition struck out. We presume that these agents of an American firm relied on the inability of the London County Council being unable to enforce the labour clauses in the United States. It seems to us probable that the same thing applies to the contract above mentioned. The English firms, besides guaranteeing to comply with all the stringent requirements of the specification with respect to the mechanical properties of the steel goods, have also to guarantee under penalty that standard rates of wages shall be paid to every man in their employ. This is not all, however. The same guarantee has to be given with respect to the sub-contractors who supply the firm with raw material, with machine tools, and even down to, we suppose, the paper-makers who supply the paper on which the invoices are sent in. There is bound to be in every manufacturing trade a certain number of standing disputes between capital and labour. The capitalists are quite as often in the wrong in these disputes as the labour organisation. If, however, bodies like the London County Council throw in their lot always on the labour side of the dispute, and without consideration, as they do by their labour clauses, they in so doing increase the cost of carrying out work for them. In certain departments they have tried to prevent this increase by doing the work themselves and saving the contractors' profit, but up to the present they do not seem to have succeeded in the attempt. The sooner the Council learn to abstain from interfering in disputes with which it has nothing to do, the sooner will they be able to get work carried out for them at same rates as it can be carried out for private individuals.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

RE CHAUVIN AND ARNOUX AGENCY.

SIR,—Our attention has been called to a recent notice appearing in the English electrical journals with reference to the above, which questions our right to terminate our agency with Messrs. H. M. Salmony and Co. We think it desirable, therefore, to write to inform you that we have no doubt whatever as to our rights under the recent agreement with this gentleman, and that we took the action in question after full and careful consideration of its importance both to Messrs. Salmony and ourselves.

We further confirm the notice which has already been given by Messrs. Geipel and Lange, that we have appointed them as our sole representatives for the British Isles and the Colonies.

If you will be good enough to insert this in your next issue we shall be much obliged.—Yours, etc.,

R. CHAUVIN ET ARNOUX.

186, Rue Championnet, Paris, Feb. 28, 1902.

Associated American Electrical Manufacturers, Limited.—Capital, £1,000. Object: to adopt an agreement between A. F. Woodley, of 90, Cannon-street, E.C., agent for England and Wales of the Gouday McLean Company—a corporation organised under the laws of the State of New York (for the purposes of managing the foreign sales of the products of a syndicate of American electrical manufactures)—and this company, and to carry on the general business of electricians and electrical engineers.

FORTHCOMING EVENTS.

FRIDAY, MARCH 7.

Royal Institution.—At 9 p.m., Prof. H. Becquerel on "Radio-Active Bodies" (in French).

SATURDAY, MARCH 8.

Royal Institution.—At 3 p.m., Lord Rayleigh on "Some Electrical Developments" (Lecture IV.).

Manchester Association of Engineers.—Ordinary meeting. Paper: "Efficiencies of Electric Cranes," by Mr. R. Matthews.

MONDAY, MARCH 10.

London School of Economics.—At 6.15 p.m., Mr. L. Macassey on "Electric Traction on Railways" (Lecture V.).

Institution of Electrical Engineers (Newcastle Section).—Ordinary meeting. Paper: "Electrical Power Supply on the North-East Coast," by Mr. C. S. Vesey-Brown.

TUESDAY, MARCH 11.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be further discussed: "Electrical Traction on Railways," by Messrs. W. M. Mordey and B. M. Jenkin.

Institution of Electrical Engineers.—Glasgow Section: At 8 p.m., ordinary meeting. Paper: "Note on a New Electromagnet for Use in Magneto-Optic Work," by Prof. A. Gray.—Manchester Section: At 7.30 p.m., ordinary meeting. Paper: "Electric Tramcars and their Equipment," by Mr. W. C. Rhodes.

WEDNESDAY, MARCH 12.

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "The Utility of Alkaline Phosphatic Manures," by Mr. John Hughes.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., ordinary meeting. Paper: The Direct Generation of Electrical Energy from Carbon," by Mr. Carlisch.

THURSDAY, MARCH 13.

Institution of Electrical Engineers.—At 8 p.m., adjourned discussion on the papers on "Electric Shocks," by Major-General C. E. Webber, C.B., Mr. F. B. Aspinall, and Mr. A. P. Trotter respectively.—Students' Section: At 12.15 p.m., visit to the works of the Incandescent Electric Lamp Company, Brook Green, Hammersmith.

FRIDAY, MARCH 14.

Institution of Civil Engineers (Students' Section).—At 8 p.m., ordinary meeting. Paper: "The Use of Long Steel Wires in Surveying," by Mr. H. J. Deane (Sydney).

Royal Institution.—At 9 p.m., Prof. S. P. Thompson on "Magnetism in Transitu."

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. Paper: "The Uses of Engineering Models," by Mr. P. Marshall.

SATURDAY, MARCH 15.

Royal Institution.—At 3 p.m., Lord Rayleigh on "Some Electrical Developments" (Lecture V.).

Institution of Junior Engineers.—At 7 p.m., annual conversazione, Westminster Palace Hotel.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution on Feb. 27 the following were the candidates balloted for:

Members.—P. N. Hooper, 15, Clevedon-mansions, Highgate-road, N.W.; G. F. Mansbridge, 25, Haydons-park-villas, Gap-road, Wimbledon; W. E. Thrift, 80, Grosvenor-square, Rathmines, Dublin.

Associate Members.—A. H. Abbott, 14, Old Court House-street, Calcutta; A. C. Coubrough, Messrs. Mather and Platt, Limited, Manchester; R. N. Fulton, 34, Hopetoun-place, Glasgow; H. Hale, 23, St. Peter's-street, Winchester, Hants; C. B. Handyside, care of Messrs. J. H. Holmes and Co., Limited, Manchester; E. Hesketh, Lymington Electric Light and Power Company, Limited; R. F. Looser, 35, Coltart-road, Liverpool; R. B. Slacke, 77, Northgate, Blackburn; E. T. Vickers, care of Messrs. Walter Locke and Co., Limited, 4, Esplanade East, Calcutta; W. B. Woodhouse, Western Villa, Wallsend-on-Tyne.

Associates.—W. Bannister, c/o Vulcan Boiler and General Insurance Company, Limited, 159, Hope-street, Glasgow; L. Breach, Electricity Works, Bolton; C. H. K. Chamen, 75, Waterloo-street, Glasgow; J. E. Edmundson, 25, Airlie-street, Brechin; W. G. Everingham, Stanford Villa, Pocklington, Yorks; T. Ferguson, 7, Westfield-terrace, Aberdeen; D. Furniss, 67, Baltic-road, Attercliffe, Sheffield; R. E. Gott, 1, Parkfield-road, Bradford; W. T. Gray, 22, Dewlands-road, Seaforth: H. Green, c/o Miss Greig, 2, Park-view, Battlefield-road, Langside, Glasgow; J. J. W. Grigg, 17, South-street, Manchester-square, W.; J. R. W. Linton, 15, Maiden lane, Strand, W.C.; J. Lord, 370, Middleton-road, Chadderton, Oldham; J. E. Newman, Electric Light Works, Fleet-street, Dublin; B. J. Pargeter, 359, Clapham-road, S.W.; J. E. Raworth, 13, Fairholt-road, Stoke Newington, N.; J. D. Richards, 11, James-street, Docks, Cardiff; P. E. Ridley, 34, Gorst-road, Wandsworth Common, S.W.; H. W. Stovold, British India Steam Navigation Company, Bombay; E. J. Taylor, Electricity Works, Strawberry-road, Pendleton, Manchester; A. Walker, 120, Osborne-road, Forest Gate, Essex.

Students.—C. A. Ablett, Pembroke Lodge, Outram-road, Addiscombe; E. Ambrose, 68, Cranbrook-road, Chiswick, W.; J. Arnold,

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6, Brownswood-park, South Hornsey, N.; D. S. Baddeley, Holmwood, New Roman-road, Chelmsford; M. C. Badhwar, R.I.E. College, Cooper's Hill: H. F. Bayley, 6, Edith-road, West Kensington, W.; A. W. Beuttell, Faraday House, Charing Cross-road, W.C.; C. R. Bland, 11, Brondesbury-park, N.W.; C. Bounett, 32, Albert-square, Clapham-road, S.W.; B. E. Bumpus, 103, Lansdowne-road, Old Charlton; R. A. Bush, 10, Royal York-crescent, Clifton; M. Chapman, Barnard's Hotel, Chelmsford; C. P. Cobb, Fairlawn, Quadrant-road, Thornton Heath; B. G. Drummond, 1, Threadneedle-street, Chelmsford; G. H. W. Gaspar, 108, London-road, Chelmsford; W. D. Halfhead, Faraday House, W.C.; T. C. Harrison, 11, Greville-place, Maida Vale, N.W.; C. D'A. Jackson, Faraday House, W.C.; H. F. Jay, 59, Swallowfield-road, Charlton, S.E.; D. Kennedy, 15, Barry-road, East Dulwich, S.E.; C. Lawton, R.I.E. College, Cooper's Hill; S. W. Lough, 14, Disraeli-road, Putney, S.W.; J. E. M. McGregor, 18, Paddenswick-road, Ravenswood Park, W.; E. L. Monk, Pendrea, Truro, Cornwall; D. N. Milestone, Home View, 7, Heathfield-road, Wandsworth Common, S.W.; E. A. A. Parsons, The Gables, Southbourne-on-Sea, Hants; H. C. N. Prance, The Priory, Mansfield Woodhouse, Notts; A. L. Rawlings, 17, York-road, Edgbaston, Birmingham; L. Roseveare and A. N. Rufford-Sharpe, Faraday House, W.C.; M. Samy, R.I.E. College, Cooper's Hill; R. M. Smith, Wyndcliffe, Himley-road, Dudley; A. J. G. Swinney, Lorne Villa, Elm-road, Sidcup; O. C. Thompson, 1, Qusquo Cottages, Fairmile, Cobham; J. Tyrrell, 33, Wentworth-place, Dublin; H. F. Vickery, Faraday House, W.C.; T. H. Vitty, Eversleigh, Marine-parade, Tankerton, Whitstable, Kent; D. C. Wardlaw, H. H. Wardlaw, and A. H. Wilson, Faraday House, W.C.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

461. Is it possible to ring a bell between a house and works a distance of 200 yards without wires? The reason I require the above is this: The property in between is not ours, and the owners will not let me cross it with wires. The bell is needed to call me in case of the dynamos or any part of the installation going wrong during the night. The distance to walk round to my house is about a mile. Describe how it can be done.—J. D. H.

462. A winch motor of 2 h.p., shunt wound, is situated on the top floor of a five-storey warehouse. Describe and illustrate a cheap electrical or mechanical arrangement for starting and controlling the motor from any floor.—A. ROBERTSON.

ANSWERS.

Question No. 455.—I notice in some makes of drum armatures the supporting wedges or horns are omitted. Trusting only to the binding bonds to prevent the conductors shifting, is this style good enough? What is the electrical and mechanical strain on the conductors? Give calculating formula.

Answer to No. 455 (*awarded* 7*s.* 6*d.*).—The method of securing the armature inductors of a drum armature suggested by "H. W."—viz., by means of binding wires only—is not sufficient. In every dynamo, whether generator or motor, there should be positive driving of the inductors; in a generator it is the inductors, and not the core, which have to be driven, and in a motor it is they, and not the core, which drive the shafts. The work done in an armature may be expressed in two ways:

1. Electrically: $P = C \times E$ watts—*i.e.*, the product of the volts multiplied by the amperes.

2. Mechanically:

$$P = 2\pi \times N \times T \times \frac{746}{33{,}000} = \cdot 142 \times N \times T \text{ watts};$$

i.e., the product of the circumferential speed and the torque,

where P = total power developed in watts;
E = E.M.F. in volts;
C = current in amperes;
N = speed in revolutions per minute;
T = torque in foot-pounds.

Equating these equations we obtain:

$$E \times C = \cdot 142 \times N \times T.$$

$$\therefore T = \frac{E \times C}{\cdot 142 \times N} = 7 \cdot 042 \frac{E \times C}{N} \text{ foot-pounds.}$$

Having now obtained the value of the torque in foot-pounds in terms of E and C, we can express the drag on the inductors. The torque divided by the mean radius of the armature winding gives the whole peripheral force acting, and the latter divided by the number of active inductors, gives the drag on each. It must be remembered that since some inductors are sliding through the lines of force at the neutral points, the number of active inductors is less than the total number on the armature. The drag on each will then be

$$f_a = \frac{T}{d} = \frac{24 \times T}{d \times N_i \times \beta},$$

$$\frac{2}{12} \times N_i \times \beta$$

$$= \frac{24 \times 7 \cdot 042 \times \frac{E \times C}{N}}{d \times N_i \times \beta},$$

$$= \cdot 7375 + \frac{E \times C}{v \times N_i \times \beta} \text{ pounds,}$$

where v = mean inductor velocity, in feet per second;
N_i = total number of armature inductors;
β = percentage of effective armature inductors;
d = mean diameter of winding, in inches.

By inserting for E the value obtained from the fundamental formula:

$$E = N_i \phi N 10^{-8},$$

we get

$$T = 7 \cdot 042 \times \frac{N_i \times \phi \times N}{10^8 \times 60} \times \frac{C}{N}$$

$$= \frac{11 \cdot 74}{10^{10}} \times C \times N_i \times \phi \text{ foot-pounds.}$$

Therefore

$$f_a = \frac{2 \cdot 82}{10^8} \times \frac{C \times \phi}{d \times \beta} \text{ pounds,}$$

where ϕ = the total magnetic flux.

Now, as any one inductor is first active and then for a short period idle, the drag is of an intermittent character, and consequently more likely to do harm than it would were it constant. Hence there will always be a tendency for the inductors to shift, which will cause the insulation to become frayed and finally break down. Positive driving must therefore be adopted, either by means of driving horns or slotted armatures. The whole question is further complicated by the centrifugal force tending to cause the armature inductors to fly apart.

With the ring armature, the driving lugs of the spiders will assist in driving the inductors, and if the centrifugal force tends to lift the outer layers, it assists by driving the inner wires closer to the core. But in practice it is found that even with ring armatures better positive driving is essential, and the writer has found by experience, and has been confirmed in his views by many of the largest manufacturers, that if a ring armature once gives way it is better to entirely rewind it, as the peripheral force will probably be found to have caused a continual shifting of the coils, and so ruined the insulation at the bends.

There is only one remedy for this with both drum and ring armatures: positive driving by means of plenty of driving horns, or else by means of slotted cores.—M.

Answer to No. 455 (*awarded* 7*s.* 6*d.*).—In the case mentioned by "H. W." I should say the armatures were from a mechanical point of view badly designed, except in the case of very small machines, where the pull on the conductors would not be very great; but for machines of any considerable output I should say the driving horns were absolutely essential to prevent the conductors shifting, and in time stripped off the armature. It is a well-known fact that there is a backward pull exerted on the armature of a dynamo when working at full load. If it were not for this we should not require such large engines to rotate the armatures, as the only power necessary to overcome to drive the armature would be that due to the friction of bearings, brushes, etc., but in well-designed machines this is found to

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be a very small percentage of the total power required, hence we must look somewhere else for the power absorbed—*i.e.*, that required to overcome the backward pull, which might be mentioned in a smooth-core armature is chiefly concentrated on the conductors In a dynamo we have two distinct magnetic fields—one due to the field magnets, and the other due to the armature. Now, a slight examination of the accompanying sketches will show that the tendency of the interaction of the two fields is to strengthen the total field above the conductor and to weaken it below the same, and when the interaction of the two fields has the above-mentioned effect, the tendency of the wire is to move in the direction of the weaker field, hence the backward pull. The actual pull exerted on these conductors when the conductors are in the position shown in sketch (Fig. 1A) can be calculated from the formulæ given by Kapp in his book on dynamos, where

$$P = \frac{l \times c \times B}{9{,}800{,}000} \text{ kilogrammes ;}$$

c = current in amperes ;
P = pull in kilogrammes (1 kg. = 2·2lb.) ;
l = length of conductor in centimetres ;
B = induction per square centimetre in air-gap.

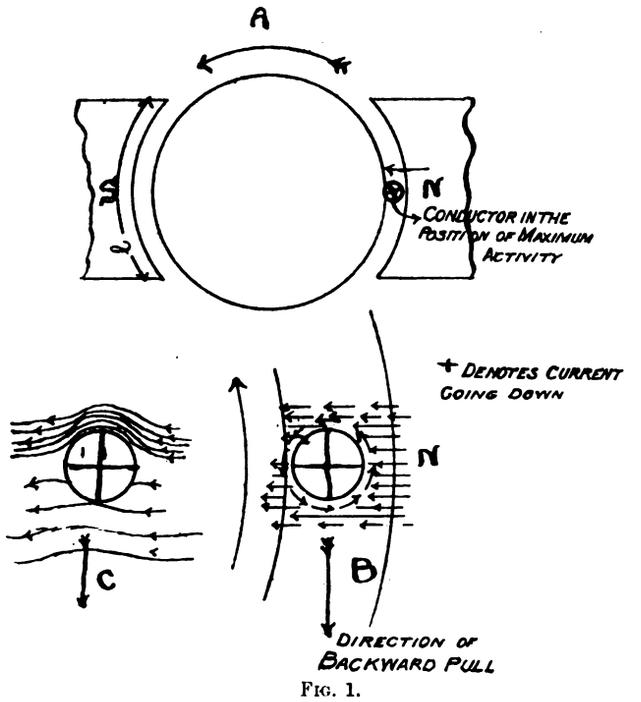

FIG. 1.

Thus a wire carrying 100 amperes, and passing for the length of 1m. through a field of 1,000 C.G.S. units, is acted upon by a force of 1·01937 kg., or very nearly 3¼lb., which means if this was applied to a dynamo that the pull exerted on any conductor as it passed the position of maximum activity would be 3¼lb. A slight explanation will show that should there be a large number of conductors contained in length marked l (Fig. 1A) the pull on the conductors will become very great ; therefore we must provide some sure means of keeping the conductors from being shifted. A glance at Fig. 2 (which, it might be mentioned, is a reproduction of a sketch which appeared in the *Electrical Engineer* of Nov. 15, 1901, in connection with the design of a 5-kw. dynamo) will show that this can be overcome by using these driving horns as shown ; in fact, in this particular case, with three layers of conductors, it would be almost impossible to make a sound job of the winding were these horns omitted.

A practical example taken from Kapp's book will show that we must not trust only to the binding bonds :

Diameter of armature = 30·48cm., length of armature = 50·8cm. Let there be 120 conductors on the outside of the armature, and let the pole-pieces embrace an angle of 120deg. on each side. We shall, therefore, have 40 conductors contained within the field on each side of the armature ; let the current traversing the armature be 400 amperes, then the current in one wire = 200 amperes. Assuming the strength of field to be 4,650 C.G.S. units, we get

$$\text{Pull on one wire} = \frac{4{,}650 \times 50{\cdot}8 \times 200}{9{,}800{,}000} = 4{\cdot}82 \text{ kg.}$$

$$= 4{\cdot}82 \times 2{\cdot}2 = 10{\cdot}6\text{lb.}$$

As there are 40 wires on each side, we have a tangential force on the surface of the armature of $2 \times 40 \times 10{\cdot}6$, or 848lb.,

which force acting on a radius of 15·24cm. = 6in. = ·5ft.
= 428 foot-pounds.

If we know the speed at which the armature is driven, we can at once find the energy required to overcome the torque due to the electromagnetic interaction between the field and the armature current. The work done in one revolution is obviously

$$848 \times 3{\cdot}14 = 2{,}662 \text{ foot-pounds (approx.) ;}$$

if the armature makes 500 revolutions per minute, the energy is

$$\frac{500 \times 2{,}662}{33{,}000} = 40{\cdot}3 \text{ h.p.}$$

As it is well known that this so-called torque is used to rotate the armature in the case of the motor, it will be easily seen that when starting up the motor the pull on the conductors will greatly exceed the normal, as all motors, especially "series" motors (which usually have to start up on full load), require a much greater current to start than when they have attained full speed. I do not think now that I need to emphasise the fact that these driving horns

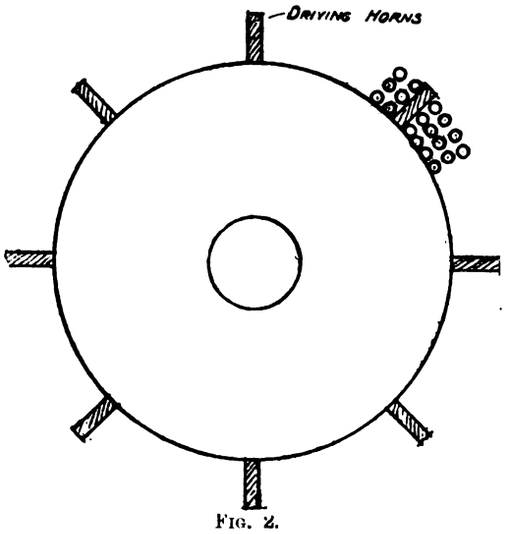

FIG. 2.

are essential on the smooth-core armature to prevent the conductors shifting. No doubt the best modern practice is to wind the conductors on a slotted-core armature, when, in addition to being a better means of driving the conductors, it will be found that most of the pull is now concentrated on the teeth of the armature core. For particulars as to the centrifugal force set up in the conductors which has chiefly to be overcome by the binding bonds, I would refer the writer to Fisher Hinnen's book on "Continuous-Current Dynamos," published by Biggs and Co. —R. F. W.

Answer to No. 455 (*awarded* 7*s.* 6*d.*).—The practice of building drum armatures without driving horns is not one to be recommended, as sooner or later vibration, and the continual expansion and contraction due to successive heating and cooling of the machine, will loosen the binding bands and crack the varnish, and the conductors will be dragged round. It is perhaps permissible in small armatures, up to 7in. or 8in. diameter (8 h.p. or 10 h.p.), but is sure to lead to trouble in larger ones. The peripheral force on the winding tending to drag it over the surface of the core, in the direction of rotation in the case of a motor, and in the opposite direction in the case of a dynamo, can be readily calculated by either of the two following formulæ. The first results directly from resolving the horse-power developed in the armature into its two components : velocity in feet per minute and force in pounds. Thus : Horse-power developed in armature

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$$= \frac{\text{Total drag on conductors in pounds} \times \text{velocity in feet per minute}}{33{,}000}$$

from which

$$\text{Total drag on the conductors in pounds} = \frac{\text{Horse-power developed in armature} \times 10{,}500}{\text{Revolutions per minute} \times \text{diameter of the armature to the centre of winding in feet.}}$$

The "horse-power developed in armature" is:

In a dynamo—

$$\frac{\text{Output in watts} + C^2R \text{ loss in armature and field}}{746}.$$

In a motor—

$$\frac{\text{Input in watts} - C^2R \text{ loss in armature and field}}{746}.$$

The second formula involves a knowledge of the number of conductors and the flux, and is less convenient than the above except in a few special cases. It is

$$\text{Total drag on conductors in pounds} = \frac{ACNP}{D \times 4{\cdot}26 \times 10^8},$$

where A = total armature amperes;

C = number of conductors in series from a + brush to a − brush;

$= \frac{\text{Total armature conductors}}{\text{Number of poles}}$ for parallel-coupled armatures;

$= \frac{\text{Total armature conductors}}{2}$ for series-coupled armatures;

N = flux per pole in C.G.S. lines;

P = number of poles;

D = diameter of armature to the centre of the winding in feet.

The total drag for a given output and diameter of armature is independent of the number and the shape of the poles, but as the drag is only exerted on those conductors which are actually in the magnetic field, the drag per conductor is always somewhat greater than the figure obtained by dividing the total drag by the total number of conductors. On this account, also, though the total drag is constant, the drag on any one conductor varies from zero to a maximum as many times in a revolution as there are poles, and this fluctuating stress adds considerably to the danger of the conductors being shifted.

By making certain more or less admissible assumptions, it is possible to get a rough idea of the margin of safety existing in a given armature, taking into account the combined effect of peripheral drag, centrifugal force, friction of the winding on the core, and the tension of the binding band wire. As an example, we will consider the case of an armature core 15in. diameter (16in. to the centre of the winding) and 10in. long, giving an output of 30 kw. at 700 revolutions per minute. The armature is of the "barrel" type, and the winding (conductors and end connections) weighs 200lb., and is held to the core and end supports by means of 10 binding bands, each consisting of 14 turns of No. 18 (·048in. diameter) steel wire, wound on under a tension of 30lb. (the breaking stress for such a wire being about 180lb.). For simplicity of calculation, the forces will be considered as divided into two parts—one in the direction P (Fig. 1), and the other in the direction P_1—tending to break the bands across the two horizontal sections, A A_1 and B B_1. The total force across these two sections due to the tension put on the binding wire whilst winding it on is—

$$30 \times 14 \times 10 \times 2 = 8{,}400\text{lb.},$$

and this force has not only to counteract the centrifugal force tending to cause the winding to fly out radially, but has also to exert the inward radial pressure of the winding on the core which is to give the necessary adhesion between the two, and so prevent shifting of the conductors. The component of the centrifugal force in the direction P, tending to break the bands at A A_1 and B B_1, is given by the well-known flywheel formula:

Centrifugal force in pounds tending to break two sections of bands

$$= \text{Weight of winding in pounds} \times \frac{\text{Radius of core to centre of winding in feet}}{} \times \left(\frac{\text{Revolutions per minute}}{}\right)^2 \times \frac{\cdot 000341}{\pi}$$

$$= 200 \times \frac{8}{12} \times (700)^2 \times \frac{\cdot 000341}{\pi}$$

$$= 7{,}100\text{lb.}$$

The peripheral drag on the winding by the first formula given above, allowing 2,000 C^2R watts for armature and field, is—

$$\frac{\frac{32{,}000}{746} \times 10{,}500}{700 \times \frac{16}{12}} = 480\text{lb.}$$

Assuming, as a safe figure, a coefficient of friction between winding and core of ·5, the inward radial pressure required to prevent dragging is $\frac{480}{\cdot 5} = 960$lb., and to obtain the vertical component of this force (at right angles to A B), it must be multiplied by the average value of the sines of all angles between A and B—*i.e.*, between 0deg. and 180deg.—which is $\frac{2}{\pi}$.

$$\therefore \text{Vertical component of force required to prevent drag} = 960 \times \frac{2}{\pi} = 610\text{lb.}$$

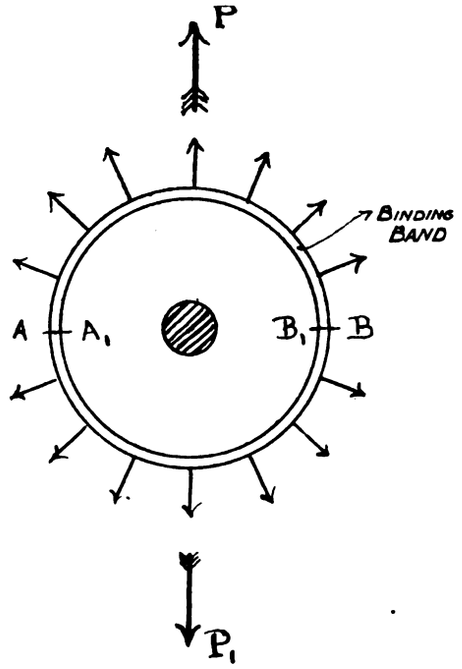

FIG. 1.

Adding this force to the centrifugal force, we get 7,710lb. as the total necessary vertical force to be applied by the bands. This is only slightly below the figure for the actual band tension—viz., 8,400lb. So long, therefore, as the bands remain tight, this armature, without any driving horns, would just be able to avoid the shifting of its conductors. If, however, the bands should slacken in the smallest degree, as they would be sure to do in time, or even if the speed increased slightly, and so increased the centrifugal force, the conductors would certainly be dragged round. An armature of anything approaching this size would, therefore, be quite unworkable without driving horns.—Q.

[N.B.—In the above answers, and still more in the large number which we have been unable to publish, there is a great confusion in symbols, as the same letter is used by different writers to denote very different quantities. It would save everyone time, trouble, and many mistakes if they would accustom themselves to use generally accepted symbols. Thus, B is now generally used for the induction in C.G.S. lines per square centimetre and H for magnetising force; yet in these answers we find H used for induction and B to represent a constant. Again, N is used to denote speed in revolutions per minute by a large number of

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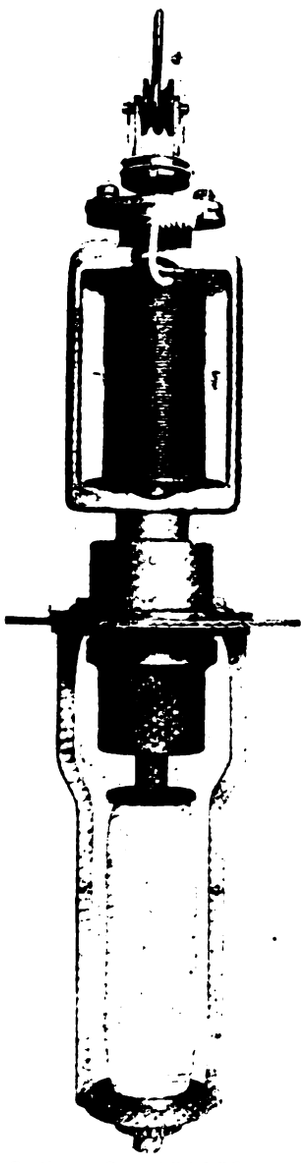
authors, whereas in one published answer N is used for flux per pole. C for both current and number of conductors s also most confusing.—ED., *E. E.*]

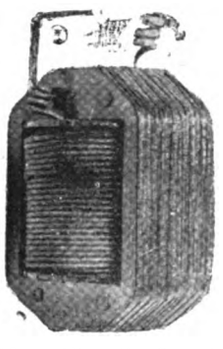
TRADE NOTICES AND NOVELTIES.

"Ark" Lamps.

One of the cardinal features of the lamp known to the trade as the 'Ark" is the ease with which it can be converted from a continuous to an alternating current lamp or *vice versa*. The makers, Messrs. Johnson and Phillips, Old Charlton, Kent, call special attention to this point. We reproduce herewith two photographs, which will serve to illustrate the simplicity of the change entailed by conversion from one system to another. The coil shown connected to the lamp and the detached coil are made interchengeable. All that is necessary in converting the lamp is the exchange of the one coil for the other as the case may be, the connected coil being for continuous and the detached



Continuous-Current "Ark" Lamp.



"Ark" Lamp Alternating-Current Coil.

one for alternate current working. There is an obvious advantage in having a lamp which can be readily adapted for all circuits—alternating or direct current, and for parallel or series working. The makers, we are told, had this in mind when they introduced the "Ark." With such lamps coming into extensive use, the central-station engineer can contemplate changing over with greater equanimity than would have been possible a few years ago.

Power Transmission Plant.

We have received from Messrs. Ernest Scott and Mountain, Limited, Close Works, Newcastle-on-Tyne, a copy of their circular No. 28, wherein is described the electric power transmission plant installed by the firm for the Normanby Ironworks Company, Limited, Middlesbrough. The generating plant comprises a steam dynamo of 150 kw. capacity, another of 32 kw. capacity, and a small pilot set of 9 kw. capacity. The two larger engines are of the Scott and Mountain enclosed, compound, central-valve type, the first-mentioned being direct coupled to a six-pole Scott and Mountain dynamo, and the second to a two-pole dynamo by the same makers. The latter set is used for supplying the lighting circuits only. The pilot set consists of a vertical high-speed engine belt-coupled to a four-pole dynamo. This set is intended for use as a stand-by to the larger lighting plant when a few lamps only are burning. There are three switchboards. The first of these—the power board—controls the 150-kw. generating set, and circuits for a 150-b.h.p. hoist motor, crane motors, and a 15-h.p. motor for driving a pig breaker respectively; the second controls the lighting sets and incandescent lamp circuits, while the third controls the arc lamp circuits. There are 14 10-ampere 16-hour arc lamps installed for lighting the works, besides a complete installation of incandescent lamps for the offices, etc. The hoist motor is controlled by one of Messrs. Scott and Mountain's special crane-type liquid reversing switches, and drives the hoist through a double set of spur gearing. An automatic electric brake is fitted to the motor, so as to bring the hoist to a standstill in the event of the current being cut off for any reason. The motor for driving the pig breaker is also controlled by a liquid reversing switch, and is capable of withstanding heavy overloads for short periods.

BOATING EXHIBITION.

A boating exhibition is now open until March 15 at Earl's Court, which contains a very representative show of motor launches. This exhibition has been instituted by the Thames Boatbuilders' Protection Association in the interests of boat-building and kindred trades, not only on the Thames, but also on other rivers in the kingdom and around the coast, and it is proposed to make this an annual institution. The exhibits are well displayed in the Prince's and Ducal Halls, while the lake in the adjoining grounds is used for trial of crafts. The Board of Trade has granted a certificate under the Patents, Designs, and Trade Marks Act, 1883, by which provisional protection for six months is secured for all inventions shown at this exhibition. The band of the Grenadier Guards and vocal concerts contribute to the amusement of the visitors. Punctually at 3 p.m. on March 1 the chairman of the Exhibition Committee, Mr. J. N. Salter, introduced Sir F. D. Dixon-Hartland, M.P., the chairman of the Thames Conservancy, who declared the exhibition open. A vote of thanks proposed by Mr. S. F. Beevor having been carried by acclamation, a tour around the exhibits was made, followed by a trip on the lake in the Thames Valley Launch Company's electric launch "Perseus." This launch is fitted with W. Rowland Edwards's patent single-lever gear, in which one wheel switches the current on or off, and drives the boat ahead or astern as desired at intermediate speeds and also steers. This is the simplest way of working a launch yet shown. The cells are always in series (thus avoiding the trouble caused when they are used in parallel), and the pitch of the propeller regulates the speed. A similar launch is shown in the Ducal Hall worked by a lever, the steering and driving of which is effected by a lever instead of a wheel. As it is only necessary to deflect the lever in the same direction in which the boat is required to go, it is evident that the merest tyro can handle the launch effectively without previous experience. Such a boat, 22ft. long, carrying six to eight persons comfortably at the rate of six miles an hour for about 35 miles without recharging, is fitted with a 2-h.p. motor and 22 Leitner accumulator cells of 44 volts and 160-180 amperes. The same company also show an electric motor (Beevor-Edwards's design) especially built for launch work, and now very largely used for this purpose. Also Beevor-Edwards's patent switch, giving two speeds ahead and two astern by means of one handle. In this switch there is no burning of the contacts, as the "make" and "break" is independent of the main switch. This switch is very suitable for electric cars. Non-corrodible connectors (W. Rowland Edwards's patent) made of antimony and lead, and containing a ridge on the nuts, which ought to increase the thoroughness of the connections and obviate the corrosion of the brass studs inside, thus making good acid-proof connections between accumulator terminals are also exhibited.

James Taylor, Chertsey, shows a very fine 23ft. launch worked by a 30 E.P.S. battery yielding 35 amperes, which will enable the boat to keep up a speed of 25 miles for six or seven hours. This launch is also worked very simply by a small wheel controlling a switch having four contact arms made by the firm. The accumulators are fixed underneath the floor, and are not removed when being charged; a charging board for making the necessary connections is concealed under the seat.

E. Andrews and Co., Maidenhead, show two 20ft. 6in. electric launches, entirely their own make. They are fitted with Andrews's patent 4-h.p. motor, fitted with carbon brush gear, developing a speed of 750 revolutions per minute. The boat will run about 50 miles without recharging.

E. A. McLachlan, Chiswick, shows a portable boat propeller, which is made in various sizes from ⅛ h.p. to 2 h.p. One of ½ h.p. when attached to a 14ft. dinghey would develop a speed of four to six miles per hour. These motors can be fixed on any boat without alteration in place of the ordinary rudder.

Various motor launches with electric ignition are exhibited, such as the "Popular," by Lister and Sons, 246, Harrow-road. In these boats the electric spark system of ignition has been adopted. The current is obtained from an accumulator, operating through a spark coil. The accumulator will run about 1,000 miles with once charging, and only costs 1s. for recharging. The insulated firing-pin extending through the sparking plug in the cylinder head is charged with electricity. The spark breaker, a solid steel rocking arm operated from the exterior, when brought in contact with the firing-pin, produces an electric current. The points of contact between these two are driven apart automatically, and as they separate forcibly, a live spark is the result. The sparking plug may be removed in a moment by unscrewing it from the cylinder head, thereby exposing both contact points for inspection. The electrodes are adjustable for wear. By means of this sparking device, the time of ignition may be retarded or accelerated at the will of the operator. The same firm exhibit a magneto-sparker, for which they claim an improvement over others It is mounted on a strong pin, on which it rocks. The square base or

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pedestal is fastened to floor of boat, and a spring attached to the bottom of the magneto draws it towards the flywheel of the engine. The armature is completely enclosed, and the magneto may be sprinkled with water without damage. It requires six Leclanché cells to furnish the initial spark. As after starting the magneto will make its own spark, these batteries will last a very long time.

F. R. Leith and Co., Piccadilly, exhibit the "Lozier." On Alfred Burgoine's "Rochester" the ignition is produced by an electric spark in the firing chamber of the cylinder, the electric spark being furnished by battery cells of proper strength. The platinum sparking points are mounted in a small cover over the admission valve and kept cool by the inflowing vapour, and making it possible to see and test the spark by removing four small screws only.

Geo. Neil and Co., 38, Fenchurch-street, E.C., show Truscott petrol motors with electric ignition, the gear of which is, when the launch is once started, switched over to a small dynamo.

There are several side shows, in one of which Mr. Charles Franklin, of the Lowther-arcade, shows how even a small application of electricity can be made to pay. He employs a one-cell eight-ampere accumulator to drive a contact breaker, which operates upon a steel needle, by means of which metal articles are engraved.

LEGAL INTELLIGENCE.

HAMPSTEAD ELECTRIC SUPPLY.

In the Chancery Division of the High Court on Saturday, the case of Read *v.* the Hampstead Electric Supply Company, Limited, came before Mr. Justice Byrne on a motion for judgment in a debenture-holder's action.

Mr. Eustace Smith, who appeared in support of the motion, said that the company had issued five different sets of debentures, "A," "B," "C," "D," and an unnamed debenture. The company carried on two distinct businesses—viz., the business of supplying electricity, and also a jobmasters' business. The "A" debentures were only secured on the business for the supply of electricity. The "B" had a first charge on the jobmasters' business, the other debentures having a charge on the jobmasters' business as well as the other property of the company. The plaintiff himself held some "A" and "C" debentures. The principal money became payable if the company made default for a period of three months in the payment of interest, and that default had happened. An effective resolution had been passed for the winding-up of the Company. The "B" debentures had appointed a receiver, under the powers in the trust deed, and a receiver had been appointed on behalf of the other debentures by the order of the Court. He asked for a declaration as to charge.

Mr. Cartmell, on behalf of other debenture holders, said he desired to have an enquiry as to priorities.

Mr. Justice Byrne said that this was a very special case. He should order an enquiry as to what were the debentures to which the property of the company was liable, and also as to the property comprised in them. The enquiry would also extend as to what were the respective priorities and an account of what was due. Order accordingly.

SECONDARY GENERATOR DISTRIBUTION COMPANY.

The Court of Appeal, consisting of Lords Justices Vaughan Williams, Stirling, and Cozens-Hardy, on Saturday heard the appeal of Mr. Adam Scott, a shareholder in the National Company for the Distribution of Electricity by Secondary Generators, from an order of Mr. Justice Wright refusing to grant a petition for the compulsory winding up of the company, which was in voluntary liquidation. The grounds which the appellant put forward for asking for a compulsory order were—first, that there were matters requiring searching investigation, which could only be obtained by a compulsory winding-up order; and, secondly, that such an order would tend to the recovery of a large sum of money which would benefit the whole body of shareholders.

Mr. Gore-Browne, for the respondent, said the matters with which the liquidator was now asked to deal occurred 19 years ago, and if he proceeded to an investigation he would at once be met by the statute of limitations.

Mr. Scott argued that the statute did not commence to run in the case of directors who had committed breaches of trust until the breaches alleged had been discovered.

In the result, **Lord Justice Williams** said he would give the liquidator the opportunity of showing his good faith in the matter. He would adjourn the case for a fortnight, which would allow of the liquidator making a report with reference to the alleged presents of shares and other matters which had been brought into question.

EDISON-BELL PHONOGRAPH.

On Friday, in the Chancery Division of the High Court, before Mr. Justice Swinfen-Eady, the case of the Edison-Bell Consolidated Phonograph Company was mentioned.

Mr. J. D. Charlton said he had to apply on behalf of the Edison-Bell Consolidated Phonograph Company for an interlocutory injunction to restrain the defendant, Henry Whitehouse, of Sheffield, from infringing the plaintiffs' letters patent No. 16,212 of 1888 and No. 19,153 of 1889, having connection with inventions and improvements in phonographs, until the trial of the action. He added that an injunction had already been obtained against the manufacturer and against the user of the instruments in question.

His Lordship granted the application, the costs to be costs in the action.

THE SMOKE NUISANCE.

Central London Railway Summoned.

Another batch of summonses was heard at the West London Police Court on Friday, taken out by the Hammersmith Borough Council against the Central London Railway Company for causing a nuisance by allowing quantities of dense black smoke to issue from their shafts at the generating station of their electric works at Shepherd's Bush. There were nine summonses in all.

Sanitary Inspector Brown gave evidence as to the result of his observations on the shafts, and in answer to Mr. Avory, who represented the company, said he had read in the report of the proceedings of the Council that there was a division as to whether the summonses should issue or not, on the ground that the Company were doing their utmost to abate the nuisance.

Mr. Henry R. D. Hooper, landlord of the Pavilion Hotel, Wood-lane, and a member of the Borough Council, said the works had been a great nuisance ever since they had been erected.

Mr. Avory mentioned that the company had expended upwards of £2,000 in alterations since the hearing of the last summonses. They were doing their best to comply with the law, having regard to the statute which compelled them to supply the public with trains.

Mr. Rose said he was bound to convict, but as the company had not shown any recklessness in carrying out their works he should only inflict a penalty of £5 in each summons, making £45 on the nine, with 10 guineas costs.

GLASGOW TRAMWAYS.

A Question of Speed.

In the Glasgow Sheriff Court on Wednesday judgment was given in the action brought by Mr. Thos. Simpson, coalmaster, of Pollokshields claiming penalties from the Corporation for contravening the Board of Trade regulations by running their tramways at a greater speed than eight miles an hour. Twenty four contraventions were alleged against the respondents. The sheriff heard evidence some time ago, and granted absolution, holding that a private individual had no title or interest to prosecute. An appeal was taken to the Court of Session, which recalled the sheriff's decision and sent the case back to him. In view of the instructions from the Court of Session the sheriff on Wednesday found two of the charges proved, and fined the Corporation the maximum penalty of £10 for each contravention and £3 expenses.

Notice of intention to appeal was given.

APPOINTMENTS VACANT.

Mains Superintendent, Oldham, £100 per annum, March 10. Particulars in our advertisement columns.

Shift Engineer, County of Durham Electrical Power Distribution Company, £108 per annum, March 13. Full particulars in our advertisement columns.

Marine Engineer, Corporation electric light and power station, Carlisle, 35s. per week, March 18. Full particulars in our advertisement columns.

Daughtsman, accustomed to the designs of electrical instruments preferred, Manchester district. Full particulars in our advertisement columns.

Mechanic, experienced in the running and testing of electric motors, wiring, and switch construction. Full particulars in our advertisement columns.

Electrical Draughtsmen, knowledge and experience of station switchgear, Ferranti, Limited, Hollinwood, Lancashire. Full particulars in our advertisement columns.

Works Engineer to superintend construction of pumping machinery in shops, and afterwards to take charge of erection and starting same in England. Full particulars in our advertisement columns.

COMPANIES' MEETINGS AND REPORTS.

CITY OF LONDON ELECTRIC LIGHTING.

Directors: George Herring (chairman); Joseph Bevan Braithwaite, jun.; Herbert Samuel Leon; Colonel B. H. Martindale, C.B.; Frederick W. Reynolds; Philip D. Tuckett. Engineer: Frank Bailey. Manager and secretary: J. Cecil Bull.

Abstract of report of the directors to be presented to the shareholders at the ordinary general meeting of the Company to be held at Winchester House, Old Broad-street, E.C., on March 12, 1902, at 2.30 p.m.:

The expenditure on capital account during the year ended Dec. 31, 1901, amounted to £154,004. 7s. 3d. The total revenue for the year amounted to £250,080. 0s. 11d., from which must be deducted the following items: expenses of generation and distribution, £85,211. 17s.; rent, rates, taxes, general and special charges, £35,836. 4s. 10d.; transfer to repairs and maintenance fund, £25.000; interest on loans, etc., £1,605. 3s. 2d.; interest transferred to debenture stock premium redemption fund, £1.143. 2s. 9d.; leaving £101.283. 13s. 2d.; to which must be added the balance brought forward from 1900, £11,342. 19s. 2d.; making a total available revenue of £112,626. 12s. 4d. Of this sum the following amounts have been distributed or provided for: interest on first and second debenture stock for year ended Dec. 31,

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1901, £27,601. 11s. 2d.; interim dividend on £400,000 6 per cent. preference shares, paid in August last on account of the distribution for the year, £11,350 ; transfer to reserve fund, £15,000 ; leaving a balance of £58,675. 1s. 2d. The directors now recommend that the following dividends for the year ended Dec. 31, 1901, be declared, subject to the deduction of income tax, to members registered on the books of the Company at the closing of the transfer books on Feb. 26, 1902: Preference shares Nos. 1 to 40,000, 12s. per share, being a distribution for the year at the full rate of 6 per cent. Of this sum 6s. per share was paid on account in August last, leaving a balance of 6s. per share for present distribution. Ordinary shares, Nos. 40,001 to 110,595, 10s. per share, being a distribution at the rate of 5 per cent. for the year. This will absorb £44,612. 0s. 4d., and leave a balance of £14,063. 0s. 10d., which your directors propose to carry forward. The generation and distribution expenses for the year, including repairs and renewals, were 43·02 per cent. of the gross earnings as compared with 61·13 per cent. for 1900, 49·31 per cent. for 1899, 36·1 per cent. for 1898, 31·3 per cent. for 1897, 34 per cent. for 1896, 36·87 for 1895, 46 for 1894, and 54·2 for 1893. The average price per unit obtained in 1901 was 4·54. On Feb. 19, 1902, there were 573,768 8-c.p. lamps (equivalent) applied for, out of which 557,164 were connected, and the customers numbered 10,786. The Board of Trade units sold during the year 1901, excluding public lighting, were 11,526,951 as compared with 11,272,968 for 1900. The directors have placed the balance of "premiums on issues," amounting to £47,360. 17s., to a debenture stock premium redemption account, and have credited such account with £1,143. 2s. 9d. from revenue account for interest. They have also made the following transfers from revenue account: £15.000 to the credit of reserve account ; £25,000 to the credit of repairs and maintenance fund, against which the repairs and renewals for the year, amounting to £17,959. 8s. 3d., have been charged, resulting in a net credit of £7,040. 11s. 9d. Cross notices of appeal to the House of Lords have been lodged by the Corporation and by your directors. Pending the decision of the House of Lords, the lighting of the public thoroughfares is being considered by your Company on the same terms as heretofore. In pursuance of the intimation made by him to the shareholders at the last ordinary general meeting, Sir David L. Salomons resigned his seat on the Board. Your directors desire to place upon record their appreciation of and thanks for his able services to your Company during so many years. They unanimously elected Mr. George Herring as chairman in place of Sir David L. Salomons. They much regret the death of Mr. Edward Lucas on Sept. 9 last, by which your Company lost the services of a director who had always endeavoured to further its best interests, and who was most attentive to his duties. In accordance with the articles of association, two of your directors, Mr. George Herring and Mr. Fredk. Wm. Reynolds, now retire, and, being eligible, offer themselves for re-election. Messrs. Pannell and Co. retire, and, being eligible, offer themselves for re-election.

REVENUE ACCOUNT.

Dr.	Public lighting. £ s. d.	Private lighting £ s. d.
Generation of Electricity—		
Coal and other fuel	4,909 5 6	51,241 2 8
Oil, waste, and stores	239 9 10	2,384 14 5
Water	143 5 2	1,421 7 1
Proportion of salaries	517 0 0	5,143 0 0
Wages and gratuities	1,195 15 1	10,338 5 0
Sundry expenditure	115 18 2	1,021 5 9
Generation expenses	£7,120 13 9	£71,549 14 11
Distribution of Electricity—		
Proportion of salaries	290 10 0	1,116 13 4
Attending mains and street boxes	81 8 7	869 4 3
Wages, etc., to linesmen, fitters, etc.	1,396 0 1	319 3 7
Wages, etc., to transformer men, and sundry stores	—	1,459 14 8
Carbons and other materials	840 13 6	168 9 4
Generation and distribution expenses	£9,729 5 11	£75,482 11 1
Rents, Rates, and Taxes—		
Rents payable	597 5 11	5,375 13 6
Rates, taxes, and lighting	1,102 14 1	9,924 7 2
Management Expenses—		
Directors' remuneration and salaries	872 9 8	7,852 7 4
Printing and stationery	96 1 4	864 12 1
General establishment charges	65 12 5	590 11 11
Meter reading	—	543 4 2
Auditors' fees	13 18 6	125 6 6
Trustees' fees	10 10 0	94 10 0
Legal charges	154 19 3	1,394 13 6
Special Charges—		
Rebates and various fines	63 16 3	760 10 10
Bad debts and reserve	—	1,234 3 4
Official testing of meters	—	7 4 6
Insurances	187 4 8	1,685 2 2
Claims and allowances to reservists	27 16 11	250 12 10
Professional charges	0 14 6	6 10 6
Repairs, etc., *re* properties sublet	—	246 9 9
Rating appeal	71 16 3	646 6 0
Expenditure arising from fires	20 0 0	180 0 7
Smoke nuisances, fines and costs	25 0 0	225 0 0
Stamp duty, second debenture stock	—	275 13 0
Depreciation on furniture, etc.	26 4 6	217 0 11
Total expenditure	£13,065 10 2	£107,982 11 8
Total of both public and private lighting		£121,048 1 10
Balance carried to net revenue account		127,201 13 8
		£248,249 15 6

Cr.	£ s. d.	£ s. d.
Sale of current	—	218,159 14 4
Revenue under contracts	13,412 3 5	—
Meter rentals	—	8,231 11 11
Rents receivable	404 6 0	6,779 11 11
Transfer fees	4 17 2	81 9 4
Rental of fittings, testing fees, etc.	—	1,176 1 5
	£13,821 6 7	£234,428 8 11

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£ s. d.
Capital account—amount received	1,805,950 0 0
Sundry tradesmen and others	28,625 0 0
Sundry creditors on open accounts	5,571 5 8
Interest on debenture stock accrued to date	14,357 6 7
Sundry deposits from consumers	1,341 3 2
Advance on freehold property	2,600 0 0
Provision for doubtful debts	1,200 0 0
Depreciation and repairs and maintenance fund	97,216 0 2
Reserve account	15,000 0 0
Debenture stock premium redemption account	48,503 19 9
Capital contingency account	33,410 8 3
Stores adjustment account	1,977 8 2
Net revenue account—balance at credit thereof	58,675 1 2
	£2,114,427 12 11

Cr. Expenditure and Assets.	£ s. d.
Capital expenditure	1,910,434 19 4
Stores at stations and elsewhere	44,105 3 7
Sundry debtors for current supplied	89,218 2 6
Other debtors and payments in advance	1,988 9 5
Cash at bankers and in hand	9,436 1 11
Investments at cost and dividends accrued thereon	59,244 16 2
	£2,114,427 12 11

NEWCASTLE ELECTRIC SUPPLY.

Mr. J. Merz presided over the general meeting of the shareholders in this Company at Newcastle on the 27th ult., and, in moving the adoption of the report and balance-sheet, called attention to the fact that in addition to the 1,405,604 units distributed in the area of the Company, there had been produced and sold to the Walker and Wallsend Union Gas Company, Limited, 1,156,779 units, the total units produced for consumption being 2,562,383. The cost of the units distributed was 1·9d., against 2·3d. per unit in the previous year, the price received being 3·82d., against 4·09d. per unit. The cost of producing the units sold to the gas company was ·7d. This latter were all produced at the central station, Wallsend. The units distributed in Newcastle were nearly all produced at Pandon Dene. There had been laid during the year 69 miles of additional mains, including seven miles of transmission mains from the central to the sub-stations in Newcastle district. The Company had now 1,673 consumers, being 513 more than at the end of the previous year, the total representing 112,000 8-c.p. lamps, an increase of 40,000 on the year. The gross revenue of the Company was £4,180 more than the previous year, to which had to be added the sum of £6,511 received for the units sold to the gas company. He then referred to the unnecessary and unwarrantable delay which the Company experienced in getting permission from the Corporation to carry out the work sanctioned by Parliament and passed by the Board of Trade, the final decisions of the Board of Trade having been entirely in favour of the Company. These delays, he said, had cost the Company at least four months' time, including the most profitable winter months, and in the past year they had practically reaped no benefit from the expensive extensions. Since the end of the year the central station at Wallsend had been connected with all the sub-stations in the Newcastle and Gosforth area, and in consequence the costs had been reduced by nearly ½d. per unit, the weekly output of the central station being at present nearly 100,000 units. The motion, having been duly seconded, was adopted.

An extraordinary general meeting was afterwards held, at which the capital of the Company was increased by £200,000, half ordinary and half preference shares, which will rank equally with the existing shares respectively.

NEWCASTLE AND DISTRICT ELECTRIC LIGHT.

The ordinary general meeting of this Company was held in Newcastle under the presidency of Mr. John Milburn.

The **Chairman,** in submitting the annual report and accounts for adoption, said the Company had been in a sort of transition state during the past year. They had been erecting new works and carrying on at the same time the old works. They had done this, however, fairly satisfactorily, for he believed they had the distinction of being the only Company in the kingdom that had derived most revenue from electric lighting as compared with capital. Referring more particularly to the accounts, the chairman mentioned the depreciation reserve fund. The directors thought it right to give the shareholders notice that they had in their minds a rather more conservative policy—viz , to put aside a large amount every year with a view to meet not only depreciation, but also as a sort of mortissement, for the life of a company was not perpetual. They had now passed the chrysalis stage. They were going to add some splendid new works in the Close, costing nearly £80,000, to their earning power. With a little more expenditure they hoped to complete these works, and by that time they should have adapted themselves to all modern requirements, and would be able to economise even on their

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present very reasonable cost of production. They had been taxed to their utmost, and so far as work went they had a very busy sphere of action before them. He then formally moved the adoption of the report, including the declaration of the dividend, which was, after paying the interim dividend and interest on debentures and loans, to pay out of the surplus of the gross earnings of £11,911. 15s. 1d., the usual dividend of 5 per cent. for the half-year ended Dec. 31, which, together with the interim dividend paid in August last, made the dividend 6½ per cent. for the year.

Colonel Angus seconded the motion and it was adopted unanimously.

A resolution was afterwards adopted, increasing the remuneration of the directors to £600.

Sir B. C. Browne and Mr. Jno. D. Milburn, retiring directors, having been re-elected, the meeting closed with the usual vote of thanks to the chairman.

TELEGRAPH CONSTRUCTION AND MAINTENANCE.

The ordinary general meeting of the shareholders in this Company was held at the offices, 38, Old Broad-street, E.C., on Tuesday, Sir Robert Herbert presiding.

The report, which appeared in our last issue, was taken as read.

The **Chairman**, in the course of his remarks, said that on the present occasion the directors had the great pleasure of being able to submit the best report that had been presented to them as far as he was aware. An interim dividend of 5 per cent. had been paid, and they now proposed a dividend and bonus of 15 per cent., making a total return of £2. 8s. a share, or 20 per cent., free of income tax, for the year. The principal work done by the Company in the period under review was the completion of 15,000 knots of cable for the Eastern and Eastern Extension Companies, being the third communication between the Land's End and Australia which was carried out by their factories and ships, and which amounted to the large sum of £3,000,000. The work done by the Company's ship "Anglia" in connection with this cable was a record. The highest speed was maintained, averaging 190 knots a day, though the vessel went through the deepest water in which a cable had yet been laid—between Fremantle and the Cocos Irlands. That was the greatest depth to be found anywhere in the Pacific, in which the Pacific cable would be laid, being 3½ nautical miles in depth. The "Anglia" was about to lay the three shorter sections of the Pacific cable, which was to be completed within the present year. In order to complete the long section of this cable they had launched their fine new ship, the "Colonia," from which they expected great results. Referring to the subject of wireless telegraphy, he said the directors had no hostility to Signor Marconi, who had made very important developments in the system, which was now a good many years old. It was, however, difficult to deal with the matter seriously at the present moment. He might remind the shareholders that it was many years since the able manager of the company's guttapercha works, Mr. Willoughby Smith, made a practical connection between the mainland of Ireland and the Fastnet Rock lighthouse, so that they had shown themselves, at all events, not incapable of dealing with wireless telegraphy, if this should prove to be the best mode in which telegraphic messages could be transmitted. Connected as they were with cable construction, they, of course, had access to the highest scientific information on these subjects, and the opinion which they had been instructed to form was that wireless telegraphy had a distinctly and strictly limited field, and that it was not likely that the system would be able to transmit the heavy traffic of commercial messages with secrecy, speed, and certainty over very long distances. They were instructed that the use of submarine cables for the greater distances, at all events, would not be at all impeded by the progress of this remarkable development. He then formally moved the adoption of the report.

Sir James Pender seconded the motion, which was agreed to.

NATIONAL TELEPHONE.

The ordinary general meeting of this Company was held at Hamilton House, Victoria-embankment, E.C., on the 27th ult.

The **Right Hon. Sir Henry Fowler, M.P.**, occupied the chair, and moved the adoption of the report, which was summarised in our issue of the 21st ult. After referring to the principal items in the accounts, the Chairman said the chief event in the history of the Company during the period under review was the agreement which they had entered into with the Post Office in reference to the London service. He would like to call attention to one or two of the salient points of the agreement, which had been fully discussed in Parliament, and regarding which very strong opinions had been expressed. When the negotiations were begun Parliament had sanctioned the construction of a competing service in London, and the Company had to consider what was the wiser course to adopt in the circumstances. There were two alternatives open—either peace or war. War would have meant hostility for the Company at all points where it came into contact with the Post Office, and sooner or later a war of rates, for, after all, that was the artillery employed in a dispute of this sort. Such a war would have benefited nobody, and it must have ended after a time in the public insisting on the two fighting bodies coming together and making a settlement which possibly would not have been so good a settlement as that which had now been arrived at by amicable means. The Secretary to the Treasury in the House of Commons had stated that it would have been criminal for the Post Office or the Treasury to have consented to reckless, cut-throat competition at the expense of the general taxpayer of the country. That was the opinion of the Government, and the Board of this Company also thought that it would have been criminal for them to consent to reckless cut-throat competition of rates at the expense of the shareholders. That being so, the directors resolved to adopt the policy of peace, and he might say that on both sides the negotiations—and he spoke on this matter as an outsider—were conducted in the most able manner. Therefore, he thought that the negotiations deserved on the one side the confidence of the shareholders, and on the other of Parliament and the public. The Company was quite ready for competition, and all they asked for was equal terms. In London and elsewhere the Post Office had the advantage of not having to pay a royalty of 10 per cent., not, it should be remembered, on the net profit, but on the gross income. Then as to the rates, the Company were often contrasted with Germany and Paris. The rate in Berlin was £9 per annum as against £17 charged by the Company, but that as it stood was not a fair comparison. The Company's charge of £17 covered an area of 600 square miles, whereas the payment in Berlin was for only a distance of three miles from the central exchange. Beyond that the subscribers had to pay £4 a mile, and if they took a distance of six miles from the central exchange there—and that was not an extravagant distance in London—the rate would work out at £21 against £17 here. In Berlin, moreover, all calls made in the night had to be paid for at the rate of 2½d. each. In Paris the charge was £16 within the walls of the city, but there the subscriber had to pay for his own instrument and the cost of connecting it from the main line to his own house. Mr. Bethell, who was the general manager of a New York telephone company, had carefully investigated the Continental systems, and he came to the conclusion that the cost in Berlin, taking everything into consideration, worked out as high as the New York charge, which was £48 per annum, while the service was inferior. In Boston the rate was £32 per annum, and in Chicago £35. It should not be forgotten, moreover, that the service in New York covered only 20 square miles, as against 600 square miles in London. If the Company had been extortionate, he should like to know where the money had gone to. The average rate paid on their capital was only £4. 10s. 8d. per cent. for the year. With regard to the inefficiency of the service, he said that the Company had transmitted 723½ millions of messages during the past year, calculating two messages for every call, which he thought was fair. It was not to be wondered at that in a big business like that there should arise complaints now and again, but he must admit that he had been struck since his connection with the company with the extraordinary ability of the men by whom it was conducted. In conclusion, he formally put the motion for the adoption of the report and accounts.

Mr. George Franklin seconded, and the motion was adopted unanimously.

Resolutions were afterwards agreed to approving the Company's Bills in Parliament with regard to the undertaking within the city of Kingston-upon-Hull and within the Manchester telephone exchange area, and for other purposes.

The proceedings concluded with a vote of thanks to the chairman, directors, and staff.

BROMPTON AND KENSINGTON ELECTRICITY SUPPLY.

The ordinary general meeting of the shareholders in this Company was held at Winchester House, Old Broad-street, E.C., on Thursday week, Mr. Henry Ramie Beeton presiding.

The report, which appeared in our issue of 21st ult., was taken as read.

The **Chairman**, in the course of his few remarks in submitting the report and accounts for approval, said the capital account showed the usual increase in expenditure, due to the normal growth of business, but notwithstanding this, owing to the large provision for depreciation given effect to in the accounts, the net cost of their installation to-day was actually less than it was this time last year. To summarise the Company's position to-day the directors had written off about £50,000 from first to last since they began business 12 years ago, and they found themselves with a capital of £200,000 free from debt, and with a reserve of upwards of £30,000. Turning to the revenue account, notwithstanding that owing to forward contracts they did not benefit to the full extent from the lower price of coal which set in last year, their works cost—*i.e.*, their cost of production of electricity—showed a further reduction, and it now not only compared favourably with that of any station in the Metropolis with a similar output, but with that of any such station whatever its output. That, he ventured to think, was a record of which they might be justly proud, and which testified to the efficiency of their installation and to the judgment and care bestowed upon their station by their manager, Mr. Bowden. The item in the revenue account which called for some comment was that of rates and taxes, which showed an increase of upwards of £1,000 over 1900, and which now amounted to nearly 15 per cent. of their total annual expenditure. In this respect, of course, they suffered in common with all enterprises carried on in this country, and he could only say that such a liberal contribution to the rates should entitle them to the gratitude and consideration of their friends the local authority. With regard to the future, although the growth of private lighting was not quite so rapid now that their area was getting filled up, there was the promise of compensation in the growth of supply for power purposes, and he thought shareholders might look forward to the maintenance of their earning capacity with unabated confidence. He then formally put the motion for the adoption of the report, and that the following dividends be declared: (*a*) on the preference shares a dividend at the rate of 7 per cent. per annum for the half-year to Dec. 31, 1901, making, with the interim dividend already paid, 7 per cent. for the year; and (*b*) on the ordinary shares a dividend at the rate of 9 per cent. per annum for the half-year to Dec. 31, 1901, making, with the interim dividend already paid, 8 per cent. for the year.

Mr. Arthur Robert Germaine seconded the motion, and it was agreed to unanimously.

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Mr. H. R. Beeton and Mr. A. R. Germaine having been re-elected as directors, the meeting closed with the usual vote of thanks.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING.

The ordinary general meeting of this Company was held at 5, Great George-street, Westminster, on Wednesday afternoon, under the presidency of Sir Frederick J. Bramwell.

The **Chairman** moved the adoption of the report (which will be found in our last issue), and in doing so announced that to fill the vacancies caused by the decease of Mr. G. Ryder and Mr. A. S. Bolton, Mr. G. H. Hopkinson and Colonel R. E. Crompton had been elected to the Board. Turning to the accounts, he said that the number of the Company's consumers had increased from 2,324 to 2,605, and they had now 222,158 lamps connected. Although the Wood-lane station was not part of their undertaking, yet many of them were individually interested in it, and this Company obtained a portion of their electricity from it. Consequently, the shareholders would be glad to learn that it was working with complete satisfaction. The opportunity having arisen for acquiring the freehold of some land adjoining the station, the Board had done so. He next alluded to the excessive rating of the Company's property for parochial purposes, and concluded by formally putting the motion to the meeting.

Sir Charles Grant seconded.

Mr. J. F. Albright said he had expected to hear some explanation of what appeared to him to be the most disastrous report which the Company had issued. For the first time they had gone backwards. The dividend was 10 per cent., against 12 per cent. in the previous year, with a reduction in the amount carried forward of £2,900. In past years as much as £7,000 to £8,000 had been placed to the renewal account fund, but on the present occasion the amount was only £300.

Another **Shareholder** enquired whether the Wood-lane station would entirely supply this Company with current.

The **Chairman** replied that he did not think so. Replying to Mr. Albright, he pointed out that, owing to the impossibility of enlarging the capacity of their old stations, it had been necessary to go elsewhere to provide for their growing requirements, and that had cost money. The capital needed for this purpose was raised subject to its repayment by yearly instalments, and in that way the Company had a large additional expenditure to face. For the second half of the year the expenses at the new generating station were far less than in the first six months, and he trusted that next year the cost per unit would be diminished. As the new shares were issued at par, it was not unnatural to expect that the dividend would show a falling off.

The report was then adopted.

CHELSEA ELECTRICITY SUPPLY.

Presiding over the ordinary meeting of the shareholders in this Company at the Chelsea Town Hall on Wednesday, **Mr. J. I. Courtenay** said there was a diminution in the dividend of 1½ per cent. as compared with last year, but there was a considerable increase on the amount placed to depreciation. He was aware that the shareholders were greatly disappointed at the reduction of the dividend, but he firmly believed that it would be for the ultimate benefit of the property. The progress of the Company, though steady, had not been as rapid as the directors looked for, but the undertaking was now better able to bear the extra charges than at any previous period in its history. With the steadily growing income these appropriations would, in the near future, be readily met, and the financial position of the Company materially strengthened. The district promised a continuous increase in the demand. Leases were falling in in the southern portion during the next two or three years, and in the northern part in six or seven years' time. Building plans were already in existence for the development of these areas, and the demand therefrom was expected to be of a remunerative order. He moved that the report and accounts be adopted.

Major-General Webber seconded the motion.

A **Shareholder** criticised the management of the Company, and moved an amendment to the effect that the report be not passed, and that a committee of shareholders be appointed to investigate the affairs of the Company and to report to an adjourned meeting.

Mr. Dawes seconded the amendment.

Eventually, after a long discussion, the amendment was lost, and the report was passed.

NORTHALLERTON ELECTRIC LIGHT AND POWER.

The annual general meeting of this Company was held at Northallerton last week, Mr. C. E. L. Ringrose presiding.

The annual report stated that the accounts showed a trading profit before deducting interest in money of £211. 2s. 6d., and after paying £185. 2s. 11d. for interest on loans and debentures there was a balance of £25. 19s. 7d., which the directors proposed to carry forward. The profit for the last half of the year had been especially satisfactory. The alterations and additions mentioned in the directors' report had greatly increased the efficiency of the station, and reduced the year's expenditure for production of current, as compared with the previous year. The directors hoped that during the ensuing year the cost of production of current would be still further reduced. During the year 24,875 units had been supplied to private consumers, as compared with 18,315 in 1900. The directors had also obtained the contract for the town lighting on more satisfactory terms. The demand for current was steadily increasing, but the prosperity of the Company was still greatly hampered by the want of working capital. Further extensions to the mains and plants to enable the Company to secure fresh consumers were necessary, and the directors felt that it would be most prejudicial to the interests of the Company to issue any further debentures. They trusted now that the electric light had taken a firm hold of the town that they would receive further applications for shares from shareholders and other inhabitants of the district. The directors had appointed Mr. F. R. Batty, A.I.E.E., as their general manager, and he had given every satisfaction to them and the Company's consumers. Mr. Jackson, one of the directors, had resigned on account of leaving the neighbourhood, and Mr. Jno. Ernest Hutton and Mr. Long retired by rotation, and, along with Messrs. W. B. Peat and Co., the auditors, were eligible for re-election. The capital and liabilities were given as £8,185. 7s. 2d., and the property and assets £7,691. 2s. 3d. The balance-sheet showed an expenditure of £1,170. 19s. 8d.; balance carried down, £211. 2s. 6d.—total, £1,382. 2s. 2d. Against this there was: on accounts for installations and for current supplied to private consumers and for street-lighting, £1,322. 6s. 6d.; meter rents, £26. 9s.; apprentice premium received, £33. 6s. 8d.—total, £1,382. 2s. 2d.

Upon the motion of **Mr. John Walker**, seconded by **Mr. T. Boddy**, the report was unanimously adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Edinburgh.—The Corporation invite tenders for annual supplies from May 15 for the electric supply department.

Brisbane (Queensland).—The Postmaster-General invites tenders for a number of telephones. Tenders by April 14.

Baeau (Roumania).—The Mayor invites tenders for electric lighting of the town by March 15. The estimate is £5,646.

St. Pancras.—The Borough Council invite tenders for supplying overhead travellers. Tenders by March 14. Details in our advertisement columns.

Bournemouth.—The Town Council invite tenders for coal and ash conveyors, bunkers, etc. Tenders by March 15. Details in our advertisement columns.

Rockhampton (Queensland).—The contract for the municipal tramways, full particulars of which appeared in a former issue, will remain open until March 31.

Paris.—The Postal Telegraph Department, Rue de Grenelle, 103, invite tenders for 330,000 kilos bronze or copper wire and 190,000 copper joints. Tenders by March 13.

Stepney.—The Electrical Committee invite tenders for the supply, laying, and jointing of cables and conduits. Tenders by March 20. Details in our advertisement columns.

Madrid.—The Postal Telegraph Department invite tenders for 12 tons 3mm. and 3 tons 1¼mm. bronze wire. Price per ton not to exceed 2,280 pesetas. Tenders by April 5.

Burgess Hill.—The Urban District Council invite tenders for the construction of electricity supply works in the district. Tenders by March 12. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of electrical equipments for cars and tramcar trucks. Tenders by March 10. Details in our advertisement columns.

Ilford.—The Urban District Council invite tenders for motor and trailer cars, trucks, motors, and equipments. Specification, etc., may be obtained from Mr. John W. Benton, clerk, Public Offices, Ilford. Tenders by March 24.

Hackney.—The Electric Lighting Committee invite tenders for the construction and erection of three water-tube boilers and accessories, and water-softening plant. Tenders by April 9. Details in our advertisement columns.

Madrid.—The Public Works Department invite tenders for extensions to the San Sebastian tramways and working the same for not more than 60 years. Particulars may be obtained from the Department. Tenders by April 5.

Wallsend.—Tenders are invited for providing, fixing, and erecting a complete refuse destructor, pug mills, electric lighting machinery, electric crane and motor for driving same. Tenders by March 19. Details in our advertisement columns.

Ilford.—The Ilford Urban District Council invite tenders for supply of motor and trailer cars, trucks, motors, and equipments. Specification may be obtained at the offices of Mr. John W. Benton, clerk, Public Offices. Tenders by March 24.

West Ham.—The Corporation invite tenders for the erection of an electric generating station at Quadrant-street, Canning Town. Specification, etc., can be obtained from the Borough Engineer, Town Hall, West Ham. Tenders by March 11.

Bradford.—The Corporation invite tenders for the supply and delivery at Bradford of steel girder rails and fishplates. Specification, etc., may be obtained from Mr. J. H. Cox, M.I.C.E., city engineer, Town Hall, Bradford. Tenders by March 15.

Birkenhead.—The Corporation invite tenders for balancer, boosters, switchboard, and accumulator batteries. Specification, etc., can be obtained from Mr. W. Bates, borough electrical engineer, Electrical Engineer's Office, Craven-street, Birkenhead. Tenders by March 8.

Ilford.—The Urban District Council invite tenders for overhead line equipment, poles, etc., and underground feeder cables, etc. Specifications, etc., may be obtained at the offices of Mr. J. W. Benton, clerk to the Council, Council Offices, Ilford. Tenders by March 27.

Plymouth.—The Corporation invite tenders for Lancashire boilers, with mechanical stokers, steam, exhaust, and other piping, and

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ejector condensers, valves, etc. Specification, etc., can be obtained from Mr. E. G. Okell, borough electrical engineer, Prince Rock, Plymouth. Tenders by March 25.

Ilford.—The Urban District Council invite tenders for the supply of meters and demand indicators, house service fuse boxes, incandescent lamps, oil and engine-room stores, and cables, boxes, and jointing materials for year ending March 31, 1903. Tenders by March 11. Details in our advertisement columns.

Croydon.—The Town Council invite tenders for lighting the extension buildings at both the central polytechnic, Scarbrook-road, Croydon, and the branch polytechnic, Selhurst-road, South Norwood. Specifications, etc., may be seen at the Deputy Engineer's Office, Town Hall. Tenders by 11 a.m. on 11th inst.

Plymouth.—The Corporation invite tenders for the supply of electricity meters, cables (paper insulated), and transformers during the 12 months ending March 31, 1903. Specifications, etc., can be obtained from Mr. E. G. Okell, borough electrical engineer, Prince Rock, Plymouth. Tenders by March 25.

Elland.—The Urban District Council invite tenders for the supply of quick-speed engines for direct coupling to dynamos, dynamos, booster, and balancers, storage battery, switchboard, travelling crane, supply and laying of cables, and condenser apparatus. Tenders by March 11. Details in our advertisement columns.

Madrid.—Tenders are invited by the Spanish Government for the supply of 141 tons of iron wire for the Government telegraph service. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m. Tenders by April 2.

Dewsbury.—The Electricity Committee invite tenders for the supply, delivery, and erection at their generating station of cooling-tower and pond, piping, valves, and tank, centrifugal pump and motor. Specification, etc., can be obtained from the Borough Electrical Engineer, Electricity Works, Bradford-road. Tenders by March 10.

Oldham.—The Corporation Electricity Committee invite tenders for supplying the whole of the work and material comprised in Contract No. 4, which includes steam, exhaust, feed and drain pipes, feed pumps, feed heaters, tanks, barometric condensers, condenser pipes, oil separators, motor-driven pumps, tools, etc. Tenders by March 25. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of 6,000 tons of steel girder tramway rails and about 195 tons of steel fishplates, 125 tons of steel tiebars for tramway rails and 36 tons of bolts and nuts for fishplates, and 5,000 tons of granite setts. Specification, etc., may be obtained on application to Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders by March 17.

Heckmondwike.—The Electric Lighting Committee invite tenders for the supply and erection of the following plant for the extension of the electricity works: steam, water, and exhaust piping, etc., steam traction generator, storage battery and automatic reversible booster, alterations and extensions to main switchboard, condenser and oil separator, water-cooling tower, and underground traction and return feeders. Tenders by March 15. Details in our advertisement columns.

Brighton.—The Council invite tenders for supplying and laying telephone conduits and cables, erecting telephone poles, standards, arms, etc., fixing subscribers' instruments, supply of creosoted telephone poles, manufacture and supply of telephone insulators, oak arms for telephone poles, ironwork used in telephone construction, galvanised iron arm bolts, nuts and washers, hard-drawn, semi-hard, and soft copper wire, silicium bronze wire, iron and steel stay wire, insulated wires, lightning arresters, high-tension guards and test jacks, primary batteries, telephone instruments and telephone switchboard. Tenders by March 24. Details in our advertisement columns.

RESULTS OF TENDERS.

Sunderland.—The Town Council have accepted the tender of Dick, Kerr, and Co. for supply of car bodies.

Croydon.—The Town Council have accepted the tender of the British Insulated Wire Company for the supply of direct-current cables.

Liverpool.—The City Council have accepted the tender of Tetlow Bros., Hollinwood, Oldham, for the supply of seven steel Lancashire boilers at £705 per boiler.

South Lancashire Tramways.—Witting Bros. have obtained the contract for the whole of the sub-station equipment required in connection with the above tramway scheme.

Derby.—The Town Council have accepted the tender of W. T. Glover and Co. for supply of half a mile each of armoured and unarmoured cable, at £88 and £66 respectively.

Aberdeen.—The Town Council have accepted the tender of P. Tawse, at £3,918. 11s. 8d., for the bonding and part relaying of the track in connection with the electrical equipment of the circular route.

Maidenhead.—The Electric Lighting Committee have accepted the tender of McDowall, Steven, and Co., of Glasgow, for arc lamp posts—viz: special pillars intended for the water-logged area, £11. 5s. each; all other pillars, £10. 15s. each; wall brackets, £4. 5s. each.

Shipley.—The Urban District Council have accepted the tender of the International Electrical Engineering Company, Clun House, Surrey-street, Strand, W.C., for the supply, delivery, and erection, at their electricity works, of traction switchboard, boosters and balancers, and alteration to existing switchboard.

West Bromwich.—The Electric Lighting and Power Committee have accepted the following tenders: Babcock and Wilcox, two boilers and accessories; Parsons and Co., two steam dynamos and surface condenser; Cowans, Limited, boosters, switchboard, and connections; J. Mallin, extensions to buildings.

Barnstaple.—The Town Council have accepted the following tenders: (Section A) boiler-house plant, Babcock and Wilcox, £1,899; (B) steam and exhaust piping, Babcock and Wilcox, £1,113; (C and D) engine-house plant, Newton Electrical Works, £3,619; (E) switchboard, Newton Electrical Works, £616. 6s.; (H) accumulators, Ashmore, Benson, and Co., £1,031. 10s.; (I) crane, etc., Chatteris Engineering Company, £115; (K) artesian well, Johnson and Phillips, £264; (F) St. Helens Cable Company, £2,001. 11s. 6d.; (Section 1 and 2) buildings, Bryant and Thorne, Barnstaple, £3,789.

Doncaster.—The Corporation have received the following tenders for the supply, delivery, and fixing of a fuel economiser at the Corporation electricity works:

A. Locock, Limited, Coleham Foundry, Shrewsbury	£350	0	0
Clay Cross Company, Clay Cross, near Chesterfield	360	0	0
E. Green and Son, Economiser Works, Wakefield (accepted)	360	16	0
J. Carter and Sons, Stalybridge	362	10	0
Goodbrand and Co., Britannia Foundry, Stalybridge	361	0	0

Bournemouth.—The Corporation have received the following tenders for tramways:

Contract No. 13.—Cables, etc.—With stoneware ducts.

J. G. White and Co., Limited	26,873	0	0
J. G. White and Co., Limited (alternative)	22,988	0	0
Siemens Bros. and Co., Limited	24,056	3	1
W. T. Glover and Co., Limited	24,006	0	0
St. Helens Cable Company, Limited	23,875	10	6
W. F. Dennis and Co.	22,914	0	0
Western Electric Company	22,885	6	9
British Insulated Wire Company, Limited	22,398	2	1
British Insulated Wire Company, Limited (alternative)	21,835	9	3
W. T. Henley's Telegraph Works Company, Limited	22,274	15	5
Callender's Cable and Construction Company, Limited (accepted)	20,669	13	5
Johnson and Phillips (informal)	—		

With Howard conduits.

Siemens Bros. and Co., Limited	27,858	11	8
W. T. Glover and Co., Limited	25,551	0	0
St. Helens Cable Company, Limited	26,102	0	1
W. F. Dennis and Co.	25,395	4	9
Western Electric Company	25,662	19	3
British Insulated Wire Company, Limited	25,367	2	10
W. T. Henley's Telegraph Works Company, Limited	24,871	14	11
Callender's Cable and Construction Company, Limited	24,509	10	10
Johnson and Phillips (informal)	—		

Contract No. 12.—Overhead equipment.

G. Hill and Co.	£22,901	1	9
Lowdon Bros. and Co.	21,419	16	4
British Insulated Wire Company	19,203	14	9
Macartney, McElroy, and Co., Limited	19,734	10	0
J. G. White and Co., Limited (accepted)	18,933	3	0
J. G. White and Co., Limited (alternative)	19,533	3	0
British Thomson-Houston Company, Limited (informal)	£—		

BUSINESS NOTES.

TRACTION.

Gloucester.—An electric tramway expert is to be consulted as to the Corporation scheme for establishing light railways.

British Columbia.—The net earnings of the British Columbia electric railway for January show an increase of £948.

Southport.—A deputation from the Southport Corporation visited Bradford this week to inspect the municipal electric tramway system.

St. Helens.—Negotiations are still proceeding between the Corporation and the tramways company with reference to the carriage of goods on the tramcars.

Gourock.—The Greenock and Port Glasgow Electric Tramways Company have granted the request of the Gourock Town Council for ½d. fares within the burgh.

Chelsea.—The Parliamentary Committee of the Borough Council have directed steps to be taken to oppose the Metropolitan District Railway Bill in Parliament.

Blackpool.—The Blackpool and Fleetwood Tramroad Company having decided on new passing-places in Dickson-road, are negotiating with the Corporation for the loops required.

Rhondda.—A meeting of colliery workmen held at Pentre on Saturday night, unanimously passed a resolution in favour of the Urban District Council's electric tramway scheme.

Accrington.—The clerk has been instructed to renew the negotiations with the tramways company with reference to the purchase by the Corporation of the Church and Clayton sections of the lines.

Torquay.—The Town Council have decided to apply for the powers to enable them to introduce electric trams. Two private companies are also seeking for similar powers with regard to Torquay and district.

Southport and Lytham Tramroad Bill.—The Court of Referees of the House of Commons has decided that the Preston and Lytham Light Railway Company have no *locus standi* to appear against this Bill.

Hull.—The city engineer has been instructed to proceed with the construction of the tramway on the Hedon-road between the Hull and

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Barnsley Railway and the sanatorium and the paving of the road with wood.

Shoreham.—At the meeting of the Urban District Council this week a draft agreement was received from the tramways company. After a desultory discussion further consideration of the matter was postponed.

The Maldens and Coombe.—By the casting vote of the chairman at a special meeting of the Urban District Council it was decided to oppose the scheme of the London United Tramways Company as regards Kingston-hill.

Blackburn.—A proposal is before the Town Council to extend the tramway on the cemetery route to the Bull's Head at Wilpshire. The residents in the Audley district are agitating for the extension of the system to their district.

Light Railways.—Answering Mr. Bryce in the House of Commons on Monday, Mr. G. Balfour stated that a Bill to amend the Light Railways Act is in course of preparation, but he was not able to say when it will be introduced.

Motor Regulations.—The Automobile Club have issued a circular protesting against (*a*) the restrictions as to speed in respect of light vehicles, and (*b*) the restrictions as to tare weight and width of heavy vehicles used for commercial purposes.

Rothesay.—Messrs. Dick, Kerr, and Co., the contractors for the reconstruction of the tramway here between Rothesay and Port Bannatyne, have made a start with the work. Passenger traffic during the reconstruction is to be carried on by 'buses.

Leeds.—The City Council on Wednesday confirmed the appointment of Mr. John Baillie Hamilton, of Glasgow, as general manager of the Leeds tramways, at a salary of £900 per annum, with an increase at the end of two years to £1,000 per annum.

London County Council Tenders.—Tenders for electric tramcars were received at the meeting of the London County Council on Tuesday and forwarded unopened to the Highways Committee, who will report upon them and recommend a tender for acceptance.

Oldbury.—The District Council have decided to withhold their consent to the proposal of the Birmingham and Midland Tramways Company to construct tramways in the district from Oldbury to Langley and Blackheath unless the company agree to certain terms.

Private Bills.—In the House of Lords on Monday the Baker-street and Waterloo Railway Bill was read a second time. In the Commons the Garston and District Tramways and Electric Supply (Transfer) Bill and the Metropolitan District Railway Bill were read a second time.

Liverpool.—The recommendation of the Tramways Committee to appeal against the decision of Mr. Justice Wills at the last assizes in the case against the Corporation for assault and false imprisonment (mentioned in last week's issue), was referred back at the Town Council meeting on Wednesday.

Huddersfield.—A trial trip has been made with one of the cars which has been fitted with the Westinghouse magnetic slipper brake, in order to test the brake. The trial is said to have given every satisfaction. It is promised that the whole of the bogie cars will be fitted with automatic slipper brakes in time.

Richmond.—Several new proposals have been submitted to the Tramways Committee of the Town Council by the London United Tramways Company with reference to the introduction of electric tramways into the town. It is believed that the local authority will take a favourable view of the company's offers.

Madras Monorail Tramways.—*Indian Engineering* states that the promoter of the above scheme is authorised, with consent of the District Board of Chingleput, to construct, maintain, and use a system of tramways to be constructed on the pattern known as "Ewing's monorail tramway" in the district of Chingleput.

Birmingham.—The opposition to the Corporation scheme for constructing tramways in the Edgbaston and Harborne district have agreed to oppose any future Bill in Parliament or provisional order promoted by the Corporation, or any company or person, which would authorise tramways in the Hagley or Harborne roads or any adjacent roads.

Brighton.—A public meeting of ratepayers was held on Wednesday to protest against the employment of outside labour in connection with the municipal tramways. A resolution was passed calling upon the Tramways Committee to import no further similar labour from outside the town, but to make all future appointments from efficient local residents.

Penge.—Formal consent has now been given by the District Council to the Croydon Electric Tramways Bill, in which it is proposed to construct a connecting line between the terminus at South Norwood and Penge and Beckenham. The Council are about to enter into an agreement with the British Electric Traction Company, who are promoting the scheme.

Glasgow.—The electric cars are now running on the section between Glasgow and Shettleston in place of the horse cars which have up till now been plying on the route. Should the weather continue favourable for work in the construction of the line, a further extension of the electric car system is expected to take place very soon from the city to Barrachnie and also to Tollcross.

Wolverhampton. — Mr. Luntley, of Birmingham, has been appointed manager of the Corporation tramways at a salary of £250 per annum. It is stated in the local Press that Mr. N. Lea, of Birmingham, the electrical expert appointed by the Corporation to report upon the Lorain system of traction, has expressed himself as satisfied with what he has witnessed.

St. Marylebone.—A letter from the Parliamentary Department of the London County Council has been addressed to the Borough Council to the effect that the County Council do not intend to proceed further with tramway No. 3 in their Tramways and Improvements Bill before Parliament, which would have been situate partly in the St. Marylebone district, and that the proposal will in due course be struck out of the Bill.

Lancaster.—A discussion took place at the last meeting of the Town Council in reference to the reopening of the negotiations with the Lancaster and District Tramway Company as to the purchase of their horse line to Morecambe, with a view of connecting Lancaster and Morecambe by an electric tramway. No decision was come to, the general opinion being that the next step to be taken in the matter rests with the company.

Prestwich.—A special meeting of the Council was held on Wednesday for the purpose of considering the tramways question. A resolution was adopted that as the Manchester Corporation had not complied with the Council's demand for the return of the agreement with respect to tramways, the clerk be instructed to commence forthwith the necessary legal proceedings for the recovery of the document, or to have it declared null and void, as counsel may advise.

Rossendale.—The consent of the local authorities to the Bill containing the proposals of the Rossendale Valley Tramways Company for constructing a network of tramways to connect Manchester with a number of places in North-East Lancashire and the West Riding has now been obtained, and the Examiner of Standing Orders of the House of Commons has reported that the Standing Orders have been complied with, and the Bill will now go for first reading in the Commons.

Hastings.—Mr. Murphy has had another interview with the Tramways Committee of the Corporation with reference to his front-line scheme of tramways, as a result of which the committee have decided that the lines to Hollington and Ore must be completed before the front-line is interfered with, and on those conditions only would the latest Bill be supported These recommendations will be submitted to the next meeting of the Council for confirmation or otherwise.

Colwyn Bay Light Railway.—Colonel Boughey, C.S.I., and Mr. Henry Allan Steward, Light Railway Commissioners, held an enquiry on Wednesday at Colwyn Bay into the application of the Llandudno and Colwyn Bay Light Railway Company for permission to make a deviation in the route sanctioned by the original order, and for an extension of time. In the result the Commissioners approved the principle of the application, but with certain stringent restrictions and qualifications.

American Methods in England.—A New York message this week says that Mr. Davies, of the British Electric Traction Company, is at present in that city arranging to bring back with him to England a number of American trolley car operators to introduce American methods on the lines owned by his company. Mr. Davies is said to be offering high salaries, and is obtaining the best men possible. They will be set to work giving instructions to English operators on their arrival here.

Mexborough and Swinton Tramways.—Mr. Campion, one of the examiners of private Bills, sat on Monday to receive proofs of compliance with the Standing Orders in the case of this Bill. The parliamentary agent for the Bill made application for a postponement. He said that negotiations were taking place between the parties, and were almost complete, and he hoped that if the Bill were put back the consent of the Swinton District Council would be given. The proceedings were accordingly postponed.

Scarborough.—An estimate has been prepared and deposited at the House of Commons showing the cost of the works proposed to be authorised by the Scarborough Tramways Bill. The total cost of these works is given by the engineer at £48,289, of which the whole will be spent upon the construction of the tramways with the exception of £1,982, which will be expended on road widening. The estimates do not include any sum for the equipment of the system. The share capital of the proposed company is to be £95,000.

Central London Railway.—A remarkable state of things existed on the "Twopenny Tube" on Wednesday morning. It appears that owing to the unusual number of passengers—caused probably by those using other routes being driven underground by the fog—the railway was unable to deal with the traffic. Trains were immediately filled at Shepherd's Bush, not even standing room being left on the platforms. At all the stations the platforms were crowded, and it was not until nearly half-past 10 that any headway could be made.

Halifax.—The Tramways Committee, after receiving a deputation from the Amalgamated Association of Tramway Men, have decided that it is impracticable in the tramway system to introduce a fixed daily limit of working hours. The committee have also resolved not to accede to the request for payment of overtime at the rate of time and a quarter, but have instructed the manager to keep a sufficient staff of employés in order to reduce overtime to a minimum. The committee have declined to reopen the question of dismissal of a prominent driver.

North Lindsey Light Railway.—The Light Railway Commissioners Colonel Boughey, C.S.I., and Mr. Henry Allen Steward) on Friday held an enquiry into the application of the promoters of the North Lindsey light railway for an amended order to authorise a diversion in their junction with the Great Central Railway Company at Frodingham. The decision of the Commissioners was practically a confirmation of the order of 1901, consenting to the new line, subject to the consent of the Great Central Railway for a convenient place of entry, and also the consent of Lord St. Oswald to the price of land.

Tube Vibration.—In answer to Sir G. Fardell in the House of Commons on Monday, Mr. Gerald Balfour stated that the Board of Trade had been in communication with the Central London Railway Company with reference to the report of the committee on vibration.

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When the company have had an opportunity of further considering the matter, he should ask them to inform him how they propose to give effect to its recommendations. The Department will take care that the committee or committees to which the Bills are referred shall have their attention directed to the report which has been made by Lord Rayleigh's Committee.

Perth (W.A.).—A special dispatch to the *Financial News* from Perth, W.A., under date March 1, states that the traffic on the Perth Tramway Company's lines is so great that the 35 cars now in use are insufficient to carry the passengers. Mr. Allen H. P. Stoneham has therefore recommended the purchase of six more cars, carrying 100 passengers each. The city of Perth is growing rapidly. There are no empty houses, and building is going on briskly and land increasing in value along the tramway routes. The various suburbs are anxious to be connected with the main line, and it is probable that extensions will be undertaken shortly promising good returns.

Presentation.—There was a large gathering at the Raglan Hotel, West Hartlepool, on Friday last, the occasion being a presentation to Mr. T. A. Cunliffe, A.M.I.M.E., who has been power superintendent of the Hartlepool electric tramways for the last 12 months, and who is leaving to take up an appointment under the Kent Electric Power Distribution Company. The presents consisted of Wordingham's book on "Central-Station Design," a very handsome dressing-case, together with a gold, diamond, and ruby brooch for Mrs. Cunliffe, subscribed for by the staff and employés of the Hartlepools electric tramways. The presentation was made by the company's local electrical engineer, Mr. T. Tyson.

Birkdale.—Messrs. F. W. Smith and Co., Limited, of Southport, who have obtained the contract for the overhead equipment of the electric tramway system in the town, commenced work on Monday on the section extending from Lord-street West along Aughton-road to the railway station. It is hoped that the section will be entirely completed in about a month from now. Subsequently the remaining sections in Birkdale will be constructed. It may be mentioned that Messrs. F. W. Smith and Co. carried out similar work on the Churchtown section of the Southport Tramway Company's system, and did all the overhead equipment, as well as the lighting of the car-sheds. This work, which was inspected last week, was passed without alteration.

Levenshulme.—It was agreed at the last meeting of the Urban District Council to write to the Manchester Corporation, stating that the Levenshulme Council would hold them liable for the loss which they had sustained and were sustaining by the delay in the purchase of the tramways in the Council's district, consequent on the agreement entered into with the Manchester Carriage and Tramways Company by the Corporation with reference to the antedating of the date of purchase of the undertaking in certain districts; and further, that in case of dispute that it be referred to the Board of Trade or to a referee to be appointed by the Board of Trade under the terms of the agreement entered into with the Manchester Corporation on Oct. 31, 1898, to settle what (if any) compensation should be paid by the Manchester Corporation to the Levenshulme Council.

Bradford.—On Wednesday the Tramways Committee held a special meeting to consider the question of tramway extensions. A resolution passed some time ago to construct double lines in certain districts was rescinded. Double lines will, however, still be constructed up Wakefield-road and along Tong-street to the present terminus, and from that spot a single line will be laid to Birkenshaw and Drighlington, where a connection will be made with the system about to be constructed in Batley, Dewsbury, and Birstall. It was furthermore decided to construct a single line from Bankfort to Shelf. Otley-road will be supplied with double lines to the terminus of the section at Undercliffe. Satisfactory reports were made of the progress of the conversion in Cheapside It is expected that electric cars will be run in Manningham-lane for the first time on Saturday.

"Tube" Ventilation.—As we mentioned in a recent issue, steps are now being taken to bring about the efficient ventilation of the Central London Railway tunnels. A fan has been placed at the base of the lift shaft at Bond-street Station to remove the vitiated air, fresh air taking its place by passing down the shafts at the various stations under the ordinary atmospheric pressure. The fan, which is 48in. in diameter and is electrically driven, is capable of exhausting the air of the tunnels in three minutes and a fraction. The apparatus was tested for the first time early on Tuesday morning in the presence of Mr. Cunningham, the general manager of the line, and Mr. P. D'Alton, the chief engineer, and was found to answer most satisfactorily. The intention is to place the fan in working every night after the trains have ceased running, and thus to obtain a thorough daily renewal of the atmosphere. If necessary, the number of fans will be increased.

Eccles.—As the result of negotiations between representatives of the Town Council and the Salford Tramways Sub-Committee, the following arrangements have been arrived at: the tramways are to be completed within the following periods—viz.: to Eccles Cross within three months; Patricroft Bridge and Monton Green within six months; Peel Green, nine months; Worsley boundary, 12 months; Parrin-lane and Monton Bridge, 18 months. The Salford Corporation are to be at liberty to supply the electrical energy required, subject to six months' notice by the Eccles Corporation requiring the Salford Corporation to take electrical energy from the Eccles Corporation. The Salford Corporation are to pay the Eccles Corporation for all electrical energy supplied by them up to 150,000 Board of Trade units per annum, at the rate of 1¼d. per unit, and for every unit above 150,000 units, but not exceeding 250,000 units, 1¼d. per unit, the above prices to be subject to revision at the end of every five years from the date of the agreement.

Newport (Mon.).—The Select Committee of the House of Commons presided over by Mr. W. S. Caine on Tuesday resumed its consideration of the Newport Corporation Bill, when evidence was given on the tramway portion of the Bill, to which opposition is waged by the Great Western Railway Company. Expert evidence was given for the promoters by Mr. Parshall, civil engineer, who said he considered the level crossing of the Great Western Railway at Newport was the easiest to negotiate that he had ever seen in his life. There was no necessity for the erection of a bridge, which, moreover, would be a very expensive matter. He could give instances of cases where trams crossed the main lines of railway on a one-minute service without accident. Evidence was also given in favour of the scheme by Mr. Alfred Edward White, Hull borough engineer, and Mr. Cottrell, general manager of the Liverpool Overhead Electric Railway. This closed the promoters' case in respect of the proposed tramways, and the enquiry into the remaining portions of the Bill was proceeded with.

South Lancashire Tramways.—We are informed that the order for the whole of the sub-station equipment required in connection with the above tramways scheme has been placed with Messrs. Witting Bros., of London. The contract comprises the complete electrical equipment of the two sub-stations at present arranged for, together with some auxiliary machinery for the power station. There will be three 250-kw. and three 150-kw. synchronous motor-generators, one 56-kw., one 20-kw., and one 35-kw. positive feeder boosters, three 8-kw. and three 10-kw. negative feeder boosters, one 40-kw., one 14-kw., and one 24-kw. reversible boosters for battery charging, and one 240-ampere, one 80-ampere, and one 140-ampere milking boosters, complete in all respects with the necessary spare parts. The whole of the power station equipment, including steam generators, condensing plants, cooling tower, cranes, and motor-generator, together with the equipments of the first 50 cars, is being furnished by the same firm, all this work being well in hand. Altogether the order for electrical machinery alone represents about 11,500 h.p.

Warrington.—The Light Railway Commissioners, consisting of Colonel Boughey and Mr. H. A. Steward, held an enquiry on Tuesday to consider the application of the Warrington Corporation for powers to construct a light railway as an extension of their tramway system through Stockton Heath from Stafford-road along Grappenhall-road to the Latchford swingbridge. It was stated that the estimated cost of the scheme was £25,814. After hearing evidence, the Commissioners held a consultation, after which Colonel Boughey said they had decided to submit a report to the Board of Trade for a light railway for both sections. They also thought that there should be an absolute minimum of 32ft. roadway in Stockton Heath, with a reasonable width of footpath, especially in regard to parts opposite to St. Thomas's Church and the Red Lion Inn. They also thought that the penny fare was not an unreasonable charge from Stockton Heath Market-place to Rylands-street, Warrington. They also sanctioned the points of agreement between the Ship Canal Company and the Corporation, and if any further differences occurred between them they would hear both parties on the subject.

Kent.—At the quarterly meeting of the County Council last week the Parliamentary Committee reported that there are four new schemes for laying a tramway or a light railway on roads within the county, one being the Croydon and district electric tramway, which will pass over main roads in Penge and Beckenham, another being for a light railway between Canterbury and Herne Bay, and the others being two light railway schemes in the neighbourhood of Dover. The committee thought that it is time that county councils, as main road authorities, should take some action with a view to protecting themselves more effectively than the law now permits against the occupation of the main roads by tramways and light railways, and they suggested that the Council should request their representatives on the County Councils' Association to call attention to this important matter, with a view to action being taken for putting these profitable undertakings under more stringent conditions and heavier obligations before they are permitted the use and occupation of roads which have been hitherto kept free for ordinary traffic.

Vienna.—A Vienna correspondent, under date March 2, says: "M. Waldeck-Rousseau's accident in Paris coincided with an outburst of popular indignation in Vienna against the increasing danger of the new electric tramway traffic. On Thursday last there were no fewer than five persons knocked down by the electric tramcars, three of them being killed and two seriously injured. So far it has been impossible to bring home the responsibility to the right quarter. The public blame the drivers. The company blames the public for what it has the audacity to call their carelessness, overlooking the fact that the Viennese were accustomed to the fastest driven cabs in Europe, and yet accidents were of rare occurrence The electric tramway drivers have a good deal to say for themselves. The signal they use is a bell worked with the foot. If too frequently rung it is liable to prove a nuisance to the passengers. The brake does not always work properly. Then the company has recently reduced the time allowed for driving from one point to another, which naturally implies an increase of speed. So far as an opinion can be formed by the public, the speed on most of the lines is too high—at all events, until both the drivers and the public get more accustomed to what is for Vienna a new system of locomotion."

Devonport.—The new Beaumont section of the Corporation tramways was inspected by Major J. W. Pringle, of the Board of Trade, last week. Major Pringle afterwards held an enquiry with reference to the tramway accident at the bottom of Albert-road the previous Friday, when a car, after descending the hill, left the metals and ran into the railings at the bottom. Major Pringle had been to the Royal Albert Hospital and seen the driver, Thomas Coomstock, who stated that the car was under control until it reached Ross-street, when a couple of carts being in the way, he rang his bell. No notice seemed to be taken of his warning, and to prevent a collision he applied a sand brake, but found it was empty. He then applied the hand brake more vigorously, but this made the wheels skid. He then let his wheels run by slackening the brake, then applied the electric brake, which made the wheels again skid, with the consequence that he left

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the metals at about 30 miles per hour. The cause of the accident was lack of sand. He had never come down the hill before without sand. There was only one sand-box available for one rail. After hearing a mass of evidence the case of speed came up, and the inspector said that the speed originally authorised of six miles an hour might be reduced to four, and then a stop at Ross-street might be made on the way down. The enquiry then closed.

Shields Electric Railway Bill.—This Bill came before a Select Committee of the House of Lords on Tuesday. In opening the case for the promoters Mr. J. D. Fitzgerald said the only present communication between North and South Shields was some antiquated and not very convenient ferries. What was proposed by this Bill was a tube railway of the type with which people were now familiar in London. The railway would commence with a station immediately adjoining the South Shields Station on the North-Eastern Railway, so that persons travelling by that railway would be able to get into the underground railway by merely crossing the street. A tunnel would run under one of the main streets, gradually descending to the river and passing under it at a proper depth, and the railway would terminate in North Shields at a convenient distance from the existing railway station there. The promoters, he said, had agreed upon clauses with the Tyne Improvement Commissioners, and they were not in opposition to the Bill. A basis of agreement had also been arrived at with the municipal authorities of the boroughs of North and South Shields and with the Duke of Northumberland, who was an owner of property in the neighbourhood. In the result Lord Elgin, who presided over the committee, said they were of opinion that the Bill should proceed. Consideration of the clauses was postponed.

Croydon.—The Croydon and District Electric Tramways Bill was before one of the examiners of private Bills at the House of Commons last Monday, when allegations of non-compliance with the Standing Orders in respect of certain portions of the scheme were presented by Mr. Cripps on behalf of the London County Council, and by Mr. Pritt for the Beckenham Urban District Council. The object of the Bill is to construct tramways in Surrey, London, and Kent, some of them forming a circular route from Croydon to Sutton and Mitcham, while others join the South Norwood lines by tramways through Penge and Beckenham and the high-level entrance to the Crystal Palace. Mr. Frere, for the promoters, admitted that he had not received all the consents for the new tramways, but submitted that as he had the consents relating to the existing tramways those should be taken as narrowing the requirements of the Standing Order. It was contended on the other side that the consents of the local authorities having jurisdiction over two-thirds of the line were necessary, and this view was upheld by the examiner. The matter will now come before the Committee on Standing Orders, who will decide whether or not the Standing Orders may be dispensed with in order that the Bill may proceed this session. A temporary stoppage of the electric tramcar service occurred here on Friday afternoon owing to a failure of the current.

London United Tramways.—The Highways Committee of the London County Council presented an interesting report at the usual weekly meeting of that body on Tuesday with reference to the London United Tramways Bill of the present session. The committee, in fact, recommend to a certain extent a change in the policy usually adopted by the County Council in similar cases. The tramways referred to, the report states, would be about a mile in length, and would be between (*a*) Glenthorne-road and Goldhawk-road, and (*b*) Goldhawk-road and Uxbridge-road, with two small junction lines, together about 2½ chains long, from Studland-street. The committee are of opinion that these short lengths should be constructed and owned by the Council, and should be leased to the company on terms to be arranged. They think, however, that the Council would probably not be willing to grant a lease to extend beyond the date in 1909, when the company's existing lines, of which the new tramways will form part, will become purchasable by the Council under Section 43 of the Tramways Act, 1870. While taking this view as regards the short lengths of tramways above described, the committee are still of opinion that the Council should not give consent to the construction by the company of the other proposed lines within the county, as they would not be so intimately connected with the company's existing system, as the Council itself will probably in the near future revive its proposals which had to be withdrawn last year on account of want of co-operation from the local authorities for tramways along the same routes. The committee made a recommendation in accordance with the above suggestions. A similar proposal was made by the Parliamentary Committee in the case of the Croydon and District Electric Tramways Bill. The tramway in question would run along Kent House-road in the Lewisham district, and the committee recommend that this line should also be constructed by the Council and leased to the company on terms to be arranged.

Belgian Rails for London.—At the meeting of the London County Council on Tuesday a discussion took place on the recommendation of the Highways Committee that the Council accept the tender of P. and W. Maclellan, Limited, of Glasgow, for the supply of 3,250 tons of track rails, 1,850 tons of slot rails, 670 tons of conductor rails, 125 tons of fishplates, 155 tons of bolts and nuts, and other accessories required in connection with the reconstruction for electrical traction of a portion of the Council's tramway; and that this firm should be allowed to sublet to the Societe Anonyme des Acieres d'Angleur, Tilleur by Liège, Belgium, the tender for the supply of rails. The price tendered was £41,742. 4s. 4d., while the lowest price for English manufactured rails was £50,463. 15s. The full report of the committee appeared in our issue of the 21st ult. In the discussion which arose on an amendment to refer the report back to the committee, Mr. W. Steadman asserted that English steel rails were better and more durable than Belgian rails, a fact which had been proved by testing. He reminded the Council that, while the Central London Railway Company got their rolling stock from America, their rails were made in England. Colonel Rotton asked whether the Council would have any guarantee in sending this contract to Belgium that their principles in regard to the payment of wages would be carried out. They were going to allow the whole of their tramway rail work to be given to foreign workmen, who they knew would not get trade union rates of wages, or work the hours of labour recognised as reasonable in this country. If the Council persisted in forcing the report through they would sacrifice their principles, and take away from themselves all right to discuss rate of wages and hours of labour hereafter. Mr. J. W. Benn, replying for the committee, said the Council were there as the representatives of the ratepayers of London, and he regarded it as a first principle that they should secure work at the lowest price consistent with efficiency and good quality. He added that the contractors would undertake to pay the usual rates of wages. If they sweated their workers, they would be visited by penalties which could be inflicted. Further, he would remind the Council that the English firms refused to submit their rails to the test submitted to by the Belgian makers. Ultimately, the amendment having been put to the meeting and lost by a large majority, the report was adopted.

London County Council Tramways.—The London County Council (Tramways and Improvements) Bill came before Mr. Campion, one of the examiners of private Bills, at the House of Commons on Monday. The promoters were represented by Mr. Cripps, parliamentary agent, who said they did not propose to offer proofs in regard to tramways 1, 2, 3, and 4, and, therefore, the parts of the Bill dealing with those lines would be abandoned. The first of these was to commence at Stoke Newington and terminate at Hackney; the second was from St. Pancras to Marylebone; the third from Shoot-up-hill, Marylebone, to Paddington; and the fourth from Paddington to Maida-vale. As to No. 5, commencing in Hammersmith, and terminating at Lower Richmond-road, Putney, he presented the consents of the Hammersmith and Fulham Borough Councils. The Wandsworth Borough Council did not consent, but they did not represent the road authority over the requisite length of the route to enable them to veto the scheme. He offered no proofs in regard to tramway No. 6, commencing at Bridge-road, Chelsea, and terminating in Westminster. With regard to tramway No. 7, commencing on the Victoria-embankment, Westminster, and running to the Bridewell, Blackfriars Bridge, the London County Council were both the local and road authority. He offered no proof as to tramway No. 8—from Putney to near The Grove on Clapham Common—and tramway No. 9, to be situated wholly in the parish of Streatham, commencing by a junction with the existing tramway in Streatham High-road, opposite the Tate Free Library, and terminating at the county boundary on the bridge carrying the road over the River Graveney. He also offered no proof in regard to tramway No. 10, which, situated wholly in the parish of Greenwich, would commence by a junction with the existing tramway in Trafalgar-road, and terminate near the southern entrance to the Blackwall Tunnel, or in regard to tramway No. 11, which, commencing in the parish of Greenwich, was to have terminated in the parish of Charlton. With regard to several Woolwich lines, he produced consents. In the case of tramway No. 13, running from Deptford to Lewisham High-street, he could offer no proofs so far as it related to the parish of St. Paul, Deptford. The examiner said there would be a report of non-compliance in respect of No. 13. Mr. Cripps said he had consents, and would offer proof in regard to tramways 15 and 15A, to run from Camberwell to Lordship-lane, and from Camberwell by a junction with No. 15 to a place near the Theatre Metropôle.

LIGHTING AND GENERAL.

Taunton.—The next issue of Corporation stock includes £33,326 for electric lighting.

Grimsby.—The Town Council will shortly borrow £17,000 for electric light extensions.

Worksop.—The Urban District Council have obtained sanction to borrow £8,000 for electric light extensions.

Colchester.—The Town Council have confirmed the proposal to borrow a further £8,500 for electric lighting.

Lowestoft.—The Guardians have appointed a committee to report upon the lighting of the workhouse by electricity.

Commercial Cable Co.—The directors have declared a quarterly dividend of 1¾ per cent. on the capital stock, payable April 1.

Salford.—The Town Council on Wednesday appointed a committee of enquiry into the tenders and specifications, etc., of the electricity department.

Newcastle Electric Supply Bill.—The Duke of Northumberland is withdrawing his petition against the Newcastle-upon-Tyne Electric Supply Bill.

Gravesend.—The Sub-Electric Committee have selected a carrier (No. 168E) and a pillar (No. 141E). Positions for arc lamps have been agreed upon.

Lecture.—A lecture on "Electricity" will be delivered by Mr. Halford Strange, M.Sc., in the Large Town Hall, Reading, on Thursday, March 13.

West Bromwich.—A sum of £10,000 is to be borrowed for the extension of electricity plant and buildings. Tenders will be found in another column.

Alton.—An agreement has been entered into between Mr. John Grover and the Council relative to the supply of electricity for public lamps at Grayshott.

Walton-on-Naze.—The Urban District Council have granted permission to a company to open up roads in connection with a proposed supply of electric light to the town.

Metropolitan Electric Supply Co.—The directors recommend the payment of a final dividend for the year 1901 at the rate of 7s. per share, making 6½ per cent. for the year.

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Stock Exchange.—The Stock Exchange Committee have ordered the Central Electric Supply Company's £250,000 4 per cent. guaranteed debenture stock to be quoted in the official list.

Newcastle-under-Lyme.—Mr. A. A. G. Malet has held an enquiry into an application for sanction to borrow £8,615 for the erection of electricity works on land adjoining the gasworks.

Mutford and Lothingland.—A report by Mr. J. S. Enright, A.I.E.E., on the subject of electric lighting in the rural district is before the Executive Committee of the Rural District Council.

Charing Cross and Strand Electricity Supply Corporation.—Warrants for the half-year's dividend (12 per cent.) on the ordinary shares of this Corporation have been posted to the shareholders.

London County Council.—At Tuesday's meeting of the Council it was agreed to lend the Southwark Borough Council £6,150 for electric light installation and £6,725 for street-lighting purposes and electric meters.

Broadstairs and St. Peter's.—We understand that the Urban District Council have approved of the draft agreement with the Isle of Thanet Electric Tramways and Lighting Company, Limited, for public lighting.

New Branch.—Messrs. F. W. Smith and Co., Limited, electrical and mechanical engineers, Southport, Eccles, St. Helens, Leigh, and Wigan, have opened central offices at 35A, Victoria-buildings, Manchester.

Romford.—The Urban District Council are discussing in committee letters from Messrs. Crompton and Co. and from the Metropolitan Electric Tramways Company, Limited, with reference to electric lighting and tramways.

Aberdeen.—On going to press we are informed that the Town Council have decided not to act at present upon the decision of the Watching, etc., Committee with regard to Union-street, to which we refer in another note.

Lydney.—At the meeting on Tuesday a lengthy discussion took place on the subject of electric lighting, and finally it was resolved not to sign a provisional agreement with the Chepstow company though advised by a committee to do so.

Monmouth.—The Town Council on Monday decided upon the expenditure of £395 for a 50-h.p. locomotive boiler, £1,115 for an alternator for the generating station, and £100 for other minor appliances for the same purpose.

Long Eaton.—The Local Government Board have deferred giving their sanction to the loan of £1,600 (part of the £15,000 applied for) for the extension of generating plant until the Council have finally decided to carry out such extension.

Stepney.—The rector has entered into negotiation with the Stepney Borough Council as to the church being lighted by electricity instead of gas. If an agreement is arrived at, this will be the first in the East-end churches to be lighted by electricity.

Broughty Ferry.—Mr. George Balfour has been appointed consulting electrical engineer to the Town Council to carry out an electric lighting scheme. The station will be built at the gasworks. The total expenditure will amount to about £1,500.

West Hartlepool.—The last report of the borough electrical engineer (Mr. Frederichs) stated that during the four weeks ended Feb. 25 34,500 units had been generated at the Corporation electric station. The number of 8-c.p. lamps, or equivalent, in use was 22,707.

Post Office Telephones.—The Post Office telephonic system has now been in operation for a week, and 250 subscribers are using the wires. Exchanges are to be opened shortly at Westminster, Kensington, Chiswick, Richmond, Twickenham, Wimbledon, and Putney.

Gloucestershire Electric Power Bill.—In addition to the Gloucestershire County Council, the Rural District Councils of Stroud, Wheatenhurst, and Dursley, and the Lydney Gas Company, have withdrawn their opposition to the Gloucestershire Electric Power Bill.

Winton.—A meeting was held last week under the auspices of the Winton and District Ratepayers' Association, at which a motion was passed heartily supporting the action of the Bournemouth Corporation in promoting an order for supplying Winton and district with electric energy.

St. Helens.—A local paper says electric lighting has now been got into full force at St. Helens Colliery. The lights can be seen for a considerable distance, and on dark nights have a very imposing effect when viewed from the trains travelling between Workington and Maryport.

Australian Cable.—Reuter's Melbourne correspondent states that a deadlock has occurred between the Commonwealth Government and the Eastern Extension Company. The former offered a 10 years' contract, which the latter refused. The Cabinet has decided to make no fresh proposals.

Oxford.—It is proposed to supply electricity to the university's departments of geology, zoology (Hope), mineralogy, chemistry, and human anatomy, and also to the Pitt-Rivers building, and to the photographic room opening on the Museum Court, at a total outlay of £1,255 for cables, etc.

Personal.—We are informed that Mr. Oswald Dewey, chief of the Notting Hill Electric Lighting Company's meter-testing department, who formerly had charge of a similar department for the Manchester Corporation, has accepted an important post in the meter department of Messrs. Ferranti Limited.

Fulham.—The borough electrical engineer has reported that from Feb. 10 to 24, 1902, applications equivalent to 522 8-c.p. lamps had been received, making a total in all of 29,319 8-c.p. lamps. Three hundred and sixty two services had been completed and connected to the mains, representing an equivalent of 14,336 8-c.p. lamps.

Liverpool.—From the end of the present quarter the prices for electrical energy supplied for lighting to any consumer in any one establishment are to be as follows: up to 3,000 units per quarter, 3½d. per unit; beyond 3,000 units per quarter, 3d. per unit. The other prices charged for electrical energy will remain as at present.

Sale of Plant.—The receiver and manager of the New British Incandescent Electric Lamp Company, Limited, 8, Hythe-road, Willesden, is prepared to receive tenders for the purchase of the plant, complete equipment, and lease of the above premises. Full particulars of this opportunity will be found in our advertisement columns.

Southgate.—At the meeting of the District Council on Wednesday a petition was received from parties who were against the Council opposing the North Metropolitan Electrical Power Distribution Company's Bill. After discussion, it was agreed that the chairman should confer privately with signatories as to the intentions of the Council with regard to electric power.

London Gazette.—The partnership existing between W. Fulton Fair and F. Leslie, trading as W. Fulton Fair and Co., electrical engineers, 83 to 87, Theobalds-road, W.C., has been dissolved by mutual consent. The day fixed for hearing the application for the discharge of G. H. Bently, 63, Cross-lane, Earlestown, Lancs., is April 3, at 12 noon, at Court House, Palmyra-square, Warrington.

St. Annes.—The mains in St. David's-road North are to be extended 130 yards to as far as Mr. Wade's property. The Urban District Council have resolved that from April 1 next the price for electric lighting for private consumption be reduced from 7d. and 4d. per unit to 7d. first hour and 2d. per unit after, with the alternative of a flat rate of 5½d. per unit, and for power and heat 4d. per unit, all to be subject to a discount of 5 per cent. if payment is made within 14 days.

Worthing.—The Town Council's electric lighting business is steadily increasing. At the end of last year applications had been received for about 1,200 more 8-c.p. lamps than were connected, and the applications received up to the end of last week were equivalent to 1,500 8-c.p. lamps over and above the number connected. When these 1,500 connections have been made, the total (including the public lamps, which were equivalent to about 2,000 8-c.p. lamps) will be brought up to 7,750 lamps.

Barnsley.—The Guardians have now received a reply from the Local Government Board to their application for powers to establish a separate plant for the generation of electric light at the workhouse, stating that as there had been no complaint that the present system of lighting the workhouse by gas had proved a failure, or that the fittings were worn out or ineffective, it did not appear to the Board that the Guardians would be justified in incurring the expense of laying down the necessary plant.

Blackpool.—When the minutes of the Tramways and Electricity Committee came up for confirmation on Wednesday, an amendment was proposed that the resolution "asking for power to borrow £14,000 overspent on the electricity works" be referred back to the General Purposes Committee, and that that body appoint an investigation committee—outside the members of the Tramways and Electricity Committee—to enquire into the working of that department. After discussion, the amendment was lost.

Ilkley.—A large number of the ratepayers have presented a petition to the District Council praying for the installation of the electric light. On Wednesday the District Council decided to reply to the petitioners to the effect that the Council desire, if possible, to arrange for obtaining a supply of electricity in bulk from the Yorkshire Electric Power Company, as they deem this course would obviate the heavy outlay which would be incurred if the local authority undertook a scheme of their own. It was also decided to make enquiries of the Yorkshire Electric Power Company as to when they expect to be in a position to supply the township.

Maidenhead.—Tenders for the construction of a chimney for the central station are being advertised. Upwards of 130 applications have been received for the position of resident engineer, and these have been handed to the consulting engineers, who will select 25 applications for consideration by the committee. Three tenders have been received for "easy" wiring, and these have been referred to the consulting engineers for examination and report. The positions for the arc lamps have been agreed upon, and the committee have sanctioned the provision of two additional enclosed lamps. A design for bracket lamps submitted by the consulting engineers has been approved.

Derbyshire and Nottinghamshire Electric Power Bill.—The Bill promoted this session by the Derbyshire and Nottinghamshire Electric Power Company, which was incorporated last session, will pass as an unopposed measure through the House of Commons, no petitions having been presented against it. The object of the Bill is to repeal so much of their Act of 1901 "as prohibits the construction of stations for generating electricity elsewhere than on the lands described in the schedule to that Act." It is contended that Section 81 of the schedule of the Electric Lighting (Clauses) Act, 1899, deals sufficiently with generating stations erected elsewhere than on lands set out in the schedule to the Act of the company.

Davis and Timmins, Limited.—The directors' report for the year ended Dec. 31, 1901, shows that the net profit for the year, including £1,990. 17s. 11d. brought forward, after allowing for depreciation and commission to managers, is £11,764. 13s. The interim dividend paid in September last on the preference shares absorbed £1,800, leaving a balance of £9,964. 13s. to be dealt with, which the directors propose to appropriate as follows: to the payment of six months' dividend on the preference shares to Dec. 31, 1901, £1,800; to the payment of a dividend at the rate of 8 per cent. per annum on the ordinary shares for the year ended Dec. 31, 1901, £3,760; to be placed to general reserve, £2,000; and leaving £2,404. 13s. to be carried forward.

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Hoddesdon.—At the last meeting of the Urban District Council satisfaction was expressed at the circumstance that the cost of the electric lighting order had not been so great as at first expected. The Council have yet to decide whether they will deal with it themselves or dispose of it to some company.

Anglo-Belgian Telephone.—The Brussels correspondent of the *Morning Post* states that the telephonic cable which will establish communication with Great Britain has just been delivered by the makers to the Belgian authorities. The laying of the cable will begin very shortly, and will take about six weeks.

St. Paul's Cathedral.—It is expected that the lighting of the choir by electricity will be complete by Easter. Other parts of the edifice will be lighted in a similar manner by the autumn as far as present funds permit. As originally designed, there are to be eight fittings under the dome, but at present only four will be completed.

Bishop Auckland.—At Tuesday's meeting of the Urban District Council a letter was read from the Edmundson Syndicate stating that their arrangements with the Cleveland Electrical Company for supply to Bishop Auckland in bulk had fallen through, therefore they proposed to begin at once with the work of putting down a station for the supply of electric light to Bishop Auckland.

Helensburgh.—At the meeting of the Town Council on Saturday it was reported that the Council had been in communication with the member for the county in regard to the recent erection of the overhead telegraph wires in the centre of the town, and as the result of his representations Lord Londonderry had ordered an investigation to be made into the whole matter, and the report would receive his attention.

Electric Power Bills.—Owing to the illness of Sir William Houldsworth, the chairman of the Committee of the House of Commons on the Leicestershire and Warwickshire, Gloucestershire, and other Electric Power Bills, the committee postponed its first meeting from Tuesday to yesterday. Requisitions have been received from the Midland Railway Company and the Warwickshire County Council for permission to withdraw their respective petitions against the first of the above-named Electric Power Bills.

Obituary.—The body of Mr. Rupert Greville Williams, the inventor of the telepantograph, was found in a greenhouse near his residence at Heywood on Saturday. He had apparently shot himself with a revolver. It is reported that, besides the anxiety and disappointment which he had latterly experienced on account of his invention, Mr. Williams had suffered acutely from neuralgia. The Coroner said he knew deceased. He was a most brilliant man, and he could not have committed suicide except during a moment of insanity. The jury passed a vote of sympathy with the widow and members of the bereaved family.

Dudley.—In their last report the Electric Lighting and Gas Committees recommended that a new incandescent lamp for better lighting of the streets be adopted, and that incandescent lamps be put on every pole through the town, and on every pole from Queen's Cross to Holly Hall, from Queen's Cross to Netherton, and on the Castle Hill-road. They also recommended that the cables for incandescent lighting be laid at the same time as those for arc lighting, and that a new cable be laid through the town for the additional incandescent lights. It was also proposed that the Council take into consideration the lighting of public courts and alleys.

Scarborough Telephones.—The Corporate Property Committee have received Mr. A. R. Bennett's report upon the installation of the municipal telephones in Scarborough. Mr. Bennett suggested that if there were 600 subscribers in Scarborough—which was the average number for a town the size of Scarborough—municipal telephones would pay if the charges were £5. 17s. 6d. a year for full service, £3. 10s. a year and ½d. per call, or £2. 10s. a year and 1d. per call. The sub-committee have been authorised to make enquiries in the town as to the amount of support likely to be given if a municipal telephone exchange was established.

Brighton.—Major C. E. Norton has held an enquiry into the application of the Corporation for sanction to borrow £1,853 for purposes in connection with electric lighting extension. Mr. J. Christie, resident electrical engineer, said that the Corporation were building a new generating station at Southwick, and the property in Spring-gardens was acquired for the purpose of laying a culvert to carry cables from Southwick to the North-road station, which would then become merely a distributing station. Mr. H. Talbot, deputy town clerk, explained that the Corporation being unable to obtain an easement were obliged to purchase the property.

English Patents in Spain.—We are informed that the Electric Lighting Boards Company have recently been successful in upholding their patent rights in Spain, where they have had to take energetic action against infringements. The company subsequently gave Messrs. Paz and Sylva, of Paris, a temporary license of the Spanish patents for the Spanish Coronation, which takes place on May 17, and this firm have obtained a contract from the Government Fêtes Committee. This is another illustration of our oft-repeated contention that there is plenty of work for British electrical undertakings in Spain if they are introduced by an agent speaking the language of the country.

Croydon.—The Corporation will after March 31 next, the date of expiry of the present cable contract, undertake its own house service connections for electric lighting. The salary of Mr. H. Philbey, the mains superintendent, who will have charge of this work, is to be increased on that date from £170 to £180, rising by a further increment of £10 on April 1, 1903, to a maximum of £190, and that of Mr. P. Macalister, who has for the past two years been in charge of the house service department, and who will act as assistant to Mr. Philbey, will be increased on the same date from £130 to £150, with a further increment of £10 on April 1, 1903, to a maximum of £160.

Watford.—The receipts for public lighting from the commencement of the electric light scheme at Watford up to March 31 last were £6,866, and the total expenditure, including the instalment of principal and interest (£2,352), has been £9,696, making a debit balance on the 2½ years of £2,830. For the year ended Dec. 31, 1901, the public lighting cost £3,789 and realised £3,094, leaving a loss of £695. Private lighting cost £1,808 and realised £2,070, showing a profit of £262. Setting off profit against the loss, there has been on the year a total loss of £433, or less than a 1d. rate. The Urban Council have 193 private consumers on their books, and a reduction is to be made in the price of current.

Hampstead.—The borough accountant's last statement shows that the accounts of electric light consumers for the Christmas quarter amounted to £11,057. 3s. 5d., as compared with £9,841. 17s. 10d. for the corresponding quarter of 1900. The total amount of the accounts for the year 1901 was £35,977. 10s. 5d., as compared with £29,734. 14s. 11d. in 1900. The total profit on March 31 last, after deducting all expenses, including interest, but without allowing anything for the repayment of loans, amounted to £31,849, which had been allocated as follows: preliminary expenses. £69; repayment of loans, £9,246; transferred to capital account, £1,091; carried to reserve fund, £18,238; carried to depreciation fund, £3,205—total, £31,849.

Southampton.—The Corporation have sanctioned the proposed electricity scheme (already fully reported by us), and will now obtain the additional plant and carry out the works advised by the electrical engineer on the Western Shore site. A loan of £30,000 is to be applied for, and on the Local Government Board sanctioning the loan the Electricity Committee are to forthwith proceed, employing Corporation labour, to fill up and wall the suggested site for the proposed works; to accept the estimate of Dick, Kerr, and Co., Limited, for the engines and dynamos at £4,257 each erected (being the lowest of the 27 estimates obtained by the committee); and to proceed with the foundations and buildings under the joint superintendence of the electrical and borough engineers.

Newcastle.—It is stated that the average price paid by the large consumers in the case of shops, public-houses, and buildings where the light is almost constantly used, is about 3d. per unit, and seldom exceeds this, while the total average is 4·08d. per unit. The net loss on the undertaking, from its inception to the end of the last financial year, was £3,436. The average life of the whole of the plant is estimated at about 25 years, and it is expected that in this period the undertaking will have paid for itself. There was a profit last year of £1,467, and the committee do not anticipate any further losses. Churches and chapels are charged a special rate of 5d. per unit. All the principal thoroughfares are now lighted by means of arc lamps, while many of the smaller side streets have been provided with incandescent lights.

Coventry.—The Chairman of the Electric Light Committee of the City Council, in introducing the recommendation of the committee—referred to in our issue of last week—that further extensions be sanctioned at the cost of £22.485, said the Council would remember that soon after the appointment of Mr. Jeckell it was stated that it was his opinion that the £75,000 capital existing then would have to be doubled before they would arrive at what they might call the self-supporting stage. Since then many economies had been effected in the cost and other arrangements had been made, so that if the committee were allowed to spend this £22,000, it would make the capital up to £120,000 instead of £150,000, and they fully believed that if the plant was put down and fully equipped and was in full working order, they would be able to work the department without any assistance from the rates.

Post Office Telegraphs.—A general balance-sheet in respect of the Post Office telegraphs for the year ended March, 1901, has just been issued as a parliamentary paper. The expenditure on salaries, rent, maintenance of telegraphs was £3,654,704, which, with amounts spent by the Office of Works, the Stationery Office, the Office of Public Works, Dublin, the Inland Revenue, and other departments, is increased to a grand total of £3,796,993. On the receipts side the income of the Post Office in respect of telegrams, private and special wire rentals, appears as £3,885,098. From this is deducted £499,352 paid to cable companies, and £5,157 telegram moneys refunded. The value of telegraph services performed for the other public departments without remuneration, £78,764, being added to the net income, leaves a total which falls short of the expenditure by £337,641. This, added to £298,860 interest on consols, which represent the debt in respect of the service, makes £636,501 the deficiency for the year.

New Issues.—The British Westinghouse Electric and Manufacturing Company, Limited, are issuing at the price of 97½ per cent. £500,000 4 per cent. mortgage debenture stock, redeemable after 10 years at the option of the company at 110. The company has issued £750,000 ordinary shares credited as fully paid, and the remainder of its share capital—viz., £1,000,000 6 per cent. preference—has been subscribed at par, and is paid up in full.—The Reno Electric Stairways and Conveyors, Limited, are issuing 20,000 6 per cent. preference shares and 22,500 ordinary shares. The purchase price of the patents, etc., has been fixed by the vendors at £63,500, payable as to £37,500 in fully-paid ordinary shares, as to £13,500 in cash, and as to £12,500 either in cash or fully-paid preference or ordinary shares, or partly in cash and partly in shares at the directors' option, and, in addition, the allotment as fully paid of one-tenth part of any future issue of shares by the company. This will leave 15,000 shares available for provision of working capital.

Aberdeen.—The Town Council on Monday resolved to apply to the Postmaster-General for a license to establish and carry on a telephone exchange within the Aberdeen area. At the same time a remit was made to the Telephone Committee to ascertain how many of the present telephone subscribers and the public generally would become subscribers to the Corporation exchange, the rate for an unlimited

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service to be £6. 6s. per annum, and for restricted service £3. 10s. per annum, with 1d. in addition for each call originated by the subscriber. At the last meeting of the Watching, Lighting, and Fires Committee it was decided, after four months' trial of the Kitson light, to continue the lighting of Union-street by electricity. The committee also reported that the electric light at present is being charged to the lighting department at a considerable profit as against the actual cost price being charged to the Tramways Committee. They expressed the opinion that their department should receive the power at the same charge as the Tramways Committee.

South Shields.—As an inducement to tradesmen and others to have the electric light installed, the Electrical Committee have decided to recommend the Council to give the option to consumers of a flat rate of 5d. per unit. At the present time the charge is 7d. for the first unit of current consumed, and 2d. for each succeeding unit, and from this, of course, only the large consumer derives any benefit. The shopkeeper or occupier of an office, whose business demands only a limited supply of current, considers it a hardship to pay, on many occasions the maximum rate of 7d. The committee also propose to supply the current free to new consumers during the months of May, June, and July. This is the time of the year when the demand for current is at its minimum, and can be supplied adequately, whereas if they waited until the rush in the latter months of the year, there is a possibility that the committee might not be able to carry out the experiment. Consumers supplied under these conditions will have to give a guarantee that they will continue to use the light for at least 12 months.

Gloucester.—Mr. Hammond in his last report stated that the makers of the new plant had since the official tests were made fitted the engines with their new type of throttle valve, and that further tests showed that the variation of throwing off full load—which was guaranteed not to exceed 5 per cent.—now worked out at 4·4 per cent. instead of 7 per cent. as recorded at the official tests. Mr. Hammond and Mr. Bache were satisfied with the results obtained. Building operations in connection with the refuse destructor had been delayed by the frost, but that on the whole good progress had been made, and the work was being carried out in an excellent manner, also that Messrs. Heenan and Froude had already delivered and erected a portion of their plant, and that the castings which were made in Gloucester were of excellent quality. The committee have arranged for the cleaning of the cells of the storage battery and the removal of a certain number of the plates, etc., with the Electric Power Storage Company, Limited, by whom the batteries were constructed. The price is £35, the Corporation providing the required materials and a man to assist. Mr. Bache's report states that the heavy winter load had been satisfactorily dealt with. He suggested that a special effort should be made to obtain additional consumers during the period of light load, and pointed out that the committee might with advantage engage a canvasser. Mr. Bache also reported that some consumers were using lamps of inferior make and low efficiency, and suggested that facilities should be afforded for consumers to have lamps tested at the works. It was also recommended that the Council give notice of their intention to terminate the contract with the National Electric Wiring Company, Limited. The engineer was authorised to have lamps tested for consumers on payment of 1d. per lamp, with a minimum charge of 6d. It has been decided that a month's free supply be granted to consumers commencing to take a supply before the end of September next, and that Mr. White be authorised to call upon present and probable consumers and afford them any information he can as to the installation of premises, etc.

Worcester.—We note from the report of the electrical engineer, Mr. C. J. Sutherland, that the net profit of £1,385. 6s. 2d. referred to last week is not entirely due to an increased revenue, as there has also been a very substantial reduction, amounting to £709. 13s. 5d. in the total costs of production, in spite of an increased load. The reduction in cost of coal is due to the lower price, but this only accounts for £326. 16s. 6d., and all the other large items of works costs have also been reduced. The committee has paid an additional £479. 2s. 10d. in interest and sinking fund during the past year, and the revenue has increased £1,187. 5s. 4d. There is an increase of 18·69 per cent. in the units supplied to public lamps, chiefly owing to the additional incandescent street lamps erected during the year, but the total increase is only 5·88 per cent. This is due to the somewhat disappointing rise in units sold to private customers, which only shows the small increase of 3·27 per cent., as compared with 17·62 per cent. in 1900. This is chiefly attributed to the general trade depression which has existed throughout the year, and small increases have been experienced in other towns. The giving up of the "free lamp" system has also had a bad effect on the units consumed. Formerly, when a customer had lamps supplied free he would always replace one when it was burnt out, but if they have to be purchased the replacing of a lamp is often neglected, and the result is that less units are used. The number of new customers connected was poor compared with the previous year, being only 38 against 69 in 1900, and the additional lamps connected were 1,748, as compared with 3,292. The mean price per unit obtained has increased from 3·45d. to 3·63d., and the average price paid by customers for private lighting only has increased from 4·48 to 4·75d. This average price again emphasises the fact that the system of charging is beneficial to the bulk of the consumers. There was a small decrease of 814 units in the total supplied for the waterworks motors, and a considerable increase of 51·1 per cent. in the units sold for private motors, owing to the decision to charge a special price of 4d. per unit for current supplied to these, even if they are used for less than an average of one hour per day, on condition that they are run as far as possible during the hours of daylight only. The result is that several motors now have separate meters, and the current used by them can be distinguished from that used for lighting. The number of motors in use is increasing very slowly, but it is satisfactory to know that where they are used the customers are pleased with them on account of the simplicity of starting and the little attention required while running. A peculiar feature of last year's drought was that it lasted through the autumn and until the beginning of December. The Teme was so low from June 3 to Dec. 19 that they could not even do the night load, consisting almost entirely of the street-lighting, on the water plant (with the exception of July 26 to 31, when there was a temporary rise of the river), but were obliged to steam every night, and from the end of June to the beginning of December water was only used for a few hours a day, sometimes as little as one hour a day. The past year may be considered as phenomenally dry, and there is no hope, therefore, of comparatively good water this year. The Corporation had wired the premises of 23 customers up to the end of last year on their own free-wiring scheme, and 14 of these were connected during 1901. The use of the Ferranti plant has undoubtedly caused the decrease in the coal consumption per steam unit. During the past year the Council have adopted the scheme for the new generating station, and the buildings are proceeding satisfactorily. The engineer has no doubt as to being ready to supply current to the traction company by Dec. 1, the time fixed as the commencement of the supply. With regard to this scheme, he points out that the whole of the extra work of preparation and getting out all necessary engineering plans, etc., has been carried out without any addition whatever to the number of the staff, and has, therefore, been done in the most economical manner possible. Mr. Sutherland expresses appreciation of the work of the staff, who have all ably assisted to secure the substantial profit which has been made in the year's working. The accounts show that the Local Government Board have sanctioned the raising of a loan of £115,308, of which a balance of £42,860 has not yet been raised. A statement of the electricity generated and sold shows that the quantity generated was 907,086 units. The quantity sold was; public lamps, 125,878; private consumers, 536,691; used in works, 10,745; leaving a balance not accounted for of 233,772. The number of public lamps is 57 arcs and 139 incandescents.

PROVISIONAL PATENTS, 1902.

FEB. 24.

4596. Improvements in electric automatic switches for motor-starting rheostats and the like. Edmund Basil Wedmore, British Thomson-Houston Company's, Limited, Works, Rugby.

4608. An improved receptacle for watches in connection with a source of electric light. Carolus Arnold, 58, Luisen-strasse, Berlin. (Complete specification.)

4623. Method of cutting out large quantities of electrical energy, in particular when of high voltage. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktiengesellschaft, Germany.) (Complete specification.)

4624. Cutting-out contact devices for electric circuits. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktiengesellschaft, Germany.) (Complete specification.)

4631. Improvements in mantles or coverings for carbons of electric arc lamps. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London (Gebrüder Siemens und Co., Germany.)

4640. Improvements in or relating to enclosed or open-type arc lamps for working on the direct or alternating current circuits. Denis Ripley Broadbent, 5, Albert-street, Lower Grosvenor-place, London.

4648. Improvements in electrical cut-outs or fuse boxes, feeder pillars, and other devices for the interconnection of a number of conductors. Frederic Arthur Pocklington, 6, Lord-street, Liverpool.

4650. Improvements in signalling systems for electric railroads. Orlando W. Hart, 60, Queen Victoria-street, London. (Complete specification.)

4664. Improvements in electroliers. Edward John Williams and Arthur Newcombe Rye, Norfolk House, Norfolk-street, Strand, London.

FEB. 25.

4704. Improvements in the poles of dynamo-electric machines and motors. Wilfred Robert Vernet Marshall, 121, West George-street, Glasgow.

4717. Improvements in portable electrically-driven drilling apparatus. Harry Thomas Boothroyd, 34, Castle-street, Liverpool.

4720. An improvement applicable to the trolley poles of electric cars. Walter Buckley, 4, St. Ann's-square, Manchester.

4729. Improvements in and relating to electric incandescence lampholders. Charles Edward Knowles, 70, Market-street, Manchester. (Complete specification.)

4740. Improvements in adjustable and raising and lowering supporting devices for electric lamps and the like. George Lewis Hogan, 27, Chancery-lane, London.

4754. Improvements in field magnets for dynamo-electric machines or electric motors. Robert Lundell, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

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4755. Improvements in incandescent electric lamps. Eugene McOuat, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

4763. Improvements in arc lamps. Walter Crudgington, 128, Colmore-row, Birmingham.

4782. Improvements in telephony. Anthony Bernard Tubini, 173, Fleet-street, London.

4783. Improved switch for operating electric currents. Frederick Rawlings, Carr Villa, Dartmoor-gardens, Wimbledon Park, London.

4793. Improvements in intercommunication telephone systems. Thomas Sloper and Isaac Hardy Parsons, 4, South-street, Finsbury, London.

4794. Improvements in cut-outs for use in connection with overhead conductors for electric traction. John Fairless Magoris, 4, South-street, Finsbury, London.

4804. Improvements in interruptors for high-voltage electric conductors. Oskar Könitzsr, 18, Buckingham-street, Strand, London.

4805. Improvements in electro-dynamometers. Rudolf Ziegenberg, 18, Buckingham-street, Strand, London. (Complete specification.)

FEB. 26.

4844. An electrical arrangement for turning points and crossings automatically. Joseph McKernan, 3, Bateman-street, Horwich, near Bolton.

4861. Improvements in devices for overcoming alternating electric currents in direct-current circuits. Alfred N. Gotendorf, 15, Took's-court, Cursitor-street, Chancery-lane, London.

4865. Improvements in automatic circuit breakers of induction apparatus. Victor Barreto, 1 and 4, Mitre-court-chambers, Fleet-street, London.

4871. Duplex link chain for electric fittings. Max Railing and George Henry Ide, 88, Queen Victoria-street, London.

4896. Improvements in or relating to induction coils. George Bowron, 111, Hatton-garden, London.

4906. Improvements in controllers for electric vehicles. Alfred Lissack Simpson, 53, Chancery-lane, London. (Complete specification.)

FEB. 27.

4930. Improvements in the galleries, holders, or supports for the globes of incandescent lamps, also applicable to the globes and shades of electric, oil, and other lamps. Philip Henry Jauncey, 30, Temple-street, Birmingham.

4936. Improvements in or connected with conduits or pipes for electric cables and the like. William Oates. Palatine-chambers, Market-street, Halifax.

4999. Improvements in electric igniting plugs for internal-combustion engines. Frederick Howe Hadfield, Clun House, Surrey-street, Strand, London.

5010. Improvements in electric meters. Arthur Blanchet, 70, Chancery-lane, London.

5018. Improvements in the construction of two-fluid electric batteries. John William Mackenzie, 40, Chancery-lane, London. (La Société Anonyme L'Eclairage Electrique sans Moteur, Belgium.)

5032. An improved electric pole change for use in railway signalling. John Patrick O'Donnell and Ernest Copeland Irving, Palace-chambers, Westminster, London.

FEB. 28.

5043. An improved trolley frame or bracket and head combined for use in electric overhead tramcars and the like. William Hunt, 6, Finkle-street, Stockton-on-Tees.

5057. Improvements in and connected with telephone transmitters or microphones. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actiengesellschaft Mix und Genest, Germany.)

5065. Improvements in overhead electric trolley wires. Joseph Preston Cribb, 76, Montgomerie-road, Southsea, Portsmouth. (Complete specification.)

5083. A maximum demand indicator for electrical supply. Tom Welbeck Graves, 33, Cannon-street, London.

5095. Improvements in conductors for electric traction. Edward Henry Tyler, 56, Killieser-avenue, Streatham Hill, London.

5101. An appliance for the prevention of accidents when placing manhole covers into position. Callender's Cable and Construction Company, Limited, and Theodor Petersen, 24, Southampton-buildings, Chancery-lane, London.

5103. An improved method of and apparatus for connecting the conductors or armour of electric cables and the like to junction boxes, earth-plates, and other parts. Callender's Cable and Construction Company, Limited, and John Charles Augustus Ward, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

5104. Improvements in the electric arc in electric arc lamps. La Société G. et P. de Mestral, 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Sept. 4, 1901, being date of application in France.) (Complete specification.)

5102. Improvements in manholes and their covers. Callender's Cable and Construction Company, Limited, and John Charles Augustus Ward, 24, Southampton-buildings, Chancery-lane, London.

5118. Manufacture of new or improved material suitable for electrical insulating purposes. Jörgen Georg Maardt, 70, Chancery-lane, London.

5129. Improvements in electric commutators. Wilhelm Loewen, 40, Chancery-lane, London. (Complete specification.)

MARCH 1.

5134. Improvements in the electro-deposition of metals. Sherard Cowper-Coles and Co., Limited, and Sherard Cowper-Coles, 82, Victoria-street, Westminster, London.

5146. Improvements relating to electrical ignition or sparking apparatus. James Francis Gill, 10, St. George's-crescent, Liverpool.

5147. Improvements in and relating to electric trolley collectors. Edward William Wynne, 35, South John-street, Liverpool.

5177. Improvements in or relating to contacts or current collectors for electric trams or railways. Harry William Charles Cox, 10, Cursitor-street, Chancery-lane, London.

5190. Improvements in and relating to electric switches and to combinations of the same with wall plugs and the like. Albert Vandam and Thomas Herbert Marsh, 322, High Holborn, London.

5209. Improvements in and relating to magnetic ore separators. Frederick John King, 139, Queen Victoria-street, London.

5211. An improved manufacture, or production, of electrical conduits, drain-pipes, and the like. Robert Lawton and the Albion Clay Company, Limited, 47, Lincoln's-inn-fields, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published March 20.

1901.

3753. Connections for electric conductors. Andrews.

4088. Safety device for overhead systems of street electric transmission of power. Le Mesurier.

4330. Connections or contacts of incandescent electric lamps for lighting and heating. Dowsing.

4820. Switching apparatus for electric circuits. Duddell and Mather.

5292. System of guard wire protection for electric trolley or other high-pressure uninsulated wires. Cowan, Still, and Miller.

5343. Method of and apparatus for actuating demand indicators or other devices on public electric supply or distribution systems. Wright and Reason Manufacturing Company, Limited.

5562. Devices for cutting out broken or short-circuited sections of trolley wires used in connection with electric traction systems. Donaldson.

6095. Transformers and the like. Burnand.

6107. Electrical measuring instruments. Heap and Smith.

6258. Electrical switches and like contact devices. Glass.

6393. Means or apparatus to be employed in or for the covering in or fixing of roofs to the tops of electric tramcars. Wilkinson.

6946. Automatic telephone exchanges. Haddan. (Strowger Automatic Telephone Exchange.)

7015. Suspending mechanism for electric arc lamps. Jandus Arc Lamp and Electric Company, Limited, and Drake and Jones.

7371. Terminals or nuts and bolts for use in electric batteries as connectors. Butler.

7966. Electro-pneumatic controlling systems. Hill. (Date applied for under International Convention, Sept. 20, 1900.)

8475. Brush-holders for dynamo-electric machinery. Lancashire Dynamo and Motor Company, Limited, and Wood.

8478. Automatic shunt for protecting electric arc lamps. Eckstein and Angold.

8936. Electrically-driven centrifugal machines. Alliott and Paton.

11537. Electric alarm apparatus. Jensen. (Zanotta.)

16175. Escapement for electromagnetically-controlled clocks and like mechanism. Grenfell.

17601. Apparatus and devices for controlling electric currents. Watkins. (Consolidated Railway Electric Lighting and Equipment Company.)

17811. Electric clock. En Holm.

21337. Protective appliance for electrical conductors. Parment. (Date applied for under International Convention, March 27, 1901.)

22795. Electric tramcars and other trolley heads. Featherstone.

25747. Electric fuse switch-boxes. Sachs.

26133. Glowers for pyroelectric lamps and process of making same. British Thomson-Houston Company, Limited. (Steinmetz.) (Post-dated Jan. 20, 1902.)

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26139. Arc lamps and electrodes therefor. British Thomson-Houston Company, Limited. (Dean.) (Post-dated Jan. 20, 1902.)

26749. Electric safety fuses. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.) 1902.

577. Insulators. Hackethal.

1344. Electric switch. Higginson.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	Feb. 22	566	550	+ 16	—	—
Birmingham Tramways	—	—	—	—	—	—
Blackburn Corporation	,, 28	598	557	+ 41	5,034	4,483
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	Mar. 1	172	139	+ 33	1,323	1,228
Bolton Corporation	,, 2	1,408	1,279	+ 129	12,609	11,696
Bradford Corporation	,, 2	2,435	797	+ 1,638	14,316	6,699
Bristol Tramways Company	Feb. 28	3,877	3,671	+ 206	—	—
Carlisle Tramways Company	Mar. 2	122	122	—	911	826
Central London Railway	,, 1	6,575	6,028	+ 547	59,336	54,807
City and South London Railway	,, 2	3,064	1,992	+ 1,072	27,400	18,131
Cork E. T. and L. Company	Feb. 27	331	348	- 17	2,774	2,845
Darwen Corporation	,, 28	178	164	+ 14	1,458	1,331
Darwen-Hoddlesden	,, 28	25	—	—	—	—
Dover Corporation	Mar. 1	169	158	+ 11	1,443	1,373
Dublin & Lucan Electric Railway	,, 2	79	75	+ 4	733	643
Dublin U. T., electric cars	Feb. 28	3,307	3,040	+ 267	—	—
Dublin S. District, Electric	,, 28	666	642	+ 24	—	—
Dundee Tramways Company	,, 26	616	435	+ 181	—	—
Glasgow Corporation	Mar. 1	10,497	8,206	+ 2,291	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 1	1,609	1,495	+ 114	80,807	66,688
Liverpool Corporation	Feb. 15	7,843	7,576	+ 267	60,664	54,442
Liverpool Overhead Railway	Mar. 2	1,418	1,431	- 13	12,208	13,188
Newcastle-on-Tyne Corporation	Feb. 22	1,604	—	—	—	—
Portsmouth Corporation	,, 22	905	—	—	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	Mar. 3	3,665	—	—	—	—
Southampton Corporation	Feb. 27	704	536	+ 168	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £387 decrease.
Barcelona Ensanche y Gracia, £28 decrease. Barcelona, £134 decrease.
Brisbane, £157 increase (month of Feb., £1,341 increase).
Buenos Ayres and Belgrano Electric (month of Feb.), £10,582; £180 decrease.
Calcutta, £20 decrease.
Cape Town (month of Jan.), receipts, £17,064; expenditure, £6,802.
La Capital Traction and Electric, Buenos Ayres (month of Dec.), £1,394 increase.
Mexico Electric (month of Jan.), receipts, £17,000; expenditure, £10,600.
Perth Electric, £139 increase.
Port Elizabeth (month of Jan.), receipts, £3,898; expenditure, £1,898.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Tramways.—	£	£
Anglo-Argentine, 1-260,007	5 ..	4-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	124-127
Blackpool and Fleetwood Tramroad	10 ..	13-14 xd
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2⅜-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6⅞-7¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9⅞
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-103 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13-14
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12¼-12⅜
—— 5 per cent. Perpetual Debenture Stock	100 ..	126-129
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅜-1¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2¼-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11-12
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	102-104
New General Traction, Ordinary	5 ..	2½-3½
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10⅜
—— 5 per cent. Cum. Pref.	10 ..	11¼-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	98-101
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	10¼-11½
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	10s. ..	½
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	50 p.c. ..	50 p.c.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅜-⅞
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅛-⅜
—— Ordinary, 1-125,000	1 ..	⅛-⅜
British Insulated Wire, Ord., 1-70,000	5 ..	9½-10½
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¾-6¼
—— 5 per cent. Mortgage Debentures	100 ..	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5⅞-6
Brush Electrical Engineering, Ordinary	2 ..	1⅜-1⅝
—— Nos. 80,001-105,731	2 ..	1⅜-1⅝
—— Non. Cum., 6 per cent. Pref.	2 ..	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	101-104 xd
—— 4½ per cent. 2nd Debenture Stock	100 ..	97-100
Callender's Cable, Debentures	100 ..	111-115
—— Ordinary	5 ..	17½-18½
—— 5 per cent. Pref.	5 ..	5¼-6
Crompton and Co.	3 ..	3-3
—— 5 per cent. Debentures	— ..	99-104 p.c.
Edison and Swan United, Ordinary	3 ..	⅛-⅜
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	78-83
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	83-88
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1⅜-1⅞
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9⅜-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	17½-18½ xd
—— 4½ per cent. Preference	5 ..	5¼-6 xd
—— 4½ per cent. Debentures	100 ..	111-115 xd
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15½-16½
Telegraph Construction and Maintenance	12 ..	37-40
—— 5 per cent. Bonds	100 ..	102-105
Telegraph Manufacturing, Ordinary	5 ..	10½-11½
—— 5 per cent. Cum. Pref.	5 ..	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	9½-10½
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-⅝
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	100-105
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9¼-10¼
—— Debenture Stock, Red.	100 ..	103-105
Brompton and Kensington, Ordinary	5 ..	9-9¼
—— 7 per cent. Preference	5 ..	9-9¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	8-9
—— Nos. 20,001-30,000	5 ..	7½-8¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10⅜ xd
Charing Cross and Strand	5 ..	8½-9¼ xd
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	104-106
Chelsea Electricity Supply	5 ..	4⅜-5¼
—— 40,501-50,936	5 ..	4⅜-5¼
—— 4½ per cent. Debentures	100 ..	109-112
City of London, Ordinary	10 ..	9-10
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	8¼-9¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6-6¼
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	106-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-4⅜ xd
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10¼-11¼
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅜-10½
London Electric, Ordinary	3 ..	1½-2
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	95-100
Metropolitan, Ordinary	10 ..	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	14½-15½
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7⅛-8
—— £4½ Shares, New	4½ ..	6⅞-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	98-101
River Plate Electric Light and Traction, Deb.	100 ..	65-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1⅜-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-2½
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14¼-15½
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	98-101
Westminster, Ordinary	5 ..	11½-12½ xd
Electric Railways.—		
Central London, Ordinary	100 ..	103-106
—— 4 per cent. Pref.	100 ..	103-106
—— ,, ,, deferred	100 ..	100-103
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-118
City and South London, Consolidated Ordinary	100 ..	65-68
—— Ordinary	10 ..	—
—— Nos. 60,001-70,000	10 ..	—
—— 4 per cent. Debenture Stock	100 ..	112-116
—— 5 per cent. Pref. Stock '91	100 ..	128-133
—— ,, ,, '96	100 ..	122-126
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-9 4
Telephones.—		
National Telephone, Ordinary	5 ..	—
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4⅛-5⅛
—— 4 per cent. Deb. Stock, Red.	100 ..	93-96
—— 3½ per cent. Deb. Stock, Red.	100 ..	101-105
Oriental Telephone and Electric Company	1 ..	⅛-1

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NOTES.

Change of Address.—We are asked to state that the proprietors of *Le Mois Scientifique et Industriel* have changed quarters in Paris. The journal will in future be conducted from No. 23, Boulevard des Italiens, instead of from No. 33, Boulevard des Batignolles, as previously.

New Edition.—A new edition of "Electric Wiring, Fittings, Switches, and Lamps," by Mr. W. Perren Maycock, M.I.E.E., has just been issued by Messrs. Whittaker and Co In this—the third edition—considerable additions have, we understand, been made to the numerical examples at the end of the book, and the whole work has been carefully revised.

Electrical Disturbances.—Mr. Landerer has recently been experimenting at Tortosa, in Spain, to determine the electrical currents set up in a land wire by thunderstorms. The wire was isolated from neighbouring telegraph lines, and a reflecting galvanometer in circuit showed the electrical disturbance. Mr. Landerer claims to have observed the effect when the storm was 160 miles distant.

The Telautographe.—Further experiments are being made in Paris with Mr. Ritchie's telautographe, an apparatus, previously described in this journal, which electrically transmits writing, figures, and drawings, and reproduces them in facsimile. So far from the accounts we have seen the experiments do not seem to have proved very successful, the writing as reproduced at the receiving end being somewhat tremulous.

Consumption in the Post Office.—A little pamphlet issued by the Postal Telegraph Clerks' Association has reached us on the above subject. The author is Mr. Chas. H. Garland, whose hints with regard to the prevention of consumption are, from the title, evidently intended for the edification of Post Office officials. The information, however, has been published before, as the greater part of it is reprinted from the *Lancet* of Sept. 14, 1901.

Obituary.—We regret to announce the death of Mr. Bryan Donkin, one of the best known of mechanical engineers, which took place last week at Antwerp, at the age of 67. The deceased engineer was perhaps best known in connection with steam-engine developments and the use of powdered coal in boilers. One time a vice-president of the Institution of Mechanical Engineers, he was the author of a large number of papers read at technical institutes, and was the holder of the Watt medal and Telford premiums of the Institution of Civil Engineers.

Winter Use of Electric Fans.—According to the *Western Electrician*, the idea has been carried into effect in Chicago of placing electric fans in show windows of shops during the winter months to keep the frost from covering the glass by a constant circulation of heated air. The plan has proved quite practicable, and during the past few months has been extensively employed for this purpose in many other cities in the States. The demand on the manufacturers of motor fans from this source, however, has not been large, as in most cases the ordinary electric fan used in summer time for ventilating purposes has been employed in winter for this purpose.

Electric Punkahs in India.—We learn that the Government of India have definitely decided in favour of electric lighting and punkah-pulling for a number of military barracks in that country. Among other places, the electric light and fans will at once be installed at Attock and Mean Mir, and the experimental system at Bareilly and Umballa is to be extended to all barracks in which the necessary power is already available. The present installation at Jhansi is to be extended to all barracks of British troops in that station, but at Rawalpindi, where gas is provided, the matter is being held in abeyance. Further enquiries are being made in respect to Fort William. The electrical engineer on whose advice electric punkah-pulling and lighting are to be adopted for Indian barracks is Mr. A. H. Preece.

Telephone Experiments.—The Post Office officials connected with the Telephone Department have for some time been making experiments with the object of so improving the telephone apparatus as to increase the volume of sound transmitted. Experiments in this direction have, however, not proved very successful, for while more sound was obtained with certain arrangements, the messages were not so clear as is ordinarily found with the apparatus at present in use. This result is in strict accord with Prof. Oliver Lodge's experiments on the subject. He found that it was impossible to increase the volume of sound without materially interfering with the clearness of some of the words transmitted. We believe that this will generally be found to be the case, but the Post Office experiments are still going on, and may yet achieve a partial success.

Batteries under Water.—The *Scientific American* records a remarkable instance of a battery of accumulators working under water, which was recently given at the municipal electrical plant in Munich. The station is situated on an island in the Isar, and during some floods the batteries were submerged. As a result one of the batteries which ran the car lines was completely cut out, and it was thought that the other, which furnished light, would have to be treated in the same way. The flywheels of the engines were half in the water. Nevertheless, as it was important to light at least the principal streets of the city, it was decided to try to operate the submerged battery. The attempt was fortunately successful, and the battery, which had been constructed to give 6,000 ampere-hours with a 600-ampere discharge, was able to furnish 4,000 ampere-hours during the night. The remainder was lost in discharges in the water.

Technical Education in London.—On Monday night the annual distribution of prizes in connection with the City and Guilds of London Institute took place in the Egyptian Hall of the Mansion House. The Lord Mayor occupied the chair, and the proceedings were graced by the presence of the Lady Mayoress, who presented the prizes and awards. The Siemens medal of the Central Technical College for civil and mechanical engineering was awarded to Mr. J. D. W. Ball, and for electrical engineering to Mr. J. J. Fasola. The Lord Mayor, in a happy little speech, said the institute was the first organised attempt to develop technical education in this country. It took the country as a whole nearly 10 years to wake up to the need of a system of technical education, and another 10 years to the fact that our captains of industry required training in the application of science and art in manufacture as much as the workman. The Central Technical College, the Finsbury School, and the Art School had all been organised by the institute, and the funds practically all came from the Livery Companies of the City.

National Electrical Manufacturers' Association. We are informed that a number of influential firms in the electrical trade have decided to form under the above title an association for the purpose of protecting their interests and at the same time of dealing with questions affecting the industry generally. The circular which the Advisory Committee are issuing inviting the co-operation of electrical supply houses and manufacturers, contains the names of some 30 well-known firms who have already

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become members of the association. We think that a society of this nature, having for its objects the placing of the various sections of the electrical trade on a sound commercial and competitive footing without antagonism towards existing trade associations or institutions, will do good work among electrical manufacturers in this country. The question of foreign competition is also one which, we think, would come well within its scope of action. In order to secure absolute impartiality in the treatment of trade matters, the Advisory Committee have appointed as secretary a gentleman entirely unconnected with any branch of the electrical industry. This gentleman is Mr. Walter Davenport, and he will be pleased to reply to any enquiries addressed to him at his address in Ridler-place, Holland-street, Blackfriars, S.E.

Baker-street and Waterloo Railway. — The official confirmation of the many rumours which have been circulated with respect to the purchase of this undertaking by the Yerkes group, makes it clear that that gentleman is by no means content with the electrification of a single line in London, or even the electrification of the present connections of the Metropolitan District Railway. The line from Waterloo to Baker-street forms a most important cross-connection between a number of main lines and the District Railway, which, being worked under the same management, will enhance the value of the line as a means of transport. The organisation of a number of different lines to be worked economically together will be not only to the advantage of the shareholders, but also to that of the public. The official announcement of the purchase is as follows: "Mr. Worthington Evans, as special manager of the London and Globe Finance Corporation, Limited, announces that the contract for sale of the interest of that corporation in the Baker-street and Waterloo Railway to the Metropolitan District Electric Traction Company has been signed. The price realised is £360,000 and interest. The first payment of £90,000 has been made. The net amount by which the London and Globe will benefit, after deducting amounts payable to secured creditors, is about £150,000."

Electrical Properties of Alloys of Copper.—Mr. G. Reichardt has recently been experimenting on the electrical properties of alloys of copper and cobalt. His results are abstracted in the March number of the *Journal* of the Chemical Society. From this it seems the experiments first found that the effect of small quantities of cobalt on the electrical properties of copper is almost as great as that of manganese, and about three times as great as that of nickel. The addition of 3 to 5 per cent. of cobalt gives an alloy with a minimum temperature coefficient of resistance (+0·00077), and with a maximum thermo-electric effect (against copper) of 33 microvolts for 1deg. temperature difference. Up to this composition the specific resistance of the alloys increases rapidly, but further addition of cobalt produces only a slow increase of resistance. The only practical application that could be made of the alloys is in the construction of thermo-electric batteries. The addition of small quantities of copper has a great effect on the properties of cobalt. The specific resistance has a maximum, the thermo-electric effect a minimum, value between 0 and 10 per cent. of copper. All alloys except those containing less than 1·5 per cent of cobalt can be magnetised, the magnetism being destroyed only at a bright-red heat. It is noted that alloys of copper and nickel cannot be magnetised.

Electric Shock.—An editorial comment appears in the current number of the *Lancet* on the three papers on "Electric Shock" which were under discussion at the Institution of Electrical Engineers last night. The article in question throws some light on the remarkable case instanced by Mr. Aspinall of a victim whose heart could not be felt to beat and whose breath did not cloud a mirror, but who recovered after 45 minutes of artificial respiration. The editor of our contemporary holds that it is quite improbable that the human heart should be able to recommence to beat if it has once been completely arrested for even 30 seconds; and if the condition were one only of arrest of respiration, it should be possible to feel the beating of the heart during the critical period which immediately follows the receipt of the shock. He tells us, however, that probably it is true that of those who receive shocks of great severity there are some in whom arrest of heart is produced once and for all—in which case no known method of treatment is of any avail—while there are others who are not killed outright in this way, but are left in a state of suspended vitality with heart and respiration almost arrested. From this state in time they may recover, either without any assistance or with the assistance of artificial respiration. Artificial respiration should, however, always be made use of, even if it be quite doubtful whether the condition of the patient is one at all resembling asphyxia.

A Portable Electric Generator.—The self-contained engine and dynamo for electric lighting purposes, which can be easily transported from one place to another, has a great future before it in connection with the army. The requirements are that the generator shall be exceedingly light for its output, and that it shall use a fuel which is capable of easy transport. Such an apparatus has been devised by Mr. Bardon, a French engineer, and is described in the issue for March 1 of *L'Electricien*. He utilises as the prime mover petroleum engines such as have been developed for the automobile industry. The engines work at high speed, and hence are light, and for the same reason the weight of the dynamos is kept down. Some trials of one of these engines gave the following results: The length of each test was nearly 11 hours. The dynamo gave 42 amperes at 149·5 volts. The speed of the machine was 960 revolutions per minute. The total output in kilowatt-hours during the trial was 67·2. This required 1·67 pints of petrol for every kilowatt-hour developed. The horse-power of the motor was 10·6. Assuming that the cost of the petrol be 6¾d. per pint, this works out at 3·65d. per unit. While this is a high figure for a supply in large quantities, it is exceedingly cheap for isolated plants. In this case the engine and dynamo only weighed one ton, and hence could have been transported easily in a cart. Such a machine would be of great use in the African war for supplying electricity to the searchlights.

Glasgow Tramways.—The city of Glasgow is setting an excellent example to other British corporations in the matter of cheap tramway fares. The sweeping reductions in the charges on the tramway system of that city, announced to come into operation on June 1 next, not only show that the undertaking is proving an exceedingly profitable one, but that it is being conducted on sound business principles. Already the fares are as low as obtain on any other electrical system of tramways in the country, but under the new *regime*, while the halfpenny stations will remain unaltered, the 1d. fare will extend over four stations, the 1½d. fare over six stations, and the 2d. fare over eight stations. This means that from June 1 passengers will be able to travel 2⅓ miles on the Glasgow tramways for 1d. It is to be specially noted that the reduction disposes of the workmen's fares, as the new charges are even lower than the statutory fares laid down for artisans, mechanics, and daily labourers—*i.e.*, ½d. per mile, with no less fare than 1d. Naturally, in view of these concessions, the authorities have refused to entertain a proposal to issue season tickets. We think that

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the policy which the Corporation are pursuing in this matter, of giving the public the benefit of the cheapest and most efficient tramway service, instead of accumulating the profits or applying them to the relief of the rates, is exceedingly commendable, and one which we are sure will be gratefully appreciated by the citizens of Glasgow.

Electrical Conductivity of Flames and Gases.—A short abstract of a paper by Mr. A. de Hemptinne on this subject appears in the *Journal* of the Chemical Society for March, as follows: "The deflection of a galvanometer needle contained in a battery circuit was observed when gas explosion took place in a tube containing free ends (electrodes) of the circuit. The deflection decreases with decrease of E.M.F. of the battery, but not exactly proportionally. It decreases as the distance between the electrodes is increased. When the electrode connected with the positive pole of the battery is large and that connected with the negative pole is small, a large deflection is obtained, whilst if the connections be reversed only a small deflection is noticed, thus indicating that the conductivity of an explosion (like that of a flame) is unipolar. The deflection is greatest when the explosion tube is open to the air, and is very small when the whole apparatus is kept at a temperature much above 100deg. Practically the same results were obtained when the electrodes consisted of platinum, gold, or iron wires, and a magnetic field is also without influence. These experiments were made with an explosive mixture of hydrogen and oxygen. With a dry mixture of hydrogen and chlorine, or of oxygen and carbon monoxide, no deflection was obtained, but when the mixture was moist, the needle moved through 0·5 mm. From the experiments it is deduced that no ions take part in the gas reaction, but the electricity is solely transported by condensed water, for conditions under which condensation may take place favour the transportation."

Edison Storage Battery.—A new patent has been granted to Mr. T. A. Edison in the United States which relates to details of his cadmium-nickel-alkaline battery. Finely-divided cadmium is employed in this battery as the oxidisable element, and oxide of nickel or cobalt as the depolariser, the electrolyte being a solution of potassium hydroxide varying from 10 to 25 per cent. When in a discharged condition the metallic cadmium will be oxidised, and the oxide of nickel will be reduced to a low condition of oxidisation. In charging, the oxide of cadmium is reduced to the metallic state, and the oxide of nickel is raised to a higher state of oxidisation than the peroxide state. The plates of the battery consist of sheet iron or steel grids carefully nickel-plated so as not to be affected by the alkaline solution. As shown, the grid has three tiers of openings, there being eight openings to each tier. Into each of these openings fits a pocket containing the active material. The pocket consists of very thin sheet steel of high carbon so as to be very elastic, and is carefully nickel-plated. The walls of the pocket are perforated in such a manner as to provide internally projecting burrs. The pocket consists of two parts, in one of which the active material is inserted in the form of blocks, the other section then being placed like a cover of a box over this section, the whole being then inserted in one of the openings of the grid, where it is crimped into place. The plates carrying the oxidisable and depolarisable materials are, of course, in alternate order, and are separated by perforated corrugated hard rubber partitions. The patent gives minute details of the process of obtaining finely-divided cadmium in desirable form, and also for obtaining the hydrated oxide of nickel in desirable form.

Lord Rayleigh's Experiments.—The fourth of Lord Rayleigh's course of lectures on electrical developments, which was given on Saturday afternoon at the Royal Institution to a full audience, commenced with some experiments on the magnetic saturation of iron and on the magnetic qualities of iron in general. Lord Rayleigh thought it probable that the molecules in iron were always in a magnetic state, and that their orientation was brought about by the influence of magnetic forces. The question of the magnetic properties of iron, as is well known, is of great importance in the construction of electrical machinery, especially dynamos and transformers, and the lecturer showed how important it is to obtain the right quality of iron for the particular purpose, for which it is to be employed. He next made some experiments with an electromagnet excited by alternating currents, and showed that a small incandescent lamp mounted on a coil of wire would light up if brought close to the electromagnet. When a copper disc was interposed between the lamp and the electromagnet, the light was almost entirely cut off, and it was a seeming paradox that insulating substances allowed the electric emanations to pass while conducting substances cut them off. The lecturer explained that the paradox was due to the inadequate nomenclature of present-day science. Afterwards some experiments were shown with the latest form of X-ray focus tube. The cathode rays inside the tube impinged on an anti-cathode consisting of a little plate of platinum, and thus the Röntgen rays were produced. These rays had a curious influence on the mist that was caused to appear in a glass flask by the withdrawal from the flask of a certain portion of the air. This mist was due to a nucleus composed of dust particles, and the effect of the Röntgen radiations was to considerably increase the fog.

Vibration on the "Tubes."—The House of Lords on Tuesday discussed the question of "tube" vibration on a motion brought forward by the Earl of Camperdown calling attention to the injury to houses and property in London which may arise if the Bills for underground railways now before Parliament should become law. The object of the resolution was to ensure that the companies promoting the schemes should be liable at common law for such damage. The Earl of Camperdown, in submitting his motion, mentioned that there are about 20 new schemes for underground railways in the present session. He claimed that the individuals under whose houses they might be run had a right to be protected against damage. The case for the Government was fairly stated by the Earl of Dudley, the keynote of which was that nothing ought to be done by Parliament to impede the development of the tubular system, which was still in its infancy. Lord Camperdown's proposal involved the introduction of a novel principle, for which there was no precedent and not sufficient justification. It seemed to him, however, that Lord Camperdown's object might be met by adopting the recommendations of Lord Rayleigh's Committee, who found that vibration was almost entirely caused by the great unspring-borne weight of the locomotives, and that if the weight were placed on springs the vibration would be reduced to an infinitesimal point. The matter, Lord Dudley added, was engaging the attention of the experts on the staff of the Board of Trade. In the subsequent discussion before the motion was withdrawn, the Earl of Morley, who is chairman of committees in the Lords, made a few notable remarks. He pointed out that if railway companies were liable to actions at common law for any annoyance, however small, all along their line of route, the effect would really be to put a stop to railway enterprise altogether. His advice was to leave the matter in the hands of the Board of Trade. He added that though there would be considerable difficulty in embodying the recommendations of Lord Rayleigh's

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Committee in an Act of Parliament, it was very necessary to introduce into the new Bills such clauses as the committee, on the recommendation of the Board of Trade, might adopt to minimise and, if possible, prevent vibration altogether.

High-Tension Transmission of Energy on the Continent.—It is well known that high-voltage currents have been in use for years in the United States for long-distance transmission of energy. Some of the plants, where the climate is very favourable, have adopted voltages up to 40,000 and even 50,000 volts. On the Continent, where water power in the immediate vicinity of industrial centres is becoming more and more scarce, long-distance power transmission with high voltage is being frequently resorted to, as the following will show: A 23-mile transmission at 20,000 volts is being constructed to supply Como with energy. In the vicinity of Zaragoza, in Spain, two plants, of 4,000 h.p. and 6,000 h.p. respectively, are being installed. The power obtained will be transmitted at 30,000 volts over distances of 28 and 50 miles. The Fure and Morge installation near Grenoble, in France, is a 7,000-h.p. plant, supplying current at 26,000 volts to a number of towns and villages, such as Voiron, Moirans, etc., the distance covered being 32 miles. This plant has been completed and is now working. The Reznau plant near Waldshut provides 10,000 h.p., and the current is sent over distances up to 37·5 miles at a voltage of 25,000. Lastly, an order has recently been placed for the machinery of a 13,000-h.p. plant to be erected on the Cellina river in Northern Italy, the energy being supplied, at a tension of 36,000 volts, to the towns of Venice, Udine, Pordenone, etc. Current in this installation is transmitted over distances up to 56 miles. In all the above plants the current is three phase, and is generated at a comparatively low tension of a few thousand volts, and raised to the transmission voltage by means of stationary transformers. The electrical machinery for all the above plants will be, or has been, supplied by the well-known firm of Brown, Boveri, and Co., Limited, of Baden, Switzerland, who for years have taken a lead in this kind of work.

The Origin of Petroleum.—At the Petroleum Institute, Bevis-marks, E.C., on Friday evening Principal P. Dvorkovitz gave a special lecture under this title, in which he discussed the several theories which have been put forward from time to time as to the origin of petroleum. It may be mentioned that this oil, which is finding such extended use at the present time for driving motorcars, is chiefly found in the Caucasus Mountains between the Black Sea and the Caspian Sea, and in the Himalaya Mountains in North India, and in the mountainous districts of North-East America. South America and Africa yield comparatively little petroleum. Broadly speaking, the formation of the oil is due mainly to the presence in the interior of the earth of various carbides which are produced by high temperature. When these carbides come in contact with water they decompose, and give off acetylene gas and calcium oxide. These gases are in their turn formed, under pressure of volcanic disturbances, into various petroleum hydro-carbons. This theory, the lecturer explained, was supported by many scientists who had given the subject attention. He next discussed the theory that petroleum is formed from the remains of organic matters. The one side claimed that the oil was obtained from the decomposition of animal remains, while the other contended that it originated from vegetable matter. The theory of the animal remains had been supported by experiments, and the experimenters had obtained some oily matter from the decomposed remains of fish which was very similar to petroleum hydro-carbons. From researches which he had made in connection with the peat bogs of Ireland and Germany, however, the lecturer favoured the theory that the decomposition of vegetable matter was responsible for the origin of petroleum. In Ireland the peat bogs averaged a depth of 20ft., and it was calculated that there were 1,816,000 acres of peat bogs in that country alone. What, he asked, would happen if an uplift were to take place in these districts? The bogs would be submerged, and there was no doubt that the consequent pressure and heat would be quite sufficient to transform the whole of the peat into liquid petroleum. His final conclusion, therefore, was that the presence of petroleum—which, by the way, represents 15 per cent. of hydrogen and about 85 per cent. of carbon—in those parts of the world where it was found was due to an uplift of the mountains, and that the oil was formed as the result of eruption in the interior of the earth. The lecture was illustrated throughout by some very interesting lantern slides.

Underground Telegraph Lines.—Lord Londonderry's reply to the deputation from the Scottish and Northern chambers of commerce, which waited upon his lordship last week with reference to underground telegraph communication with the North, gives good grounds for believing that the extension of the Birmingham underground cable to Scotland is only a matter of time, and that it will be taken in hand as soon as the Treasury sees fit to sanction the necessary expenditure. But, as the Postmaster-General pointed out, in existing circumstances, with the war in South Africa still going on, the fulfilment of the work at once is almost an impossibility, but he hopes to proceed with the contemplated extension next year. In his reply to the deputation, which was representative of some of the largest commercial interests in the North, Lord Londonderry admitted that a great amount of protection against interruption was to be found in underground wires, but he again put forward the plea that in past years the cost of such cables was extremely heavy, and it had only been within the last few years that the Department had been in a position to make appreciable extensions of that system. The cost had been diminished by the introduction of paper-insulated cables. The underground cable to Birmingham, which was laid at a cost of £165,000, had been found extremely useful, especially during the recent storms. It had now been extended further north as far as Stafford, and in the course of the present year it would be carried on to Warrington, where it would join the existing underground line between Liverpool and Manchester. A section of the line north from Preston had been laid for about 30 miles, which would form a link in the contemplated extension of the line to Scotland. With regard to the east coast, from Manchester it was in contemplation to extend the underground line north through Leeds to Newcastle, and the various towns *en route* would benefit by it. The laying of an underground line from London to Glasgow along the route mentioned above would cost at the lowest computation £700,000. It must be clearly understood, however, that the underground cable system would be merely supplementary to the overhead system, and would have for its object the preventing of important centres of commerce being entirely without telegraphic communication in case of storms or from other causes. The Department must continue to rely on the overhead wires, which were cheaper and electrically more efficient. It was also necessary that the telephonic trunk wires should continue to be carried overhead, as in the present position of telephonic science, speaking was not satisfactory over long distances by means of underground wires. According to the latest available statistics, Germany had 27,000 miles

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of underground wires, France between 16,000 and 17,000, and this country 47,000, and at the present time our mileage was considerably larger. He suggested that the Chancellor of the Exchequer should be approached in reference to the matter of an underground cable to Scotland. It was far more a Treasury matter than a Post Office matter, as the former department would have to supply the money for carrying out the scheme.

Shallow Underground Tramways. — At the present time, when the London County Council are embarking on a scheme of underground shallow tramways in London, the report of an examination of the Metropolitan Railway of Paris made by Lieut.-Colonel H. A. Yorke, R.E., which has just been presented to Parliament, is of exceptional interest. As is well known, the underground railway of Paris is as yet only partially completed, but when the whole system of inter-communication between the different portions of the French capital is carried out, the railway will have a total length of over 38 miles. The Municipal Council, which is responsible for the execution of the undertaking, calculates that, inclusive of two lines about 8¼ miles long not yet authorised, the total expenditure on the railway will reach about 12 millions sterling. The traffic conditions on the sections of the railway at present giving a public service of trains in Paris—about eight miles in all—are practically the same as those existing on the Central London Railway in London. Thus, Colonel Yorke mentions in his report that in 12 months the Paris Metropolitan carried nearly 40½ millions of passengers, which compares very favourably with the returns of the Central London, on which the number of passengers carried in 1901 was 41,011,000. On the question of the introduction of underground shallow tramways in London, Colonel Yorke's conclusions are almost identical with the views expressed in these columns a short while ago. Briefly they are that the network of sewers, water and gas pipes, and electric light mains, which is to be found in practically every main thoroughfare in London, is an obstacle of such a formidable nature that the difficulties in the way of shallow underground tramways in such streets are almost insurmountable; but that the construction of new streets offers many advantages for introducing such a system of communication as that proposed by the London County Council under the new street from the Strand to Holborn. Reasoning from what he saw in Paris, Colonel Yorke arrives at the following true conclusions. He says: "It cannot, I think, be doubted that as regards the convenience of passengers and economy of working the balance of advantage lies with the shallow tunnel or subway as compared with the deep-level tube. It is easier of access, affords greater opportunities of escape in case of a breakdown or accident, and possesses a purer atmosphere. But the difficulties of constructing such subways along the principal streets in London are formidable. Apart from the unavoidable interference with the surface of the streets and consequent dislocation of traffic, which would cause much inconvenience and dissatisfaction, there remains the still greater difficulty due to the presence a few feet below the surface of a network of sewers, drains, water-pipes, gas pipes, electric light cables, telegraph and telephone conduits, etc., to which must in many places be added vaults and cellars extending under the roadway. All these would have to be diverted and reconstructed, or heavy compensation paid for their abolition. The problem is further complicated in London by the narrowness of the thoroughfares. Where, however, new thoroughfares are in process of formation the obstacles to shallow subways are not so serious, and advantage may well be taken of the opportunities so offered to build subways for tramway or railway purposes (perhaps even for ordinary vehicular traffic) in the manner proposed by the London County Council along the new street now being made from the Strand to Holborn."

Motor Regulations.—As we briefly announced in last issue, the general council of the Automobile Club have issued a circular protesting, first, against the restrictions as to speed in respect of light automobiles, and, second, against the restrictions as to tare, weight, and width of heavy vehicles used for commercial purposes. The circular is signed by a large number of influential gentlemen who constitute the general council, among whom may be mentioned the Duke of Sutherland, the Earl of Shrewsbury, Lords Onslow, Grey, Wharncliffe, Montagu of Beaulieu, and Brassey, Sir James Pender, and Mr. Alex. Siemens, also by the presidents and secretaries of the district automobile clubs in Great Britain and Ireland, and by the presidents of the automobile clubs of France, Belgium, Germany, Austria, and Switzerland. The circular in the first instance urges that in view of the powerful brakes with which all motor vehicles are fitted, and the perfect control which drivers have over them, it is evident that the existing law restricting the speed to 12 miles an hour cannot command respect or observance. Then follows a reference to electric tramcars in our big cities and their suburbs, and it is alleged that these are driven at speeds up to 18 miles per hour. Recent experiments have shown that motor vehicles can be stopped on the flat on a fairly dry road when travelling at a speed of from 11 to 14 miles per hour in 1⅘ times the car's length, and at a speed of from 20 to 24 miles in 3½ times the car's length. From these results it will be seen that motorcars can, on an average, be stopped when travelling at 20 miles an hour in less distance than the ordinary horse vehicle could be stopped when travelling at 10 miles per hour. Of these facts the general council possess incontestable evidence. The circular goes on to refer to the damage to the automobile industry which the present state of the law involves, and compares the industry as it exists at present in this country with that obtaining abroad. We are, in fact, repeating the same error of over restrictive legislation which, in respect of electrical enterprise, stifled development in the United Kingdom so completely years ago. Having pointed out the evils of the existing legislation, the circular puts forward the claim that the specific speed limit imposed under the Act of 1896 should be removed, and in support of this the opinion of the Right Hon. Henry Chaplin, M.P., who, as President of the Local Government Board in 1896, introduced the Act to the House of Commons, is quoted. On this occasion the Minister is reported to have advocated an average speed of 20 to 25 miles an hour—that is, of course, on a clear and open road. In the second place, it is conceded that, provided the existing speed limit be abolished, the suggestion made by the County Councils' Association a short while ago, that there should be an easy and complete means of identification, is one to recommend itself to all drivers of motor vehicles. In regard to the tare weight and width of motor wagons for conveying heavy vehicles, it is pointed out that the present restrictions in many cases prevent the employment of this form of transport, while the speed limit prevents the development of the use by farmers and landowners of motor wagons, which would otherwise enable them to send vegetables, fruit, and other perishable goods direct to market. In conclusion, the signatories urge that the Government should pass a Bill on the lines indicated above, which would remove without delay the unnecessary and damaging restrictions which at present hamper mechanical traffic in this country.

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BRISTOL EXTENSIONS.

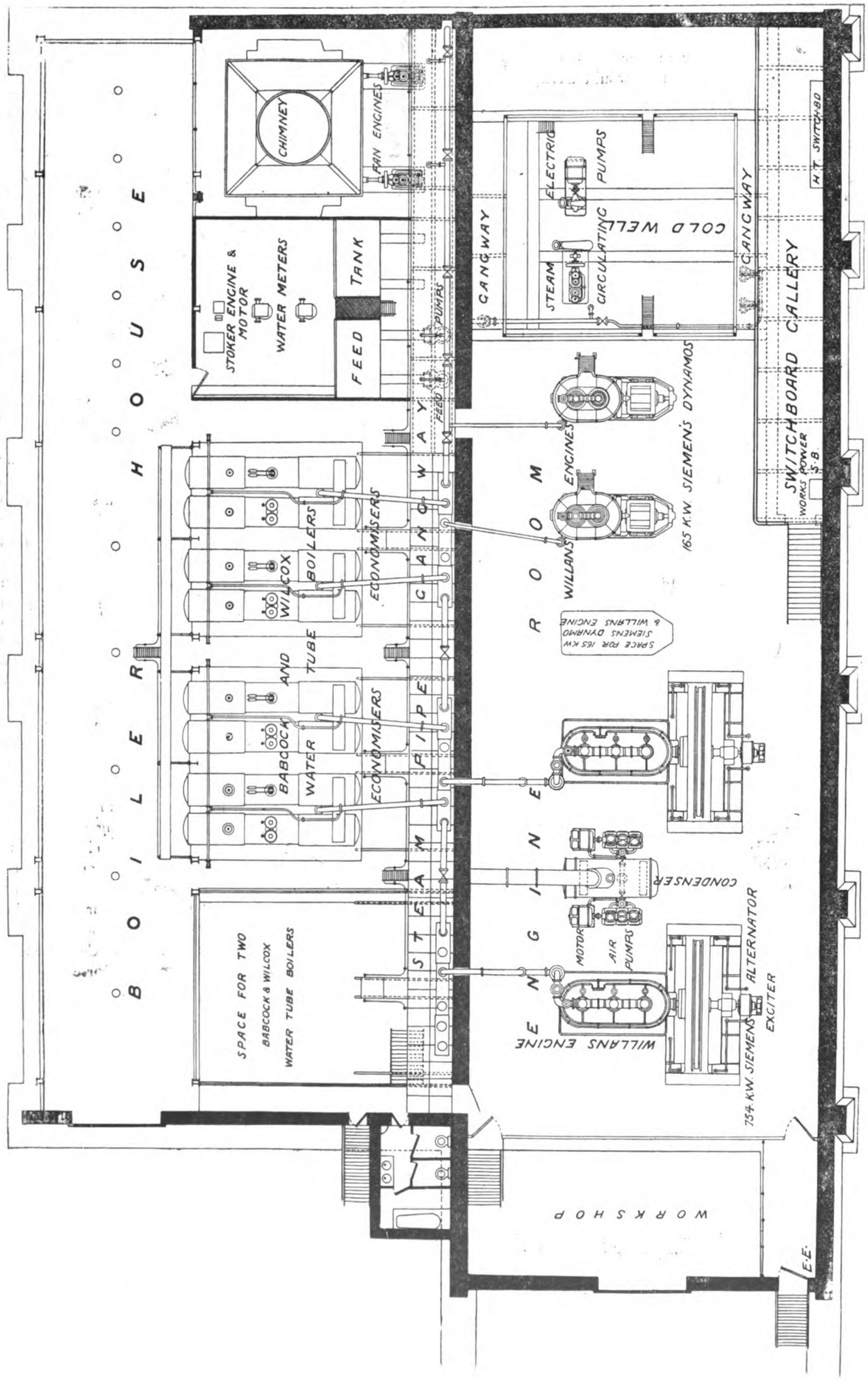

FIG. 1.

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On Feb. 19 last the Avonbank extension of the Bristol electricity works was formally opened by the Lady Mayoress of Bristol (Mrs. C. E. L. Gardner). A large gathering of people interested in the works attended at the opening ceremony, and were received by the Electrical Committee. The proceedings were exceedingly business-like, the speeches brief and to the point, and all the programme went as merrily as the marriage bells. Later on this year we shall take an opportunity of discussing at some length the admirable way in which Bristolians are conducting their affairs, and especially is this noticeable in electrical development, where the guiding spirit is to be found in the chairman of the Electrical Committee (Alderman G. Pearson), in collaboration with the able electrical engineer (Mr. H. Faraday Proctor). Meanwhile we shall restrict ourselves to a simple description of the new extension works. It must be premised, however, that the site of the original works at Temple Back is completely filled with apparatus, and it was therefore necessary to obtain a new site, and this the Council acquired in St. Philip's Marsh to the extent of 11 acres—an area amply sufficient to ensure room for developments for many years to come. This area is bounded at one end by a branch of the Great Western Railway, while on another it is bounded by the Feeder-road, and separated by that road from the canal. On another side is one of the collieries of the Bedminster Colliery Company. The accompanying illustrations (Figs. 1 and 2) show a plan and elevation of the first instalment of the new works, the whole arrangements having been thought out so as to simplify all future extensions; the present portion of the works forming only about one thirty-third of the ultimate works as projected. The site adopted being that of a marsh, considerable trouble has been taken to ensure satisfactory foundations. The ground was found by boring to consist of 14ft. depth of made ground, 11ft. of peat, 2ft. of blue clay, 3ft. of yellow clay, and 4ft. of gravel, under which was hard red marl; and as the land is sometimes dry and sometimes wet, the conditions were unsuitable for timber pile foundations, hence the foundations at Avonbank are formed of concrete walls of varying thicknesses, from 4ft. 6in. upwards. The whole building is arranged for utility, and has no architectural pretensions. There are no windows in the wall of the engine-room; the roof, however, is of glass, the wall being utilised for switchboard requirements.

Fig. 3 is intended to give an idea of a building as it stands with the coal-conveying arrangements. The one end of the coal-conveying arrangement, it will be seen, is on the canal bank, the other in the building. From the elevator pit an endless chain of buckets (Fig. 4), driven by

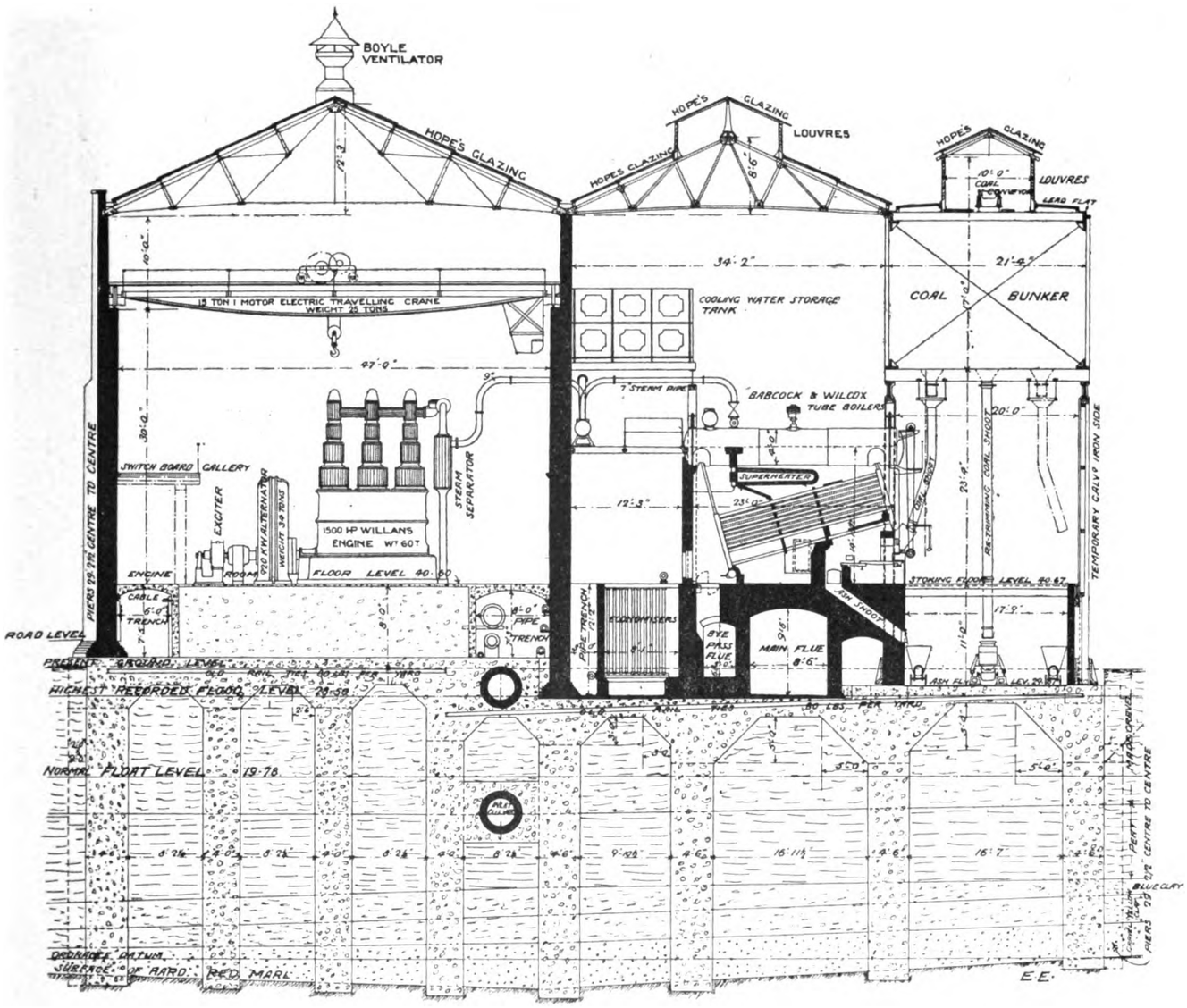

FIG. 2.

an electric motor and gear placed in the conveyor-house above the coal bunkers, carries the coal to the top of the building and over the whole length of the bunkers, into any part of which the coal can be automatically emptied. From the coal bunkers overhead long shoots are arranged into which the coal can be discharged, as shown in Fig. 5. Here, as elsewhere, foresight for further extension has been shown, the ultimate requirements having been kept well in view, so that upon the extension of the buildings it will be necessary only to lengthen the chain of buckets to obtain the same economical results in carrying the coal as are found in this portion of the installation. It will be seen that coal shoots are fitted to mechanical stokers, and arrangements are made by means of which the coal can be weighed as it is used.

The mechanical stokers are of Meldrum's Koker type, working in conjunction with induced draught. At the present time four Babcock water tube boilers have been

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erected, each to evaporate 1,400 gallons of water per hour, working at a steam pressure of 200lb They are fitted with superheaters, so as to avoid condensation in the pipes. Green's economisers are fitted in the flues at the back of the boilers. With regard to the induced-draught plant, the necessity of this will be seen when it is stated that the chimney stack is of mild steel, 9ft. in diameter and only 70ft. high. At the base of this stack are placed two

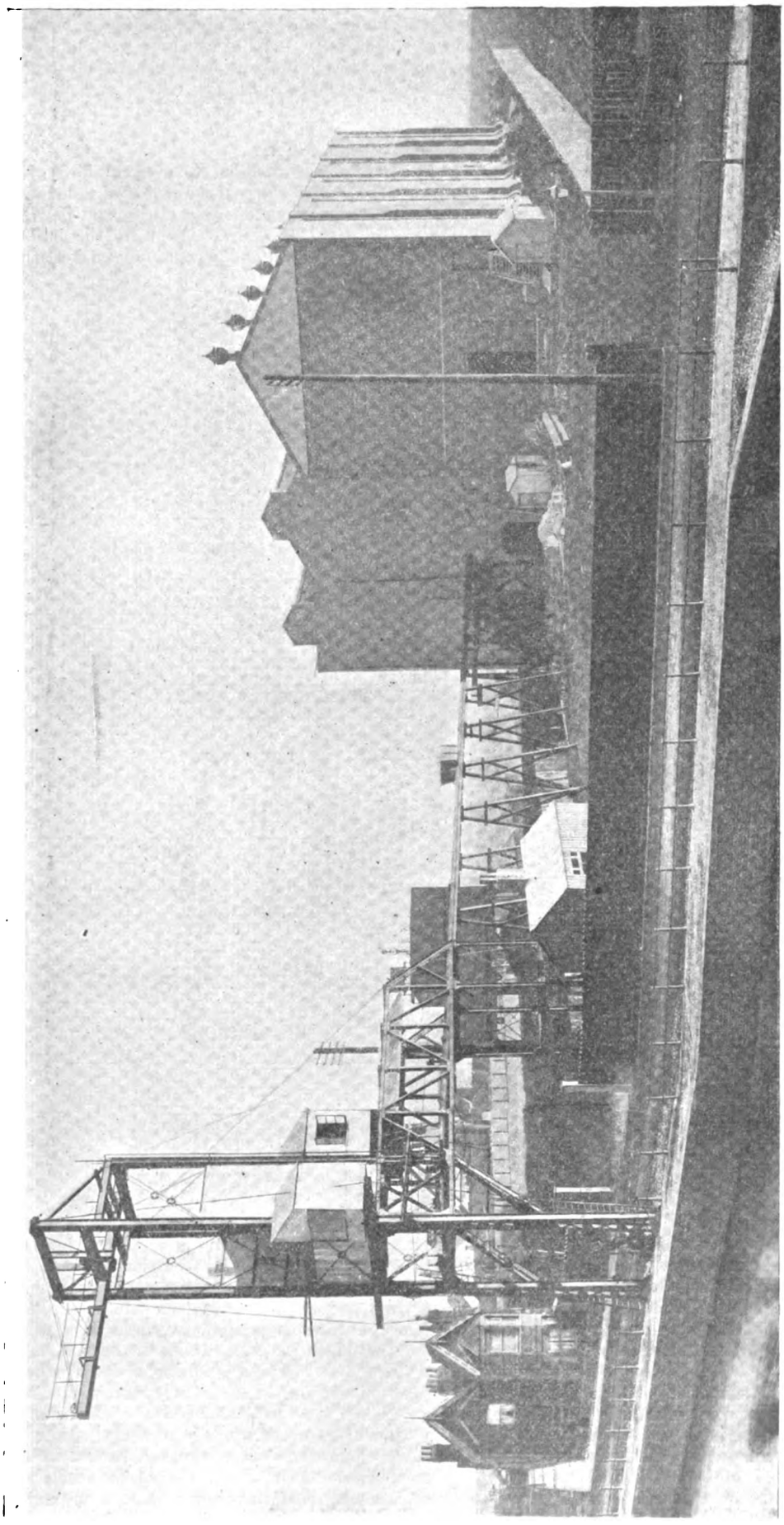

FIG. 3.

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fans, each 7ft. 6in. diameter, 25in. in width, driven by Bumsted and Chandler's two-crank high-speed engines of 75 b.h.p.

Fig. 6 gives a view of the dynamos, and we are glad to see that the experience of the Bristol authorities has been sufficiently good to induce them to continue the new installation with apparatus by the same makers as is to be found in the old installation. Here, at the Avonbank works, we find a combination of the Willans engines with

It will be unnecessary to dwell at any length on the type of engines adopted, these being of the well-known Willans central-valve, single-acting, triple-expansion make, the larger ones having three lines and the smaller ones two lines of cylinders. It is increasingly satisfactory to find these engines sustaining the great reputation they have obtained for central-station work Each of the larger engines is coupled direct to a Siemens copper-type alternator running 224 revolutions per minute, and

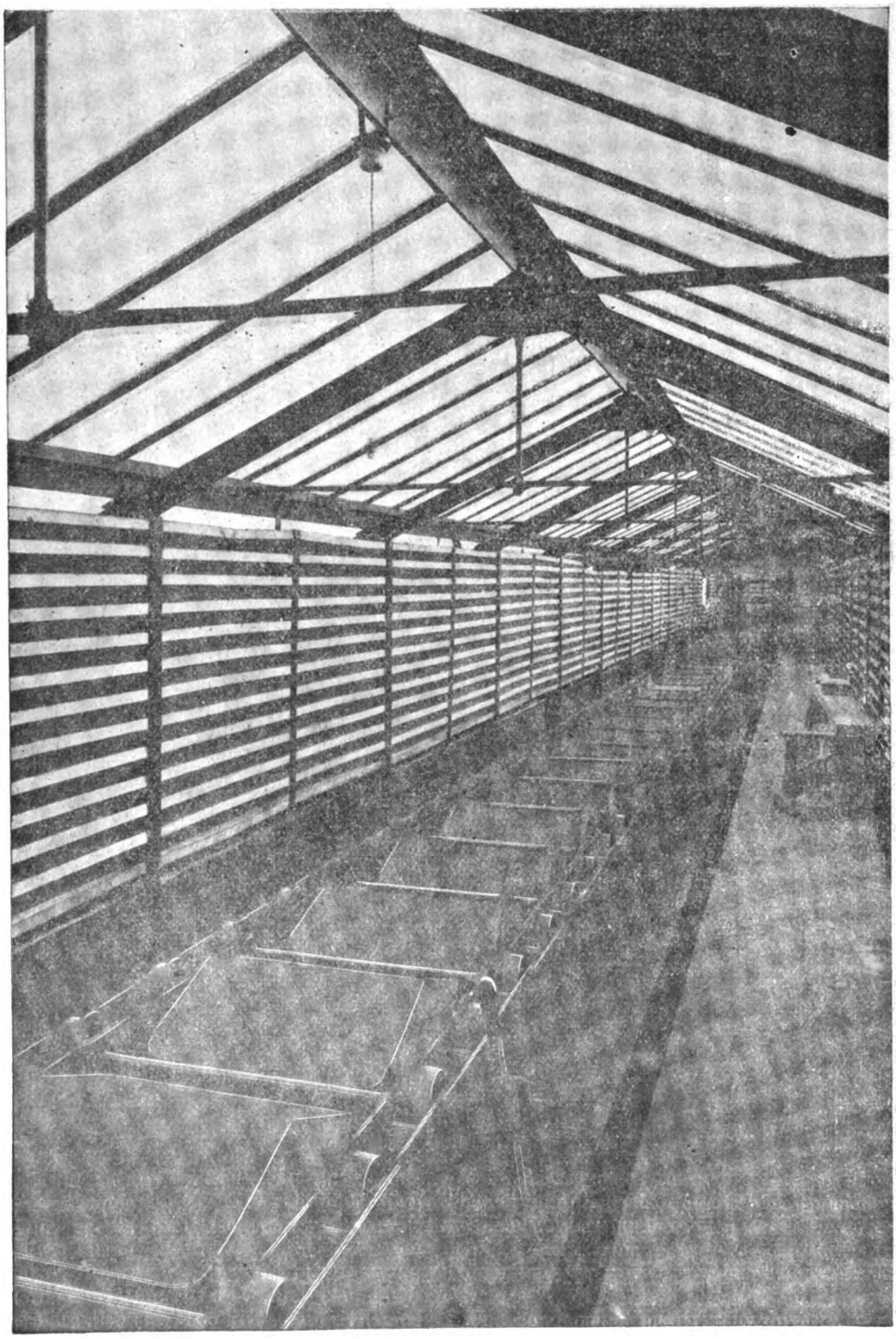

Fig. 4.

Siemens generators, as at the old station. In the engine-room, which is 150ft. long by 47ft. wide, and 40ft high to the springing of the roof, there are at present placed two 745-kw. steam alternators, each capable of an emergency load of 920 kw.—that is, of supplying sufficient energy at the emergency load to energise 30,000 8-c.p. lamps. There are also two 165-kw. steam dynamos intended for driving the works power—that is, for supplying to the motors used for driving auxiliary plant in the present instalment in the immediate future extensions of the installation.

giving electric energy at a pressure of about 2,000 volts. The exciters are also of Messrs. Siemens's make. The smaller engines are coupled to Siemens two-pole, compound-wound dynamos, giving an output at 500 volts. The motors are by the same firm, and known as their 4-D type.

The condensing plant is by Messrs. W. H. Allen, Son, and Co. The condenser is of the surface type, having cast-iron casing fitted with brass tubes, with a total cooling surface of 4,000 square feet. This condenser is capable of dealing with 45,000lb. of steam per hour with cooling water

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at 60deg. F. Two electrically-driven three-throw air-pumps are provided, each having a diameter of 10in. by 10in. stroke, and each is capable of dealing with 22,500lb. of steam per hour when running at a speed of 170 revolutions per minute. These air-pumps are conducted on Edwards's patent principle, and are driven direct through connecting rods from a three-throw crankshaft, which is coupled direct to an electric motor of Messrs. Siemens's shunt-wound type. The casing of the air-pumps is of cast iron, while the barrels, valve seatings, and guards are of gunmetal, and the valves of best rolled brass. The circulating water for the condenser is supplied by two centrifugal pumps. One of the pumps are of Messrs. Allen's well-known "Conqueror" centrifugal type, having suction and discharge branches 12in. diameter, and is capable of delivering 2,500 gallons of water per minute. This pump is coupled direct to an electric motor. The other pump is driven by a Bumsted and Chandler steam-engine, in all respects similar to those employed for driving the induced-draught fans.

The switchboards are of the Ferranti type, built into the wall. They are composed entirely of non-inflammable material. Heavy slate panels are fixed horizontally and grouted into the wall. Between these main slates, and sliding into grooves in them, are arranged a number of vertical division slates, about ½in. thick, dividing the whole base into a number of distinct compartments. The switches, instruments,' bus bars, etc., are mounted in such a way that each appliance and each conductor is separated by insulating material, each fitting being mounted in an entirely separate compartment. The cables run from the machines, are sealed in receivers fixed to the bottom of the board, and in the case of the alternating-current board one conductor is connected to the earth bar, also fixed to the bottom slate, the other being joined to the fuse panel contacts. Each machine and circuit panel consists of an oil-break fuse, with duplicate contacts, a high-tension oil-break switch, high-tension ammeter and contacts, and 'bus-bar fittings. Water softeners, supplied by Messrs. Doulton and Co., are used, and consist of cast-iron tanks, placed at a

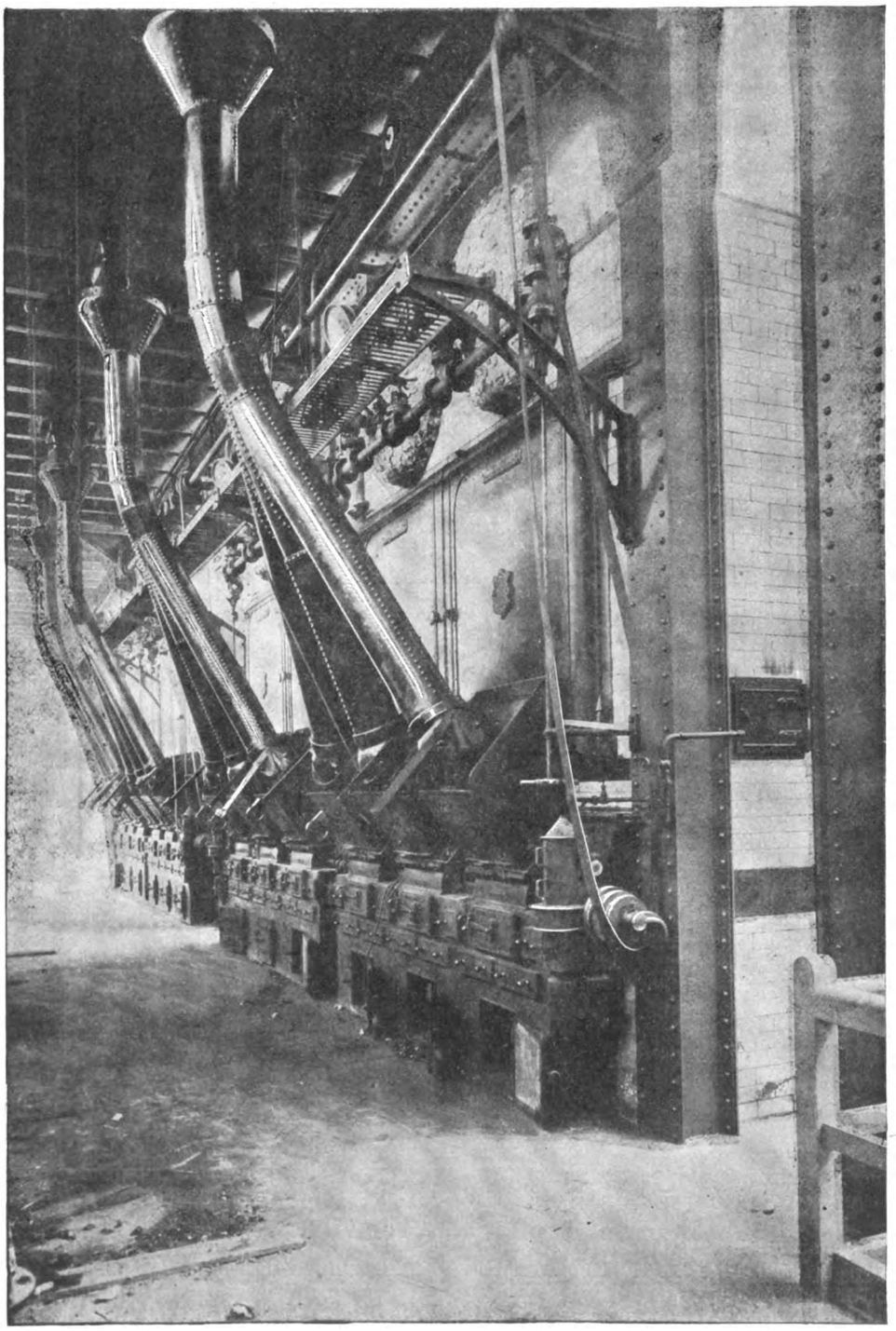

FIG. 5.

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suitable level, in which the chemicals for softening the feed water are mixed. The water is afterwards delivered into settling tanks, from which the feed pumps draw their supply.

THE ELECTROLYTIC ALKALI COMPANY'S WORKS.

Last week we were privileged to see the works of the Electrolytic Alkali Company's works at Middlewich, where company was formed. The works at present are equipped with 56 of these cells, but 56 more are in course of erection, and the building with the accessory plant will contain ultimately four times the present number. This plant has now been at work for 10½ months, and we were pleased to have the opportunity of seeing the same in regular work. As some of our younger readers may not be acquainted with the working of this process we propose to describe the same, commencing with the raw materials brought into the works.

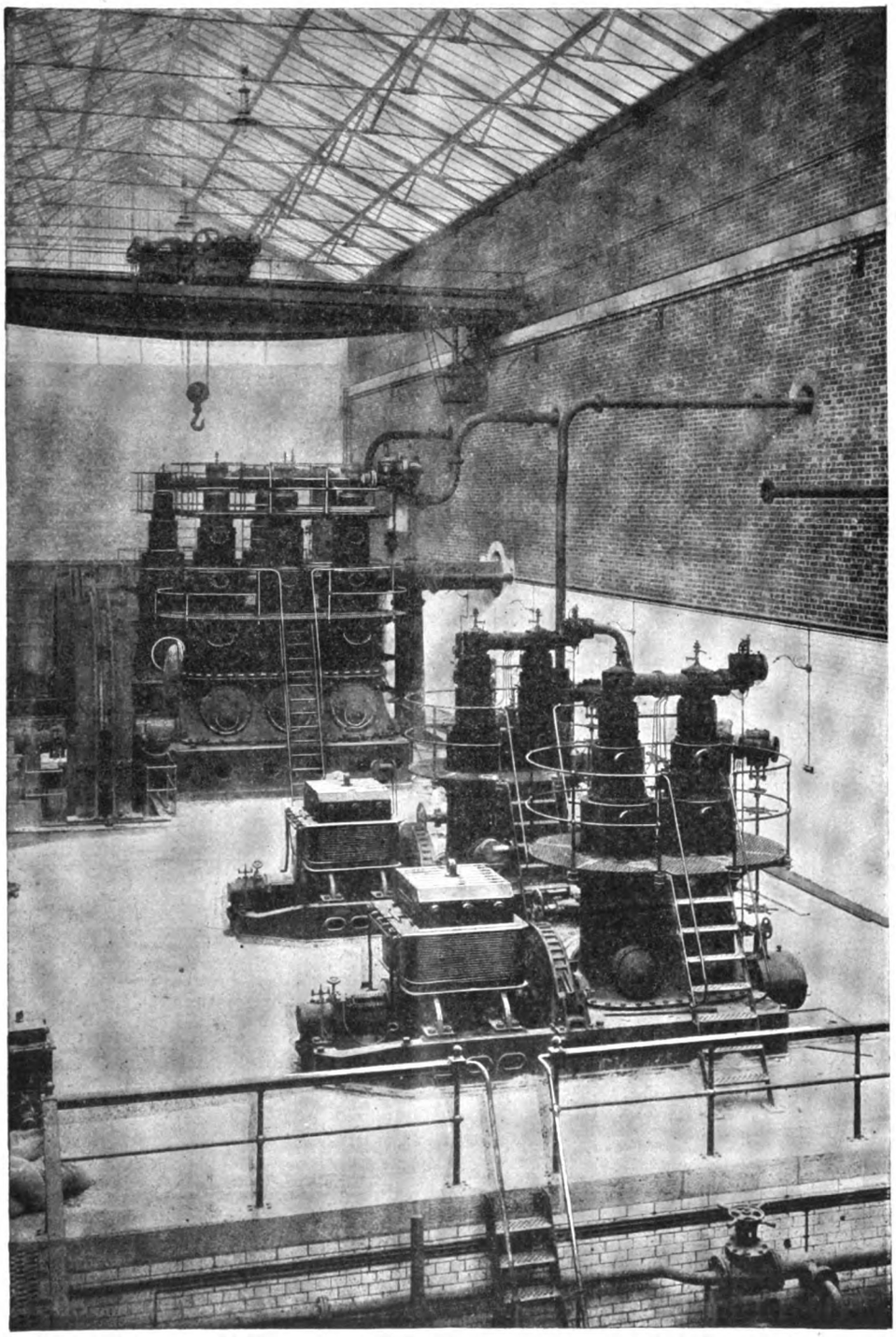

FIG. 6.

the Hargreaves-Bird process is used. We had as our guides in the tour of inspection Mr. A. C. Davidson, the general manager of the company, and Mr. L. Hargreaves, the works manager. This gentleman is the son of Mr. James Hargreaves, who with the late Mr. Bird invented the process. Mr. L. Hargreaves has from the commencement assisted his father in the perfecting of the process, which is not in its infancy. For instance, they had a cell of a commercial size as now used at Middlewich under experiment for a number of years before the present

The most important of these is the brine, and in order to obtain this at a cheap rate the works of the company were located at Middlewich, over the extensive salt beds of Cheshire. A 10in. borehole was put down into this salt bed, which was struck at 180ft., hard salt being obtained at 181ft. 6in. The borehole was continued down to 305ft. through beds of rock salt, mixed with a little marl. The lining of the borehole was carried down a few feet into the salt, so as to prevent *débris* from the upper layers being washed down into the borehole by surface

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water. Owing to the fact that a number of natural fissures were struck in the salt beds containing saturated salt solution, there has been no need to pump water down the borehole in this instance. All that has been done is to provide a compressed-air pipe down the centre of the borehole, and the mixture of air and brine, by reason of its lower specific density, then rises up and supplies the works. The actual cost of this brine comes out at about 3d. per 1,000 gallons, which is an exceedingly low figure. A storage tank has been provided at the surface, in which a reserve of brine is kept, but this has never been drawn on, as the supply by means of the compressed-air system has been uninterrupted. The same air-compressors are also used to drive a force pump about three-quarters of a mile away, which raises up the fresh water required for the boilers. The boiler plant consists of a series of Lancashire boilers, which were, when we visited the works, being partly fired by hand and partly by means of mechanical stokers. A large number of experiments have been made with these stokers in order to obtain an even proportion of CO_2 in the furnace gases. We understand that the underfed type of stoker is ultimately to be used, and then the products of combustion after purification will be used in the electrolytic cells for converting sodium hydrate into sodium carbonate. The steam from these boilers is supplied at 150lb. to two Robey engines of the horizontal type seen in Fig. 1. Each of these engines at 80 revolutions per minute will give a normal output of 425 h.p., or can give 470 h.p. if required. The engines drive by means of ropes four direct-current dynamos, manufactured by Messrs. Ernest Scott and Mountain, which are remarkable for their large current output and low voltage. Two dynamos are mounted on the same shaft, which is carried in four bearings, the driving pulley coming between the two inside bearings. Each of the six-pole dynamos is designed to give continuously an output of 2,300 amperes at 60 volts. This output is not on a six-hour run, but night and day for months. Thus, although the plant has only been at work for some 10½ months, the average run per day throughout that time averages over 23½ hours. This average speaks well for both the engines and the dynamos. It also is most creditable to the staff. Mr. Davidson explained to us how this continuous running is made

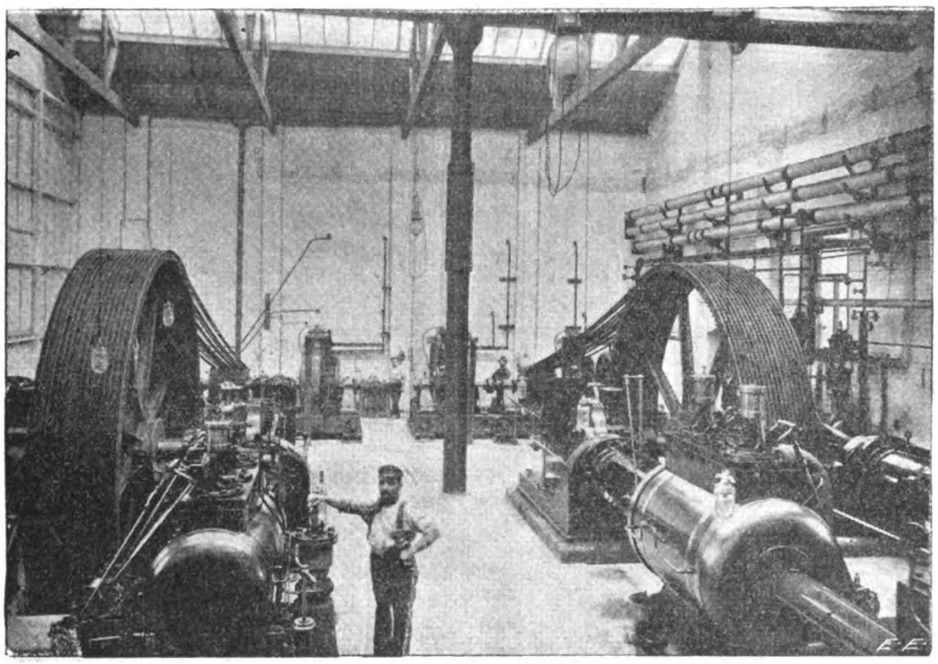

FIG. 1.—The Electrolytic Alkali Company's Engine Room, with Robey Engines and Ernest Scott's Dynamos.

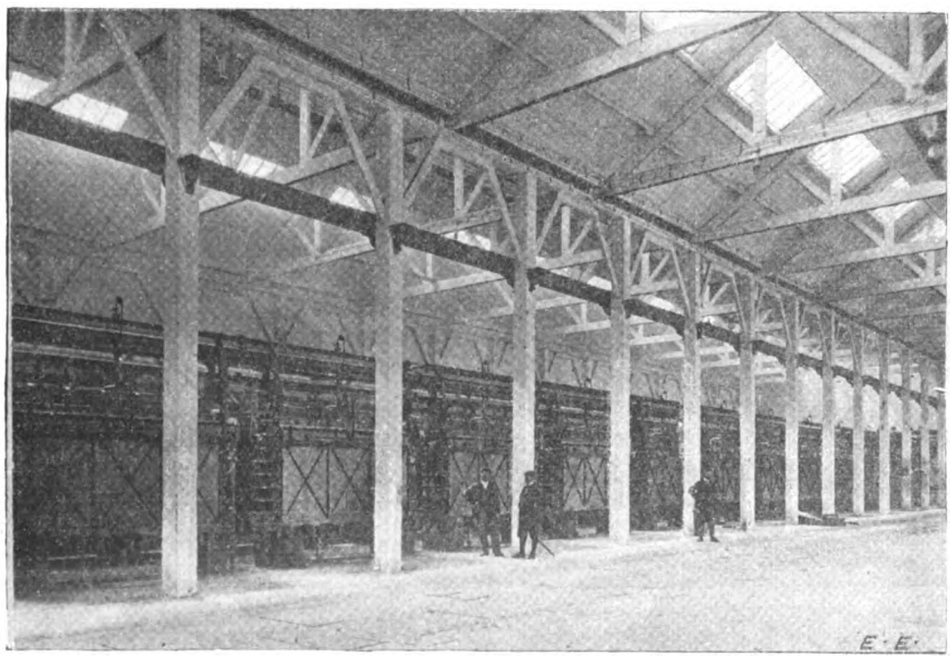

FIG. 2.—View of the Hargreaves-Bird Cells for making Bleach and Soda.

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the subject of a report by the men in charge, who have to put down the exact interval that any process is interrupted, and also the cause. The dynamos were running without sparking when we saw them, and the commutators were not unduly heated. We were particularly struck with the great thickness of the collecting brushes, which consisted of a number of ordinary gauze brushes placed the

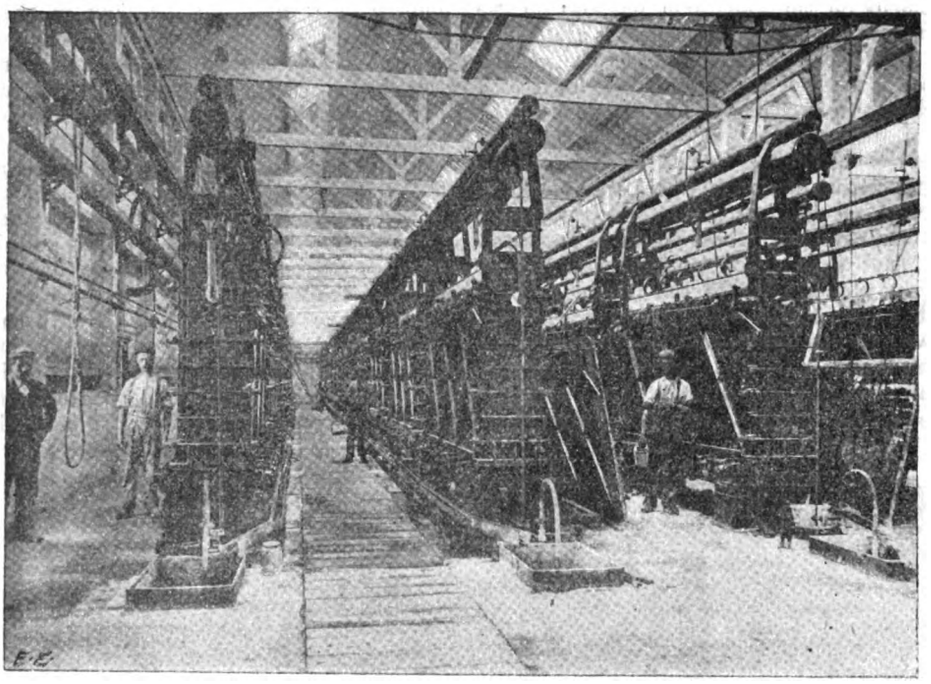

FIG. 3.—End View of the Cells, showing Soda Tanks.

one over the other. The brushes on alternate brush arms round the commutator are staggered, so that the whole surface of the commutator is employed for collecting purposes. The leads from the machines up to the switchboards and also from the switchboard to the cells were remarkable for their extreme simplicity, and their cost was evidently the cost of copper plus a very small item for

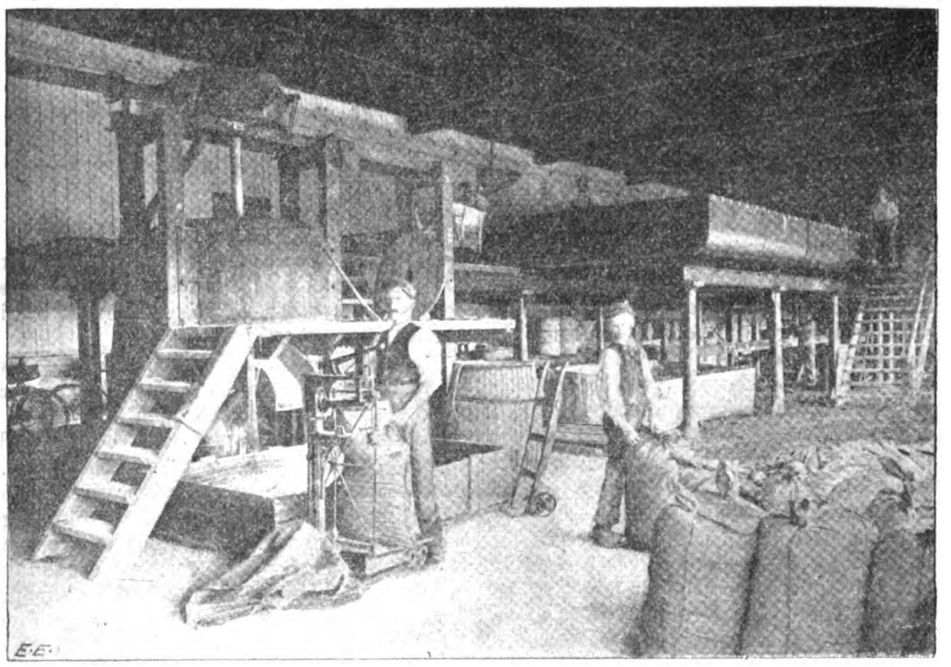

FIG. 4. Soda-Crystallising Tanks, with Dehydraters and Packing Plant in foreground.

labour of fixing. They consisted of a number of copper strips clamped together by means of bolts and nuts. The cross-section of these copper strips, forming the leads in question, was three square inches for the normal current of 2,000 amperes. Where the direction of the lead changed, one composite bar was bolted on to the side of another going in the required direction without any attempt at interleaving the component strips. In view of the current

density at these joints we expected to find local heating, but this was not the case in any of the numerous joints which we felt. The four machines each supply individual circuits to series of 16 cells, and hence work independently. In this way all voltage regulation is done by means of the shunt resistances. Before leaving the generating department we may mention that the engines are worked condensing, the water for the jet condensers being obtained from the canal. As the boilers supply steam for the various other apparatus throughout the works and for the electrolytic cells, the actual cost of generating electricity at Middlewich has not yet been divided out. The coal used is a cheap slack, and we should expect the total cost per unit to come out exceedingly low in view of the wonderfully high load factor, which is over 98 per cent. We now come to the cell-room, in which the 56 cells of the Hargreaves-Bird type are placed in rows of 16, each row being supplied by independent dynamo. A side view of these cells can be seen in Fig 2, while Fig. 3 shows the ends of three rows. The essential feature of the cell is that eth cathode is placed behind a diaphragm which is impervious to the brine solution, and yet allows the sodium ions to be

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forced through it by the process of electrolysis. Steam is then passed over the cathode if sodium hydrate is to be made, and if sodium carbonate is required a mixture of steam and carbon dioxide is employed. In Figs. 2 and 3 the upper pipe contains steam, and the larger pipe below this at the top of the cells contains carbon dioxide. They are mixed together in the breeches pipe seen in Fig. 2, and then pass down over the cathodes. The success of the process depends chiefly on the diaphragm, but also on the details used throughout the cell. These details are briefly as follows: The framework forming the two sides and bottom of each cell is made of cast iron. It is lined with blue vitreous bricks set in special cement. The top of the cell is also made of the same material, which is found to resist the action of the chlorine set free at the surface of the anode. The anodes consist of a number of large blocks of retort carbon carried on lead supports, which are also protected by a cement covering. These blocks of untreated retort carbon are found to be much more serviceable than any moulded carbons obtained up to the present. They are placed on either side of the vertical supporting conductors, and are arranged to face outwards. The two sides of the cell are then closed in by the two diaphragms, the exact composition of which is naturally kept a secret. They are constructed of a silicate composition carried on a basis of asbestos fibre. These diaphragms are held up against the edges of the blue bricks by means of the copper-gauze cathode, behind which again are a series of sheet-copper supports, which are secured by cement into the cast-iron backing, which is seen in Figs. 2 and 3. The clamps at either end are then screwed up, which makes a water-tight joint between the diaphragm and the brick lining of the cell, the surface of which is screwed up with cement. The space all round the copper supports projecting from the iron backing leaves a free course for the mixture of steam and carbon dioxide to play upon the copper-gauze cathode. The actual size of each diaphragm is 10ft. by 5ft., which gives an active diaphragm surface of 100 square feet for each cell. The brine is fed into the cell from the third pipe, seen above the same in the illustration. It is carried down inside to the bottom of the cell, and the weakened brine solution flows over an escape pipe at the top. This pipe is also used to convey away the chlorine gas given off at the anode. It is found in practice that by admitting the denser saturated solution at the bottom, and drawing off the weakened solution at the top, two-thirds of the salt can be taken out. This is being done now, and the cheapness of the brine makes it not worth while to reconcentrate the weak solution leaving the cell. The other product—*i.e.*, the carbonate of soda solution formed by a combination of the sodium with the steam and carbon dioxide—flows out at each side of the cell through holes in the bottom of the frame casting. In Fig. 3 these outlets are not visible, but the two round recesses seen at the bottom of the framework correspond to the holes which come at the other end of the cell. Under these a transverse troughing is placed, which conveys the solution into the longitudinal troughs seen in this illustration. The soda solution then runs into the tank in the foreground, and every time these are full it is siphoned away into the concentrating department. In these transverse troughs a neat provision is made for preventing the salt solution from mixing with the soda if a diaphragm suddenly gives way. The end of the transverse trough from each cell comes nearly out to the outer edge of the longitudinal trough, into which the soda solution trickles in the ordinary way. In the event of the diaphragm fracturing, the greatly increased flow will cause the mixed solution to jump over the edge of the collecting trough on to the floor. This will be quickly seen by one of the men in the building. Every time the collecting tanks are emptied a record is made, and a small measured quantity of the solution is transferred into the jar seen standing by it. The contents of this jar are analysed each day in order to ascertain how the diaphragms are working. If more than a very small per cent. of chloride is found in the solution, samples are taken from each individual cell in that line in order to locate in which of them there is a diaphragm which should be replaced.

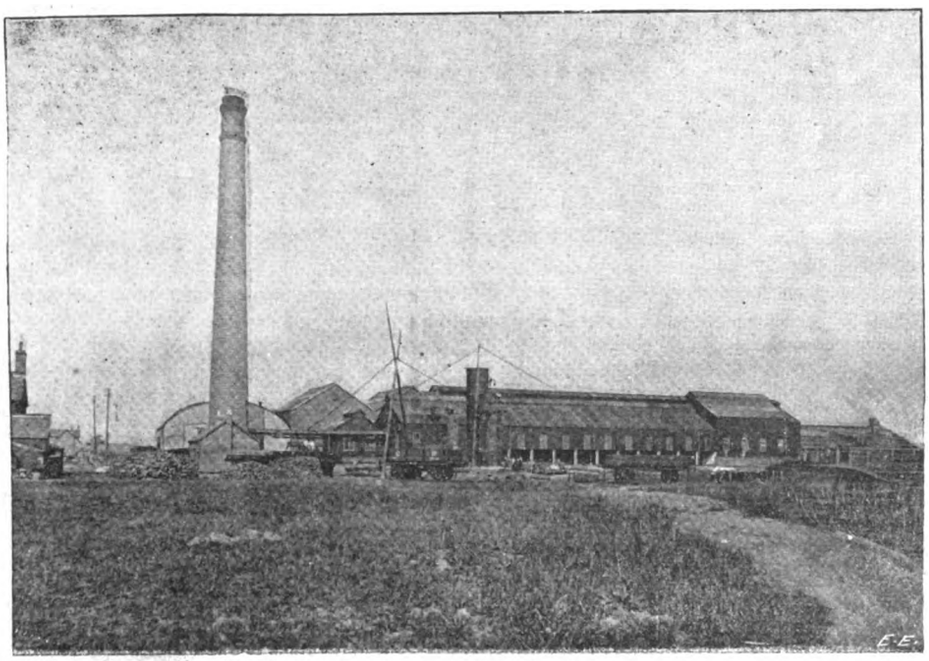

FIG. 5.—General View of the Electrolytic Alkali Company's Works.

As the cost of working the process as far as the upkeep of plant is concerned is mostly that of the diaphragms, a good system of giving the men who make the diaphragms and who put them in the cells bonuses which depend on the life of the same has been instituted. Thus, in the prospectus of the company it was estimated that 28 days would be the average life of these diaphragms, but by care in manufacture and in handling an average life of 70 days is now obtained, with a record of 155 days for a single diaphragm. The men engaged in the process of manufacturing and fitting these diaphragms receive a bonus of 10s. for every one that lasts more than 50 days and £1 for every one that lasts more than 100 days. Longer life than this results in a considerable increase in the bonus, and the effect has been to obtain care both in manufacture and handling from the unskilled type of labour employed. It also makes the number of cells in actual use higher than would otherwise be the case, and the records show that not more than two cells out of 56 are, as a rule, out of service at the same time.

The point which struck us most especially was the total absence of chlorine in the atmosphere round the cells.

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This is secured by careful workmanship, and also by the sucking away of the chlorine by means of a pump. Thus, if any leak occurs in the various pipes conveying the spent salt solution and chlorine away, air leaks in and not chlorine out. The pump used for this purpose is a most interesting one; it is made up entirely of glazed earthenware, and is of the centrifugal type. It was supplied by the German firm of March Sohnes, of Charlottenburg, after other types had been proved unsuccessful, owing to the action of the chlorine on them. The chlorine is conveyed away by earthenware pipes to the bleach chambers, which are situated at some distance from the works. This distance enables all moisture to be extracted from the gas, and results in a superior quality of bleaching powder. In the bleach chambers it is passed over a layer of slaked lime spread over the floor; the arrangement of these bleach chambers and of the chlorine pipes is such that the circulation can be altered in numerous ways, to ensure that the chlorine in any chamber shall be practically removed before the chamber is opened. This precaution is most necessary, not only for the health of the men employed, but also for the commercial success of the company, as chlorine discharged into the atmosphere means great damage to the surrounding farmers and heavy compensation. This the Electrolytic Alkali Company have avoided. They now produce about 55 tons of bleach per week, and find no difficulty whatever in disposing of the same. This is not surprising in view of the high percentage of available chlorine which they obtain, and which for certain deliveries has been certified by the buyers' chemists to be as high as 39·5 per cent., whereas 35 per cent. is a common commercial figure. It is interesting to note that the company is exporting a considerable portion of its bleach to the United States.

The other product of the works is washing soda, of which from 82 to 85 tons per week are obtained from the present plant. The soda solution is first concentrated by the vacuum process, and then stored in heated settling tanks until the mechanical impurities settle out. It is then turned into the crystallising pans, which can be seen overhead in Fig. 4. The crystals are dried, crushed, and then made up into sacks for sale, as seen in this illustration. The whole process strikes one as being eminently successful, and the first cost of the apparatus is not unduly high, as the materials employed, with the exception of the diaphragms, are cheap. Stock articles are employed wherever possible, which keeps the cost of upkeep down. Also the class of labour employed is cheaper, and proves that the process can be managed easily. We are pleased to note that already the output is considerably more than was estimated in the prospectus of the company, which gave 49 tons of bleach and 70 tons of soda as the probable output from the present plant. The figures actually obtained are 55 tons of bleach and from 62 to 65 tons of soda. We gather from the figures given us that the financial result is equally favourable, and that a profit of £7,500 was made during the last six months. The Chairman, at a meeting of the shareholders held on the works last Saturday, said that more capital was required to get three other units of 56 cells to work. He predicted that when this was done proportionally larger profits would be earned, and we see every reason that this should be so.

THE TUNBRIDGE WELLS TELEPHONE ENQUIRY.

The whole of Thursday and Friday in last week were occupied by the adjourned enquiry by the Local Government Board inspector into the granting of a further loan of £15,000 for the municipal telephone undertaking at Tunbridge Wells. At the first proceedings, held about a month ago, we reported the enquiry somewhat fully, and condemned editorially the line taken by the opposition. The proceedings on these last two days were so much on a par with what took place then that further detailed report is hardly necessary. Mr. A. R. Bennett, the consulting engineer for the work, was cross-examined by a local solicitor much in the same way as would have been the case had a criminal charge been under investigation. The object of the cross-examination was to prove that estimates given by Mr. Bennett were quite unreliable, and would be greatly exceeded. In spite of lengthy cross-examination, Mr. Bennett was only shaken on two points, the first being as to the number of spare lines which would be provided by the estimate, and the next a slip in the cost of the telephone instruments. Expert evidence was then given as to the efficiency of the work already installed, and from what we can see, no serious defects were proved in the construction. The town clerk, Mr. W. C. Cripps, in replying to the case for the opposition, put the point in a nutshell. One department of the Government had authorised the Corporation of Tunbridge Wells to carry on a telephone undertaking in competition with the National Telephone Company, and the opposition now asked another department of the Government to refuse to grant a loan for carrying out this work. He felt strongly that if the Local Government Board took such a course, the sooner the Telegraph Act was repealed the better, because the Corporation would have been grossly misled. He also pointed out that the exchange was a success, and that any refusal to grant loans now would tend to benefit the rival undertaking of the National Telephone Company, and would place a heavy charge on the rates of the town. It was obvious, too, that if the Corporation undertaking were allowed to go under, the charges of the company would be immediately increased, so that the sacrifice of public money would have been made without serving any good purpose. He concluded by claiming that Tunbridge Wells deserved well of the country, and did not deserve the slight which the Local Government Board were invited to administer to it. The decision as to the loan will be communicated later, but we fail to see any grounds on which the application of the Corporation can be refused.

TRADE NOTICES AND NOVELTIES.

G.E.C. Catalogues.

We have recently received from the General Electric Company, Limited, Queen Victoria-street, London, E.C., a copy of their catalogue, Section P, which deals with electric generating plant, etc. First of all, we have particulars and illustrations of the several types of continuous-current dynamos and motors manufactured by the firm, various combinations of engines and dynamos being shown. Then follows alternating-current plant, the first machine shown in the class being a single-phase generator of the inductor type with stationary windings. The armature of this machine is composed of two parallel rings of iron stampings, with open slots for receiving the coils, which are wound on formers insulated with seamless mica tubes, and held in position by fibre keys. The exciting coil is of bare copper strip insulated with asbestos band. This type of generator is built in 18 standard sizes. The average efficiency of standard types from 100 h.p. upward is, it is stated, 93 per cent. at full load and 89 per cent. at half load. The maximum drop in voltage between full load and no load, provided the speed and excitation remain constant, is about 5 per cent. on lighting circuits and 15 per cent. on power circuits. The rise of temperature above the surrounding atmosphere does not exceed 35deg. C. in any part of the machine. The excitation watts are about ½ to 1 per cent. of the normal total output of the machine. Three-phase generators of the inductor and other types are also listed, besides single and three phase motors and electric overhead travelling cranes. The last pages of the catalogue under notice contain prices and particulars of boilers, steam, gas, and oil engines, turbines, and other apparatus and accessories of standard types supplied by but not manufactured by the General Electric Company, Limited. This addition has been made, we are told, so as to render the catalogue complete for the purpose of estimating and reference.

A separate list just issued by the same firm contains particulars and illustrations of a number of special illuminating devices for the Coronation. Some of these devices are very elaborate in design and of considerable artistic merit. Timely enterprise of this nature should certainly prevent the decorations in connection with the forthcoming great ceremony from lacking in originality.

It may interest some of our readers to know that the General Electric Company, Limited, have added to their stock in trade a show case which illustrates the manufacture of the filament of a Robertson electric incandescent lamp from cotton wool and cellulose to the finished article. The firm are supplying this case, we understand, at a merely nominal price, to customers who may care to exhibit it.

The Nernst Lamp.

Much has been written from time to time about the Nernst lamp and its evolution from the experimental stage, but it is only now that we are able to welcome its introduction to the English market as a commercial reality. The Allgemeine Elektricitäts-Gesellschaft, Berlin, are to be congratulated upon this practical result of their perseverance in perfecting the lamp. From the Electrical Company, Limited,

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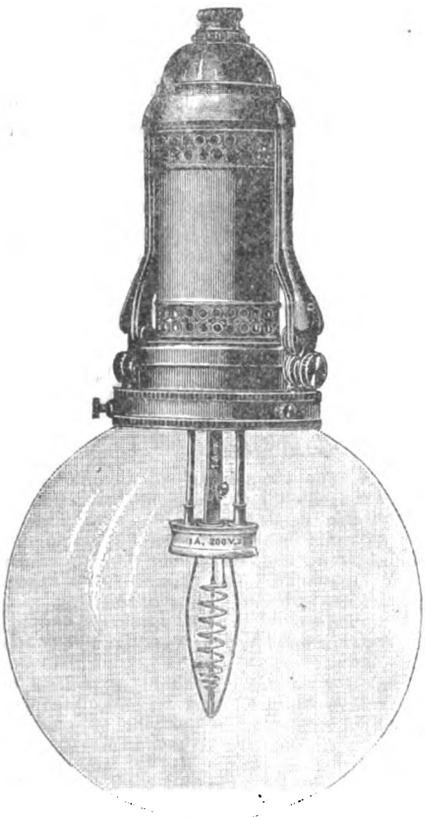
122-124, Charing Cross-road, W.C., the London branch of the parent establishment, we have obtained some particulars relative to the latest development of the lamp. We are told that Nernst lamps of the 1902 pattern A type can be supplied for all the usual pressures between 100 and 150 volts, also between 200 and 250 volts. A complete lamp is shown herewith. All parts are interchangeable in lamps of corresponding power. The two parts which require renewal are the steadying resistance and the burner. The resistance, shown separately, acts as a safety fuse, protecting the filament from destruction in the event of a sudden increase of voltage across the lamp terminals, whereby in the ordinary course the resistance of the filament would be so decreased as to allow a destructive flow of current in the lamp circuit. Under normal conditions this resistance rarely gets out of order. It will, we understand, absorb a maximum excess pressure of about six volts, and should, therefore, amply suffice for ordinary fluctuations of the supply. Not until this limit has been exceeded will the resistance be destroyed. The resistance itself is composed of fine iron wire. As shown in the accompanying illustration, it is enclosed in a glass bulb fitted with a socket, through which the terminal ends are brought. This form has been adopted to facilitate renewal in case of necessity. The bulb is mounted upon a porcelain base-plate in the body of the lamp, so that to replace a resistance it is necessary to remove the hood of the lamp body. Upon the same base-plate is also mounted an automatic cut-out which controls the heating circuit. This heating circuit is shown in the accompanying illustration of a complete lamp. It is made in the form of a spiral, the convolutions of which embrace the filament of the



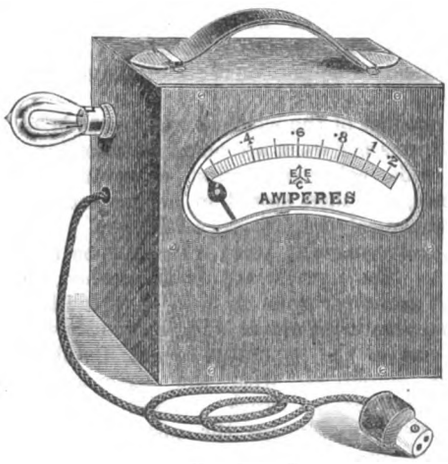
A Complete Nernst Lamp.

Steadying Resistance for Nernst Lamp.

lamp. When the lamp is switched on, current is diverted through the heating circuit, whereby the spiral becomes incandesced, and, in its turn, heats the filament by radiation, rendering the latter in the course of a few seconds sufficiently conductive to pass current and so complete the circuit of the lamp. Directly the lamp circuit proper is thus completed, the heating circuit is cut out by the automatic controller. The whole arrangement is beautifully simple. The filament and spiral heater are attached to a common base-piece of porcelain fitted with the necessary terminals. This combination, or burner, as it is technically termed, may be readily detached, and a new one substituted. The current consumption in amperes is marked on the middle contact piece of the body of the lamp, while both the burner and the resistance are marked with the amount of current as well as with the voltage which each of them absorbs, the sum of the two voltages thus given being equal to the pressure of the supply. Full instructions for fixing are given with each lamp. Attention is also called to the futility of overrunning a Nernst lamp, as this would shorten the life of the resistance without increasing the amount of light obtained. Special burners are supplied for alternating and direct currents respectively. The filament will be destroyed if a direct-current burner is run on an alternating-current circuit; also if on a direct-current circuit the lamp is connected with wrong polarity. Lamps yielding from 59 c.p. to 168 c.p. can be supplied for terminal pressures ranging from 100 volts to 250 volts. The higher the voltage of the lamp the greater correspondingly will be its efficiency, although the figures given for lamps of relative low voltage leave little to be desired in this respect. For instance a 1-ampere 100-volt Nernst lamp of 59 c.p. takes 100 watts, or 1·70 watts per candle-power. Again, a 1-ampere 150-volt Nernst lamp of 94 c.p. takes 150 watts, or 1·59 watts per candle-power, and a ½-ampere 250-volt lamp of 168 c.p. 255 watts, which corresponds to a consumption of 1·48 watts per candle-power. Thus it will be seen that the efficiency of the Nernst lamp increases correspondingly with the voltage for which it is constructed. We understand that the life of a burner averages from 400 to 500 hours, which marks a considerable improvement as compared with previous results. It remains to be added that the price of a Nernst lamp complete is 20s. Spare burners rated for half an ampere are supplied at 2s. each, and for one ampere at 2s. 6d. each, while resistances cost 1s. each. We have seen many of the lamps in use for lighting restaurants, etc., on the Continent, and there can be no two opinions as to the brilliancy of the effect obtained. They are claimed to be equally suitable for street-lighting and for replacing small arcs on large incandescent lamps of the ordinary type. We shall watch the progress of the Nernst lamp with added interest now that its development has reached the commercial stage. Much is being done to reduce the cost of electricity at the generating end, and while this endeavour will doubtless alone conduce to its more extended application for lighting and power purposes, the fact cannot be overlooked that there is an almost unexploited field for economy at the consumers' end of the transmission main, hence the great value from the electrical engineer's point of view of a departure which time and experience may prove to contain the elements essential to the more rapid advance of electric lighting.

A New Lamp Tester.

The accompanying illustration shows a lamp tester which has been introduced by Messrs. Everett, Edgcumbe, and Co., 22, Charterhouse-square, London, E.C. Its purpose is to enable the efficiency of electric incandescent lamps to be readily determined. In using this tester all that is necessary is to remove the lamp to be tested from its usual holder, and place it in the holder attached to the instrument as shown. On inserting in the vacated holder the adaptor attached to the flexible cord connected with the instrument, the pointer will at once indicate the current taken by the lamp at the voltage of the regular supply. A table is supplied with the instrument, from which the efficiency of any



A New Lamp Tester.

lamp in watts per nominal candle-power can be readily found from a knowledge of the approximate supply voltage, and a reading taken on the tester. It may be added that the instrument is similar as regards internal construction to Messrs. Everett, Edgcumbe, and Co.'s "Universal" type instruments, so that it can be used upon either direct or alternating current circuits with equal accuracy. It is spring controlled and extremely portable. Providing, as it does, a means whereby a check may be kept upon the relative efficiency of the individual units comprising an installation of electric incandescent lamps, this tester should prove of value in all cases where economical conditions are striven for.

A LARGE ELECTRIC PUMPING PLANT.

Messrs. Ernest Scott and Mountain, Limited, electric light and power engineers, Newcastle-on-Tyne, have recently completed an electric pumping plant at Eldon Colliery for the South Durham Coal Company, which plant is claimed to be one of the largest of its kind in the kingdom. It comprises an engine of the horizontal long-stroke compound type, rope-coupled to a generator of 220 kw. capacity. The engine has high-pressure and low-pressure cylinders of 18in. and 30in. diameter respectively, and a stroke of 40in. It runs at 80 revolutions per minute, at which speed it is capable of developing 440 i.h.p., with a steam pressure of 100lb. per square inch at the engine stop-valve. The generator to which this engine is rope-coupled is of the Scott and Mountain over-compounded multipolar type, designed for an output of 220 kw. at an E.M.F. of 500 volts on open circuit, or 550 volts at full load when running at a speed of 400 revolutions per minute. The generator is mounted on an extended bed-plate with outer bearing, the pulley shaft being coupled to the armature shaft by means of turned steel bolts. This plant is used for driving the two pumps at present installed, but is of sufficient capacity for driving a third set of pumps which it is proposed to instal, and also the motors for working the coal-cutting machines to be put down. The generating plant is situated at what is known as the Harry pit, the current from the generator being taken to a main switchboard, whence it is transmitted to the John Henry pit, a distance of half a mile, by means of overhead conductors, consisting of four cables each composed of 19

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wires No. 11 S.W.G. run on poles with porcelain insulators. At this point it is taken down the shaft through heavily insulated and armoured cables to the pump-room, the length of the shaft cables being 150 yards each. In the pump-room there are two sets of Scott and Mountain's three-throw ram pumps, with rams 11in. diameter by 18in. stroke, each pump being capable of delivering 500 gallons per minute, or collectively 1,000 gallons, against a head of about 400ft. when running at a speed of from 27 to 28 revolutions per minute. The pumps are of the firm's latest design, with gunmetal rams, independent pump barrels, valve boxes, and connecting pipes. The two motors are each of Scott and Mountain's four-pole type, with extended bed-plates, and are capable of developing 120 effective horse-power each at a speed of about 450 revolutions per minute. These motors drive by cotton ropes on to the pumps, whereby the motor armature is relieved of all jar. The plant has now been constantly at work for over two months, and in order to determine its efficiency an exhaustive set of tests has been made, with the following satisfactory results: One boiler, 30ft. long by 7ft. diameter, of the Lancashire type was easily capable of supplying steam to the engine when driving the two sets of pumps to their full capacity, the coal consumption being 906lb. per hour. The pumps delivered 64·8 gallons of water against a head of about 400ft. per pound of coal used in the boilers. The efficiency between the actual electrical output at the dynamo terminals and the horse-power in the water pumped, the pumps being a distance of 1,000 yards from the generator, was 72·7 per cent. The efficiency between the electrical horse-power at the motor terminals and the actual horse-power in the water pumped was 77·4 per cent. The efficiency of the motors was 91 per cent. The efficiency of the pumps—*i.e.*, the difference between the actual horse-power applied at the motor shaft and the horse-power in the water delivered was 85 per cent. The high efficiency of the pumps is attributed to their slow speed and also to the use of machine cut gearing throughout and the very large valves used, but although the above efficiency is high no doubt a still higher efficiency would be obtained against greater heads.

LEGAL INTELLIGENCE.

METROPOLITAN ELECTRIC SUPPLY.

Compensation for Displacement.

In the House of Lords on Monday, the Lord Chancellor and Lords Macnaghten, Davey, Shand, Robertson, Brampton, and Lindley, heard the appeal of the London County Council in a case against the Metropolitan Electric Supply Company from the decision of the Court of Appeal. It appeared that under the powers of the Act which authorised the construction of a new street from the Strand to Holborn, the London County Council had taken the premises of the defendant electric supply company in Sardinia-street, where the company had their generating station for supplying the surrounding district. The question in dispute was on what basis was the compensation to which the company were entitled for the loss of their original premises to be fixed. It appeared that the company had since acquired the generating station at Willesden, but under the Act the London County Council were bound to provide a site, and the company were to be compensated by being put as nearly as possible in the same position as they were before they were displaced. The Council were not themselves to build or reinstate, however, but were to provide a sum which was to be arrived at in this way: "A sum equal to the costs and expenses of erecting and fitting up a new generating station upon the new site, with new plant of a capacity to generate and supply electrical energy to an output of not less than 4,000 kw., and all expenses," and so on. Mr. Justice Farwell, in the court of first instance, decided that the arbitrator was debarred from allowing anything more than would cover four engines graded up to a capacity of 4,000 kw. The Court of Appeal reversed this decision; hence this appeal of the London County Council.

The **Lord Chancellor**, in allowing the appeal said in this matter they were dealing with a contract between two parties to which the Legislature had given its sanction, and they had no authority to add to or take away from that to which both parties had agreed. The question was not whether it was reasonable and proper to make provision for contingencies, but whether the parties had done it. He protested against supplementing and amending contracts which people had made and in which they had omitted to provide something that it might have been reasonable and proper to provide for. He moved that the appeal be sustained.

The rest of their Lordships concurred, and the appeal was allowed, with costs.

CAPE TOWN TRAMWAYS.

The Judicial Committee of the Privy Council, consisting of Lords Macnaghten, Davey, Shand, Robertson, and Lindley, recently had before them the matter of the Eastern and South African Telegraph Company, Limited, *v.* the Cape Town Tramway Companies, Limited. It was an appeal from a judgment of the Supreme Court of the Colony of the Cape of Good Hope, which dismissed the action of the appellants—the Eastern and South African Telegraph Company, Limited—who were the plaintiffs in the action. It was explained that the appellants are an English company, having their head offices in London, and transmitting messages between Europe and Cape Town by cables. The respondents supply Cape Town and its suburbs with tramway communication, which since 1896 has been worked by electric power on the overhead trolley system, and the complaint of the appellants was that the working of their cable—which runs along the West African Coast from Loanda to Table Bay, a distance of about 1,600 miles, being landed near the central jetty, Cape Town, whence communication is established with the appellants' central offices by means of a cable buried in a trench beneath the streets—was interfered with by the escaping current from the respondents' rails, which had caused great inconvenience and expense to the appellants ever since the adoption of electric power by the respondents. The latter contended that the escape of electricity from the tramrails to the earth did not constitute a "leak" within the meaning of the Acts of 1895 and 1896, under which the respondents undertook to make good losses caused to anybody in the event of an electric leak taking place. The Colonial Court took the view of the respondents, and held that the alleged damage to the appellants was too remotely the consequence of the respondents' acts, and that the respondents were not guilty of the culpa which the Roman-Dutch law required the appellants to prove, and dismissed the action with costs. Hence the appeal to the Judicial Committee.

The arguments of counsel having concluded, judgment was reserved.

ELECTRIC LIGHT IN A COUNTRY MANSION.

Mr. Justice Wright, sitting in the King's Bench Division of the High Court, this week heard the case of Dolby and Williamson *v.* Lord Wenlock, in which the plaintiffs, who are electrical engineers, claimed £318, professional charges, in connection with the installation of the electric light at Lord Wenlock's seat, Escrick Park, York. Defendant paid £150 into court, with a denial of liability.

Mr. Ernest Richard Dolby, one of the plaintiffs, gave evidence of interviews he had with Mr. Walker, Lord Wenlock's agent, in connection with the installation, and stated that he was told that Lord Wenlock did not want to spend more than £3,000 in the first year, and subsequent work was left open for future consideration. Mr. Walker never, either verbally or in writing, said there was a limit of £3,000, and plaintiffs were only to be paid upon that.

Mr. Lawson Walton, K.C., for the defence, said Lord Wenlock was anxious that plaintiffs should be paid something, and he considered the sum paid into court ample for the services they had rendered.

Mr. Francis Elliot Walker, agent to Lord Wenlock, gave evidence to the effect that from beginning to end the limit of £3,000 was insisted upon.

Mr. Justice Wright, in giving judgment, said he came to the conclusion that the sum paid into court was sufficient to meet the claim, but as it had been paid in with a denial of liability, judgment would be for the plaintiffs, with costs down to the time of such payment into court.

KILLARNEY ELECTRIC LIGHTING.

In the Rolls Court, Dublin, the case of Callender's Cable and Construction Company, Limited, *v.* Killarney Electric Lighting Company, Limited, was heard on an application by the plaintiffs to use the name of the defendants for the purpose of getting a lease of the water power for electric lighting purposes from Colonel Quill, the landlord, and also for certain enquiries as to debentures and the priorities of debentures. It was also sought to obtain a declaration that the plaintiffs were entitled to certain salvage charges in respect of sums advanced by them to keep the lighting and the works from being shut down. It was now stated that there was no prospect of a settlement of the questions at issue.

The **Master of the Rolls** said he was of opinion that the claims made by plaintiffs in respect to sums advanced by them were not salvage claims, but he reserved the question for later decision. He granted the other branches of the application.

NEW COMPANIES REGISTERED.

Barnsley and District Electric Traction Company, Limited.—Capital, £10,000. Objects: to carry on in the United Kingdom or elsewhere the business of carriers of passengers and goods, electrical engineers, manufacturers of and dealers in all railway, tramway, electric, and other apparatus, etc.

Albion Battery Company, Limited.—Capital, £25,000. Objects; primarily to acquire and turn to account any patents relating to the production, treatment, storage, application, distribution and use of electricity; in particular to acquire from C. Tunstill J. Opperman, of 2, Wynyatt-street, Clerkenwell, George Fowler, of the Portland Hotel, Great Portland-street, and R. G. Margetson, of 76, Great Portland-street, certain existing inventions in regard to the above; to develop and work the same, etc.

APPOINTMENTS VACANT.

Electrical Engineer, as sole travelling representative for the United Kingdom, by storage battery manufacturers of high standing. Particulars in our advertisement columns.

Marine Engineer, Corporation electric light and power station, Carlisle, 35s. per week, March 18. Full particulars in our advertisement columns.

Electrical Draughtsmen, knowledge and experience of station switchgear. Ferranti Limited, Hollinwood, Lancashire. Full particulars in our advertisement columns.

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TO CORRESPONDENTS.

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ENGLISH UNITS.

There is much to be said in favour of the metric system for weights and measures, and, again, there are great objections to it for certain reasons which we do not propose to go into here. The fact remains that throughout the British Empire, and with few exceptions amongst the whole English-speaking race, one system of weights and measures is in general use. Commercial intercourse with foreign nations demands, especially amongst engineers, a knowledge of the units of weight and length used by others, but this knowledge does not lead to the employment of these units in the engineering literature. That this should be so is to the advantage of all, as it renders the direct comparison of the work of different experts more easy. A man learns, as a rule, to think in one system only, and has to convert all statements of fact to that system before he can appreciate their value. Hence uniformity in the literature of any particular art is most desirable as far as units are concerned. In this connection we are surprised to find that Mr. James Swinburne in his recent paper on the "Electrical Problem of Railways," read before the Manchester Local Section of the Institution of Electrical Engineers, adopts the centimetre-gramme system in all his calculations. We do not know if the paper was circulated amongst the members before the meeting, but if this was not the case, we should attribute the lack of real discussion to the units adopted by Mr. Swinburne, which did not lend themselves to a ready mental comparison with other facts known to his audience. We do not for a minute deny that the frequent conversions to English measure which are given in the paper make the reading more easy, but these conversions, even in the paper itself, have led to several mistakes, and require to be carried out much more fully before the results of the calculations can be conveniently compared in the mind with those of other experts. We do not in any way infer that members of the Manchester Local Section are not fully capable of making all the conversions required, but we strongly object to this extra thought being demanded from them. As an example of Mr. Swinburne's figures we would quote the following: "Let the sample train weigh 100 tonnes, or 100,000 kilos (98·5 tons), and let there be acceleration of 0·7 up to 60 k.p.h." The acceleration is expressed in metres per second per second, and this is clearly stated elsewhere in the paper. Yet in the recent arbitration over the conversion of the Inner Circle to electric traction, at which Mr. Swinburne was a witness, all the data for acceleration was expressed in feet per second per second. The case turned largely on the maximum allowable acceleration, and hence the figures obtainable by both the systems brought forward will be in the minds of many engineers. They, on turning to the paper above mentioned, will now find acceleration expressed in metres per second per second, and must multiply by a constant to get at the author's assumptions. Surely it would have been just as easy to save all this trouble and confliction of units by sticking to miles, tons, and English units of acceleration. Otherwise numerical conversions have to be performed in the mind of the engineer when reading Mr. Swinburne's paper, and the result in many cases is that the reading is not continued. Again, when the question of the cables for conveying the current to the train has to be gone into, we find all the current densities expressed in amperes per square centimetre and the weights worked out in "tonnes of copper per kilometre." Curiously enough, in working out the cost, the author takes copper at £70 per ton, and then multiplies this figure by the number of "tonnes" to get the total cost. Although the error may be under 2 per cent., it is a sample of the kind of mistakes that continually

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creep in when a variety of systems of units are employed in the one paper. These mistakes and the confusion which arises therefrom greatly detract from the value of the original calculations given by the author. We utterly fail to see why, when Mr. Swinburne devotes himself to the pressing problem of the conversion of railways for electric working, he should not use English units when addressing an English audience. One would gather from the paper that he thinks in "centimetres" and "tonnes," but this is not the case with one engineer in a thousand in this country. The result can only be confusion in the literature issued by the Institution of Electrical Engineers, entailing additional labour on the individual members. This has rightly been avoided by the Institution of Civil Engineers, who in their *Proceedings* insist on all figures of cost, size, and weight, etc., being expressed in English units. When it has been decided by the whole engineering profession to change over to the metric system, it will be time to consider the best way of making the change in our engineering literature; but till then it is better that the one man should expend his time in converting his calculations into English units, than that each of his many readers should be called upon to do so. We have not referred to the subject-matter of Mr. Swinburne's paper, as the same is to be discussed by him in a communication to the Institution of Electrical Engineers in London shortly.

FORTHCOMING EVENTS.

SATURDAY, MARCH 15.

Royal Institution.—At 3 p.m., Lord Rayleigh on "Some Electrical Developments" (Lecture V.).

Institution of Junior Engineers.—At 7 p.m., annual conversazione, Westminster Palace Hotel.

MONDAY, MARCH 17.

London School of Economics.—At 6.15 p.m., Mr. L. Macassey on "Electric Traction on Railways" (Lecture VI.).

TUESDAY, MARCH 18.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., ordinary meeting. Paper: "Some Points in the Equipment of Electrical Tramcars," by Mr. W. G. Rhodes.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be further discussed: "Electrical Traction on Railways," by Messrs. W. M. Mordey and B. M. Jenkin. Papers to be read: "The Greenwich Footway Tunnel," by Mr. W. C. Copperthwaite, and "Subaqueous Tunnelling through the Thames Gravel: Baker-street and Waterloo Railway," by Mr. A. H. Haigh.

WEDNESDAY, MARCH 19.

Institution of Electrical Engineers.—Birmingham Section: At 7.30 p.m., ordinary meeting. Paper: "Tests on the Nernst Lamp," by Mr. R. P. Hulse. — Students' Section: ordinary meeting. Paper: "Electric Cranes," by Mr. J. C. Smail.

Royal Meteorological Society.—At 7.30 p.m., ordinary meeting.

Institution of Civil Engineers.—At 2.15 p.m., students' visit to the works of the Incandescent Electric Lamp Company, Limited, Brook Green, Hammersmith.

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "Electric Traction: London's Tubes, Trams, and Trains," by Mr. J. Clifton Robinson.

THURSDAY, MARCH 20.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. If the discussion on the papers on "Electric Shock" is concluded at the meeting on March 13, the following paper will be read: "Problems of Electric Railways," by Messrs. James Swinburne and W. R. Cooper.

FRIDAY, MARCH 21.

North-East Coast Institution of Engineers and Shipbuilders.—Meeting at South Shields.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. Papers: "Fencing of Steam and Gas Engines," by Mr. Henry D. Marshall; "Fencing or Guarding Machinery used in Textile Factories," by Mr. Samuel R. Platt; "Protection of Lift-Shafts, and Safety Devices in connection with Lift-Doors and Controlling Gear," by Mr. Henry C. Walker; and "Guarding Machine Tools," by Mr. W. H. Johnson.

SATURDAY, MARCH 22.

Royal Institution.—At 3 p.m., Lord Rayleigh on "Some Electrical Developments" (Lecture VI.).

Manchester Association of Engineers.—Ordinary meeting. Paper: "Modern Flour Milling: Grain Storage and Silos," by Mr. J. Whitaker.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ENGLISH MEASUREMENTS.

SIR,—Please will any of your readers advise me, through the medium of the correspondence column of the *Electrical Engineer*, which is the best book on *practical design of dynamos and motors*. For preference a book treating the subject practically without the aid of calculus and using English measurements.—Yours, etc., YOUNG ENGINEER.

ELECTRIC SHOCK.

Below we give in abstract the main points brought forward in the three papers on the subject of electric shock, which were read at the meeting of the Institution on the 27th ult. Taking them in the order in which they were read, Major-General C. E. Webber's paper, entitled "Electric Shock and Legislation Thereon," calls for prior notice. The first half of this paper treats practically of the electric shock from the scientific aspect, while the latter part deals with the legislation affecting the subject. Thus the author favours the theory that the arrestation of the circulation by an electric shock is due to some check or stoppage of the distribution of energy to all parts of the path of blood circulation, notably to the capillaries, and most notably of all to those capillaries which are cutaneous, and he gives a few experiences of which record has been made, which very materially help a consideration of this interesting question. The author apparently agrees with the conclusion come to by Dr. A. M. Bleile, professor of physiology in the Ohio State University (*vide Transactions* of the American Institute, August and September, 1895), who has laid it down that "death in electric shocks is entirely due to the fact that the current produces a contraction of the arteries through an influence on the nervous system, and that this constriction throws in such a mechanical impediment to the flow of the blood as the heart is unable to overcome."

Turning to the question of legislation, the author explains that by the expression "electric shock" the factory inspectors under the Home Office have sought to define the physical injury from contact between the animal structure and opposite poles of electric conductors. Legislation has now been brought into operation at the instigation of the Home Office in the Workshops and Factories Act of 1901, by which it is sought to afford protection to some persons whose employment exposes them to the possibilities or probabilities (as the case may be) of such contact. It should be interesting to electrical engineers to trace how this enactment has come about, and he accordingly, at the latter end of the paper, goes at some length into the origin of the legislation on the subject. He also gives a list of the regulations proposed in 1897 by the Home Office Committee appointed to report on electrical generating works, and, in conclusion, he asks station engineers to consider: (*a*) The power of rendering it impossible for any person inadvertently to touch two parts of all apparatus which differ opposingly under high pressure, as laid down in the regulations; and (*b*) what constitutes a "skilled electrician"? If he takes a "workman" with him behind a switchboard, is he to be responsible for the results of the man's possible carelessness? He also submits that 'a system of distribution" which is included in the rules has nothing to do with generation or manufacture, except in so far as lies in the contention that transformation is to be regarded as part of the process of making electricity for purposes of sale, and recommends the point to the consideration of engineers.

Mr. F. B. Aspinall's paper on "Electric Shocks" was taken next. The author starts out with the suggestion that electrical engineers may be able to render great assistance to the medical profession by obtaining as much information as possible on this subject. He first considers the question, Is everyone equally susceptible to an electric

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shock? His opinion is that not only are different people differently affected, but the same person under different conditions does not feel the same. For example, from two or three experiences which he mentions, he concludes that a diseased person may be either more or less susceptible according to what disease he may be suffering from. He also puts forward three cases with a view to showing that the physiological condition one is in at the time a shock is received makes a material difference. In the first of these cases a man received a 2,000-volt shock when he was wearing a thick flannel shirt, which was wet with perspiration. The result was that he got a most severe shock, a hole being burnt in his trousers, and the back of his head and thighs were severely burnt; but he was not even rendered insensible. The author's conclusion is that the sweat shunted the current, thus saving his life, although the burning probably protected him. In the second case the victim was under the influence of drink when he received a 2,000-volt shock. He was only burnt, and the author thinks that his being drunk had something to do with his not being killed. Also, in the third case, a man going to sleep and falling on a cable charged to 5,000 volts received only some severe burns about the hands. An important consideration which the author discusses is as to whether the path which the current takes through the body has any effect as regards the shock proving fatal. To illustrate the different paths the current can take, he gives a few cases which have come under his notice, and also what the victim felt most: hand-to-hand, blow in chest; right hand to right foot, nothing; right hand to left foot, nothing; right hand to both feet, nothing; left hand to left foot, blow in back of neck; left hand to right foot, blow in back; left hand to head, blow on top of head; head to buttocks, could not ascertain if anything was felt. From other cases which have come under his notice, he concludes that the left side of a person is more vulnerable, the reason being that the valves of the heart on this side are more easily damaged. He then goes minutely into whether the question of contact made, and whether burning takes place or not, have any effect upon a person's chance of being killed. He believes that burning is a wonderful provision of nature to protect us against fatal shocks, as the burning not only numbs the nerves and thus prevents us feeling, but will also be found to increase the resistance, thus preventing the current passing. He gives actual cases in support of this theory. As to whether a person can receive a fatal shock without giving a cry, further information is urgently required, but from his own experience he can only say that a man need not necessarily give the cry; and he also believes from an actual case that it is possible for the victim to speak after a fatal shock has been received. He next considers whether an alternating or a direct-current shock is more likely to prove fatal. The conclusion he comes to is, that if death occurs from an electric shock, both are equally dangerous; but if death occurs from burns, the continuous current is more dangerous. Although it is true to say that burns are a protection against electric shocks, yet if carried to extremes they may themselves cause death due to shock.

The author next calls upon the doctors to advance a more certain method of concluding whether a man is dead or not than that at present employed of ascertaining if the sphinster muscle is relaxed, and, in conclusion, he asks: cannot something more be done to help those who receive a shock? On this point he cites a rather amusing case. "B" received a 2,000-volt shock from hand to hand, and, becoming insensible, had all the appearances of death. His heart could not be felt beating, and his breath did not cloud a mirror. This man gave the cry, and an engine-driver who picked him up stood him on his head and thumped his chest, his reason being, as he put it, to start the blood flowing, and, as the heart is a pump, to free the valves if they were stuck. After 45 minutes of this artificial respiration the man recovered. The question prompted by this case is, should we before applying the ordinary form of artificial respiration, hold the body for a few seconds head downwards at an angle of 45deg., thus flushing the brain and stimulating its action? The question is intended more for the medical man than the electrician.

The last of the three papers was contributed by Mr. A. P. Trotter, under the title of "Electric Shocks at Five Hundred Volts." The object of the paper is to show that only under exceptional circumstances does a 500-volt shock prove fatal, or, indeed, harmful. Irresponsible correspondents, says the author, have suggested in the newspapers that to fall on the electric rails of the Central London Railway is to be grilled alive; they knew no better But when, during the inspection of the last extension of the City and South London Railway, he stood on the rails in wetted boots, and sat on the live conductor and slapped the running rails with his bare hands, engineers, electricians, railway employés, and others who ought to know better, were surprised, and spoiled the effect of his demonstration by suggesting that he was peculiarly insusceptible to shocks. Discussing first the physiological and electrical conditions, Mr. Trotter mentions that with four or five square inches (30 square centimetres) of contact between dry metal and bare skin (for example, grasping a trolley wire), a steady, continuous current of one or two milliamperes is hardly perceptible. From three to eight are easily supportable, above 10 milliamperes is painful, and above 35 almost unendurable. Another interesting point is that alternating currents seem to be about four or five times more painful than continuous currents, but the sensation is of a different character. To grasp with bare hands two pieces of metal at 500 volts would give a very painful shock, but a light and quick touch is no worse than the shock from a half-pint Leyden jar, an experience more familiar to schoolboys than to engineers. A 500-volt shock may be described as worse than touching a kettle of boiling water; not so bad as touching a red-hot poker; about the same as touching a soldering iron at working heat; or as when an inexperienced blacksmith's boy picks up a black-hot horseshoe. A bad 500-volt shock burns the skin. Cases of fatal accident from 500 volts are so rare that the conditions can only be guessed at; but if the skin resistance be reduced by moisture, especially if salt or chemicals be present, and if the contact be large and prolonged, 100 volts may prove fatal. As to dangers connected with trolley wires, the author asserts that neither the man in the street, nor a man on a car, runs any risk of taking 500 volts skin to metal. On several occasions during inspections of tramways, when a trolley wire has been within reach from the top of a car, he has grasped it with both hands, and with more or less difficulty he has persuaded others to do the same. In each case the weather was fine, the car dry, and no shock—not even the least sensation—was perceptible. In the case of fallen trolley wires, Mr. Trotter says there is no danger to anyone who may come in contact with it on a dry or frosty day, even if he stand on the tramrails. With wet boots and ground the conditions are different. In the case in point, the author, with old boots worn into holes, and after walking a couple of miles on wet pavment, standing on a rail and grasping a trolley wire, took 35 milliamperes for several seconds. With regard to dangers connected with third rails, he mentions a case in which after walking in the wet for about an hour with sound but not thick shoes he stepped on 500-volt rails and felt nothing, but on touching with the finger he received a smart shock, perhaps 30 milliamperes. It is very desirable, however, that the live rails of third-rail railways should be guarded by planks to prevent short-circuits by tools, etc., and to make it less easy for a person falling on the rails to make contact with the bare skin. While experience has shown that a person so falling may receive a serious and even fatal shock, this can only occur if he make contact with both a live rail and a running rail with bare skin, or thoroughly wetted clothes, and if he lie there for a time. Numerous accidents to horses show conclusively that these animals are peculiarly susceptible to electric shocks A horse makes excellent contact with its shoes, and these are well connected by nails to its body. It is probable that the resistance is very small and the current very large, but even making this allowance the horse appears to be more susceptible.

The general conclusions of the paper may be summed up as follows: The dangers of electric shocks at 500 volts have been much misunderstood, greatly exaggerated, and little investigated. The pressure of 500 volts has been deliberately chosen by electrical engineers because it is not

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dangerous under ordinary conditions. The conditions under which serious shocks are not produced by 500 volts are discussed in the paper, and it is safe to assume that all shocks more serious than those which are recorded are dangerous. Dry wood and dry boots without large nails offer so great resistance to electric current that it is perfectly safe to touch a trolley wire while standing on a dry tramcar, or even while standing on the ground, or on the rails. Wet weather makes a considerable difference, but boots must be very wet to allow enough current to pass to produce a severe shock. Men engaged in electric traction work receive many slight electric shocks at 500 volts, and they might avoid most of them by taking more care. Dry clothing offers so great a resistance that no shock can be transmitted through it. The peculiar conditions under which shocks at 500 volts have caused death are discussed, and are shown to be very exceptional. Experiments have been made on some 30 persons, including 12 women and six children, and it is proposed to make other experiments. With sound dry boots hardly anybody can feel a shock when standing over the live rail of an electric railway with one foot and a running rail with the other. With damp or wet boots a shock is felt, but neither the sensation nor the degree of wetness of the boots can be measured accurately. It is not possible to receive a shock by sitting or lying on a live rail so long as the clothes are dry and continuous—that is to say, so long as the live metal is not touched by the bare skin. In order to give a practical demonstration of the correctness of this last statement Mr. Trotter carried out some experiments on himself at the conclusion of the reading of his paper, receiving a number of shocks under different conditions. Some sections of the actual rails used on the Central London Railway had previously been secured, and Mr. Trotter laid on these in different positions while the middle rail carrying the current was charged to 500 volts.

The following is Mr. M. B. Field's contribution to the discussion on the above papers:

I am heartily in sympathy with the attempt which Mr. Trotter has made to allay the misapprehension under which the non-technical Press and the man in the street labour as regards the dangers inherent in 500-volt shocks. Nowadays it is not altogether an unusual occurrence for one to overhear, perhaps in a railway train, at a restaurant, or elsewhere, some non-technical wiseacre, while dilating upon the mysteries of electric traction, explain that if anyone should be so foolish as to touch the third rail he would be instantly reduced to a charred mass; or failing that, make some other equally extravagant statement as to the inevitable result of a momentary contact with a 500-volt main. Mr. Trotter's paper will, I hope, do much to remove such exaggerated notions; but I am almost afraid some, after reading the paper, may be inclined to rush to the opposite extreme, and consider that the dangers of 500-volt circuits are merely mythical. Mr. Trotter says, for example, "Neither a man in the street nor a man on the car runs any risk in taking 500 volts skin to metal." Personally, I do not like to see such statements published by an eminent authority without a caution being appended. As I shall afterwards show, I consider a very great risk *might* be attendant upon such a procedure. Mr. Trotter goes on to say in explanation that he has frequently grasped a live trolley line in both hands from the top of a car. This may very well be done without feeling a shock, seeing the car itself in dry weather insulates the experimenter very perfectly. Grasping the handrail and flicking the trolley wire with the finger (supposing the handrail grounded) is to most people a painful operation, though by no means dangerous; but grasping both handrail and trolley wire, skin to metal, will, I think, I might say, in 75 cases out of 100, give a shock of sufficient severity to render the experimenter powerless to release his grasp—and therein lies the danger—a point not brought out by Mr. Trotter. The danger to life involved in a shock is not solely dependent on the voltage. Cases of shock at 250 volts and less have been known to prove fatal, while others at 5,000 have not been attended with loss of life. The question as to whether a shock will prove fatal or not is probably decided by a large number of factors: (1) the physical peculiarities of the subject; (2) the strength of current traversing the body; (3) the body traversed; and (4) the duration of the shock, etc. I should be inclined to make the following classification of shocks: (*a*) Painful, but not dangerous. When two metallic bodies—*e.g.*, terminals—are grasped one in either hand, but the potential difference between them is sufficiently small to allow of them being voluntarily let go again; or when the body is momentarily placed in circuit with a moderate* voltage without grasping, or in such a way that grasping is impossible. (*b*) Dangerous, if prolonged. When the potential difference is sufficiently great that the hands involuntarily grasp the terminals if they touch them, and the victim is powerless to open the hands, though able to cry out intelligently or otherwise. (*c*) Dangerous, though not necessarily producing immediate unconsciousness. When the potential difference is still greater, so that while it is impossible to release the grip, the victim is unable to utter any cry whatever. (*d*) Very dangerous, unconsciousness ensuing immediately on contact. Considerably higher potentials than foregoing; momentary contact produces unconsciousness and perhaps death. It is impossible to lay down limits of voltage for the above cases; they depend so much upon circumstances and individuals. But I will instance here a few typical cases that have come to my knowledge: (1) I have seen a man writhing with his hands grasping two wet water plates with only about 80 volts between them. He could not release them, but shouted intelligible instructions. (2) I myself received a very severe shock from a 2,000-volt alternator running excited. I doubt if it were giving as much as 200 volts. I was standing on the top of a concrete wall forming part of a reservoir, in very powerful sunshine. My left hand came quite accidentally against a wire leading to a water resistance dipping into the water, and it immediately gripped the wire firmly. I was powerless to release my grip, but running along the wall I sprang down (about a 5ft. drop), by which action I tore myself free of the wires. While in contact I could distinctly feel the current, first in the right, then the left leg at each step. I shouted, but could give no clear directions. (3) A man standing on fairly dry ground was unable to release the handle of a fuse-box which had become alive from a 500-volt tramway circuit. He shouted and was pulled off. (4) A linesman standing on the handrail of a car was unable to release a trolley wire at 500 volts he had gripped. He shouted and was pulled off. (5) A man tripped over a coil of wire and made contact for an instant with the brush gear of a 550-volt machine. The contact was only momentary, for as he lay on the floor he was quite clear of the machine. During his fall the brush-holder had, however, scratched and entered the skin of the neck, and such a severe shock resulted that resuscitation methods were resorted to for nearly half an hour before any signs of life were manifested. (6 A few years ago I saw a poor fellow who had been killed by 2,000 volts alternating. He uttered no cry (as far as I could ascertain), but stood stiff and erect grasping the fatal switch, which had become alive, for fully half a minute until the circuit was broken, when he instantly collapsed. It should be borne in mind that moderately low voltages—*e.g.*, 500 volts—may be very dangerous if contact be made at a part of the body where an open sore or cut exists. This may easily be on a workman's hands (*vide* case 5). There is one important difference between high-tension direct-current and alternating-current systems from the point of view of shocks, and it is this: With a direct-current system, provided both poles be thoroughly insulated, they may be touched one at a time by anyone standing on earth without running the risk of a fatal shock. For example, if the insulation to earth of each pole be 30 megohms, and the supply voltage be 3,000 volts, the current flowing to earth through the body, if in contact with one pole, would be less than one-tenth of a milliampere. With the same conditions, but with an alternating system, the current through the body might be several thousand times as great. If the amount of underground cable be at all large the insulation resistance of the system plays a relatively small part in reducing the current to earth; for owing to the capacity to earth of each pole, the body is practically forming part of a circuit of relatively low impedance, through which a large current will flow. Take an actual case*: supply voltage, 3,000; frequency, 50; capacity of each pole to earth, 3·33 microfarads. The capacity current will be in this case 1·57 amperes. Now connect a resistance of 5,000 ohms, representing a human body, between earth and one pole (Fig. 1).

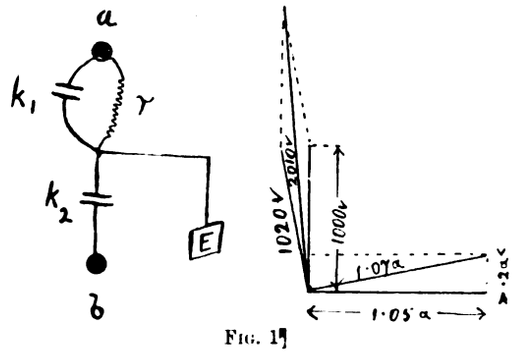

FIG. 1.

Assume for the time being pole *a* is 1,000 volts above earth; the current through *r* will be ·2 ampere, and through k_1 1·05 amperes. The resultant will be 1·07 amperes. This flows through k_2, and therefore *b* will be 1,020 volts above earth. Combining these two voltages, as in Fig. 1, we find the potential difference between *a* and *b* is 2,010 volts. Or if we take the supply voltage at 3,000 instead of 2,010, the current through *r* will be proportionately increased—viz., to ·298 ampere—that is to say, as far as prevention of shocks is concerned, the insulation of the cable is only equivalent to about 5,000 ohms to earth, though in reality it may measure 30 megohms or more. It is, of course, theoretically possible to neutralise this capacity effect in the usual way by connecting a corresponding self-induction in parallel, as in Fig. 2. If these be perfect capacities and self-inductions, the current through k_1, l_1, *r* would be zero, whereas through k_2 and l_2 comparatively large currents would flow in opposite phases; *r* would likewise be zero. It certainly seems remarkable that although no current whatever flows from *a* to earth either through k_1, l_1, or *r* (representing the human body), an appreciable

* Perhaps up to 800 volts.

* A single-phase case is taken by way of example, though such systems would usually employ concentric cables with the outers earthed.

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current is flowing between earth and b in each of the circuits, k_2 and l_2. Of course, this method of connecting self-inductions between the mains and earth to overcome shocks is not really practicable: firstly, because it is not possible to obtain sufficiently pure self-inductions and capacities—*i.e.*, devoid of dielectric and magnetic hysteresis, ohmic losses, etc.; secondly, true compensation is only obtained at a given frequency, and if this frequency be departed from by only a small percentage, currents of fatal magnitude would probably traverse the resistance, r.*

Coming now to a more practical point, I would like to touch upon the treatment of those rendered unconscious by electric shock. It is well known that in cases of collapse, such as result from severe electric shock, it is highly beneficial, and sometimes imperative, to use artificial means to stimulate the action of the heart, such as the hypodermic injection of ether, brandy, etc. Now, it is quite possible

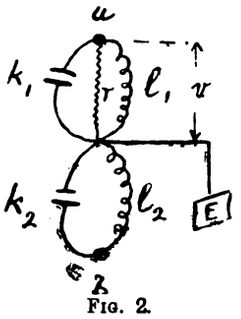

FIG. 2.

that after such an accident, a medical man hastily summoned would not be provided with the necessary apparatus for the treatment referred to above. To meet this emergency, I have hitherto recommended that all high-tension sub-stations and generating stations be provided with a small sealed case containing a hypodermic syringe, together with small phials of the necessary drugs. I might mention that Messrs. Park, Davis, and Co. supply aluminium cases, which can easily be carried about in the waistcoat pocket, containing hypodermic syringe, together with hypodermatic tabloids of strychnine, nitrate, cocaine, hydrochlorate, morphine sulphate, etc. One engineer with whom I am acquainted on the Continent claimed to have saved several lives by the timely injection of ether. The medical profession in England seems, however, to consider it altogether beyond the province of unqualified persons to apply this restorative, and I should be glad to elicit the views on this point of any medical man present.

As mentioned in our last week's issue, Mr. A. P. Trotter arranged to test on Tuesday last the members of any scientific institutions in order to see what current they would take at known voltages under the following conditions—*i.e.*, from the finger of one hand to the finger of the other, from foot to foot when standing on rails, and from foot to hand when standing on rails. The results as expressed in milliamperes are given below.

Foot to Hand.			Finger to Finger.		Foot to Foot.	
Milli-amperes.	Number of persons. At 100 volts.	At 500 volts.	Milli-amperes.	Number of persons at 100 volts.	Milli-amperes	Number of persons at 500 volts.
0·0	—	14	1·0	1	0·0	17
1·0	1	5	1·5	9	·25	1
1·5	2	—	2·0	10	·5	5
2·0	1	4	2·5	7	1·0	2
2·8	1	–	3·0	5	1·5	1
3·0	2	1	3·5	1	1·75	1
4·0	2	4	4·0	3	2·0	5
5·0	2	—	4·5	1	2·5	1
5·5	1	—	5·0	—	3·0	3
—	—	—	6·0	2	4·0	1
—	—	—	8·0	1	5·0	2
—	—	—	10·0	2	8·0	1
—	—	—	12·0	—	11·0	1
—	–	—	14·0	—	14·0	1
—	—	—	15·0	—	15·0	1
—	—	—	—	—	17·5	1
—	—	—	—	—	20·0	2
—	—	—	—	—	24·0	1
—	—	—	—	—	25·0	1
—	—	—	—	—	28·0	1
—	—	—	—	—	30·0	1

It will be seen from these that when experimenting from finger to finger 90 per cent. of those measured received less than 5 milliamperes at 100 volts, and the highest for two persons was 10 milliamperes. When passing the current from foot to foot standing on the rails, 82 per cent. of those tested took less than three milliamperes with 500 volts between the rails. In this case the variation was much larger, as will be seen from the table, as six persons took 20 milliamperes or over, the highest recorded current being 30 milliamperes. It must be remembered that Tuesday was damp under foot in London. The results from foot to hand are given for both 100 and 500 volts.

* If k and l be arranged to neutralise each other at a frequency n, then the combination of k and l for a frequency $n + \delta n$ is equivalent to merely a single capacity of value k, but working with a frequency $2\,\delta n$ instead of $n + \delta n$ if n be positive, or to a single self-induction of value l with a frequency $\frac{n^2}{2\,\delta n}$, if δn be negative

COMPANIES' MEETINGS AND REPORTS

CITY OF LONDON ELECTRIC LIGHTING.

The general meeting of the shareholders in this Company was held on Wednesday at Winchester House, Old Broad-street, E.C., Mr. George Herring presiding.

The **Chairman**, in submitting the directors' report (which appeared in full in our last issue) for confirmation, said that during the year the capital of the Company had been increased by £100,000 in 4½ per cent. second debentures. They were offered the stock at par, and the Board pledged themselves to take whatever was left on the same terms. That issue was successfully carried out, and the expenses were nil, with the exception of the cost of printing and stamps. Dealing with the accounts, he said it would be seen that there was an increase in the receipts of £27,000 and a decrease in the expenses of £23,000, making a total of £50,000. Twenty-two thousand pounds had been saved on the coal bill, and it would naturally be thought that that was in connection with the price. As a matter of fact, the Company paid in 1900 18s. 8d. per ton for coal, and last year the average price was 19s. 11d. Therefore, it appeared to be a wonderful result to have saved £22,000 and paid 1s. 3d. per ton more. The explanation was that they burned 78,000 tons in 1900 and 55,000 tons in 1901—a reduction of 23,000 tons. This satisfactory result was entirely due to their engineer, Mr. Bailey. He had often heard that the school of adversity was a most excellent school in which to graduate, and he was almost glad that Mr. Bailey had had to graduate in that school because of the extraordinary accomplishment he had just referred to. They had generated 250,000 more units in 1901 than in 1900; they had burned 23,000 tons less coal; and they had saved £22,000. The average price per unit had been slightly in advance of 1900, but the charge was by no means heavy at the present time. During the year the Company had connected 38,000 new lights, making a total of 549,000. That increase had been made in face of the competition of the Charing Cross and Strand Company, and must be regarded as highly satisfactory. With regard to the dividend, the sum which it was proposed to distribute had undoubtedly been earned, and in his opinion an ample sum had been provided for depreciation. The plant had been kept in first-class order, which was absolutely necessary if they were to keep their customers and maintain the increase which they had made. Having alluded to the difficulties which had arisen between the Corporation of the City of London and the Company, the chairman, continuing, said that cross notices of appeal to the House of Lords had been lodged by the Corporation and by the directors. Pending the decision of the House of Lords, the lighting of the public thoroughfares was being continued by the Company on the same terms as heretofore. With regard to competition, he was of the opinion that if they continued to give as good a light and charge as low a price they need not fear either the Corporation or the rival company.

Mr. J. B. Braithwaite, jun., seconded the motion, which was carried.

On the motion of the **Chairman**, seconded by **Mr. F. W. Reynolds**, the following dividends were then agreed to: On the preference shares 12s. per share, being a distribution at the rate of 6 per cent. for the year. Of this 6s. per share having been paid in August, 1901, that the balance of 6s. per share be paid; and on the Company's ordinary shares 10s. per share, being a distribution at the rate of 5 per cent. for the year.

The proceedings terminated.

HOVE ELECTRIC LIGHTING.

Colonel A. J. Filgate presided over the annual meeting of this Company at Salisbury House, London-wall, on Wednesday.

The **Chairman**, in moving the adoption of the report, said the result of the past year's working could not be considered unfavourable, in view of the heavy increased charge on account of coal and the very largely increased assessment for rates and taxes. The present length of the Company's mains was nearly 17 miles. The shareholders were informed last year that, after considerable trouble, the directors had acquired a suitable site for the new generating station, and that the plans for it had been matured. These were shortly afterwards laid before the Hove Corporation for their approval. The Corporation, however, withheld their consent for a considerable period, and made the Company add no small sum to the cost of the building; and eventually they stated that, in their opinion, their consent was not necessary, as the proposed building was not one of the works contemplated in the contract of 1892. The directors rejoined that the works were part and parcel of the undertaking and must be considered as such, and they asked the Corporation to explain the position they put forward. In reply, they were briefly told that the Corporation did not consider the additional works to be necessary. The directors were, however, advised that with the steadily increased demand they were necessary, and that, although the Company might possibly meet their obligations next winter, it was not safe

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to count on doing so. There was no doubt that the new station would be needed in 1903. While the Board were anxious to meet the customers by reducing charges, any step in this direction must stand over until the new station was completed and working. The contract for the new station had been placed, but owing to the delay caused by the negotiations with the Corporation, it was very doubtful if it could be completed in time for next winter's load. They were at issue with the Corporation on another matter. In 1896 the Corporation gave their consent to new customers being supplied at the 220 volts pressure, but stated that their consent must be obtained in each case to the transfer of customers on the 110 volts to the 220 volts. A considerable number had changed over, and the Corporation had recently received a large number of applications to the same effect. To these applications, however, they apparently not only delayed their consent as long as possible, but he was told that they, both officially and privately, did all they could to prevent customers from changing over. The directors recommended the transfer of £2,250 to the credit of the reserve account, and the payment of a final dividend at the rate of 9 per cent., making with the interim distribution 8 per cent. for the year. This year up to date showed a satisfactory and further increase in the demand for electricity.

Colonel Henry Wood seconded the motion.

The **Chairman**, in answer to a shareholder, stated that the reserve fund was invested in the business. If the Corporation bought the undertaking, they would have to pay the Company the whole of the amount that had been expended, with an accumulated dividend of 7 per cent. from the start. The report was then adopted, and the dividends recommended were declared.

OLDHAM, ASHTON, AND HYDE ELECTRIC TRAMWAY.

The ordinary general meeting of this Company was held at Hamilton House, Victoria-embankment, on Tuesday, Mr. Emile Garcke presiding.

The **Chairman**, in moving the adoption of the report, congratulated the shareholders on the results which had been secured by the Company since the system had been open for traffic, rather more than two years. It afforded one more example of what could be done by means of electric traction on tramways. Interest on the debentures had been paid from the first, the ordinary shareholders received 6 per cent. for 1900, and the Board now recommended a distribution which would make the dividend on the ordinary shares for the past year 8 per cent. The permanent way, stock, and plant had been maintained in thorough order out of revenue. During 1901 upwards of 4,800,000 people were carried over the Company's system, against 4,100,000 in the preceding 12 months. The receipts per passenger showed a slight falling off, but the average expenditure per passenger was also a little smaller than in the previous year. Terms had been arranged with the Hythe Corporation in regard to a lease of certain lines, and an agreement relating to mutual running powers had been entered into with the Stockport Corporation. He expressed regret that the attitude of the local authorities had been so hostile to the Company. He thought that a system under which the electric tramways of a district were split up between companies and the local authorities was most unsatisfactory, and not conducive to the convenience of the public.

Mr. Atherley Jones, K.C., M.P., seconded the motion, which was carried.

AUTOMOBILE MANUFACTURING.

The statutory meetings of the creditors and shareholders under the liquidation of this Company were held on Tuesday at the Carey-street offices of the Board of Trade.

Mr. A. S. Cully, assistant receiver, reported that the Company was formed in April, 1900, to acquire the goodwill and assets of a business of electrical engineers at Hythe-road, Willesden; also the business of the Southern Motorcar Company, carried on at Brixton. The nominal capital was originally fixed at £100, but it was almost immediately increased to £15,000. A prospectus, which was stated to have been issued privately to friends of the vendors, invited subscriptions for 5,000 shares, all of which were applied for and allotted, but 1,890 of the number were subsequently cancelled. The Company agreed to pay for the two businesses £10,000 in shares and £130 in cash. In September last a debenture bond for £10,000 was issued to certain of the directors to secure them in respect of a guarantee given by them to obtain an advance of £5,000. The advance wae made in November, 1900, but it was not until the Company was in difficulties that the debenture was issued to the directors, and that was a matter for further enquiry. The accounts showed unsecured debts £3,787, against assets £3,718, but if the debentures (upon which £5,500 was now due) were held to be valid bonds, the deficiency to the creditors would be about £6,000. The liquidation was left in the hands of the official receiver.

WINDSOR ELECTRICAL INSTALLATION.

The report of the directors for 1901 states that the Company's business continues satisfactory. The number of lamps and motors installed on Dec. 31, 1900, was equivalent to 17,808 of 8 c.p. During the year 4,881 were added, bringing the total to 22,689 at the end of the year 1901, of which 1,203 represent the motor power. The capital expenditure for the year amounted to £5,633. 14s. 8d., bringing the total up to £59,303. 18s. 1d. As usual, the principal expenditure has been on mains and machinery. Various small extensions have been made to connect up additional customers, and a new boiler and other plant have been added. The battery of accumulators which was provided the previous year has effected a considerable saving by supplying the day load, instead of the plant being run continuously. The net profit for the year is £4,350. 11s. 11d., and the most gratifying feature of the accounts is the fact that £3,949. 16s. 5d. of this has been derived from the supply of electricity. The profit on the installation department is only £400. 15s. 6d., but the Board believe that the carrying out of this class of work in Windsor and Eton at a reasonably low price benefits the lighting department, and the steady increase of previous years in the number of lamps connected has thus been maintained. The total amount of profit available for distribution, including the balance brought forward from the previous year, but allowing for interest on loans, is £4,763. 16s. 1d. Out of this the directors recommend that the sum of £500 be added to the depreciation renewal and revenue fund, bringing it up to a total of £6,419. 10s., and the shareholders will be asked to vote the usual sum of £350 for the directors' fees. The directors paid in September last an interim dividend of 2½ per cent., free of income tax. They now recommend the declaration of a dividend of 5½ per cent., less income tax, making, with the interim dividend already paid, 8 per cent. for the year. The total amount of capital expended exceeds the amount received from the issue of shares by £9,303. 18s. 1d., and this has been met temporarily as shown by the balance-sheet. The directors do not consider that it would be advantageous to issue further shares at the present time, and they have therefore arranged for a loan up to the sum of £20,000 for five years as required at a low rate of interest. The directors retiring in rotation are Messrs. H. L. Prior and Edward Riley, and, being eligible, they offer themselves for re-election.

NOTTING HILL ELECTRIC LIGHTING.

Abstract of directors' report and accounts for year ended Dec. 31, 1901:

The expenditure on capital account, which at the date of the last balance-sheet stood at £164,990. 2s. 11d., has been increased during the past year by £31,489. 18s. 4d., of which the principal items are £15,258. 1?s. 6d. for new mains (principally the completion of trunk mains from Wood-lane to the distributing stations, and distributors connected therewith); £3,717. 14s. 9d. for the leasehold property in Holland-mews (bought for the purpose of erecting a subsidiary station to supply the southern area), and freehold property adjoining the Victoria-gardens station; £4,544. 2s. 8d. for the erection of the buildings in Lancaster-road and Holland-mews to contain the transforming machinery; and £6,161. 1s. 3d. for the necessary machinery for equipping these stations. To provide the balance of capital necessary for this expenditure, 2,200 ordinary £10 shares were issued to the shareholders *pro rata*, at a premium of £2 per share. The number of lamps connected is 82,054, and the number of consumers 1,445, of which 93 per cent. are supplied at 200 volts. The profits of the Company show an increase of 30 per cent. over those of last year, but owing to the large amount of additional capital expended on new works, not yet earning revenue but already ranking for dividend, the rate of distribution is lower than in 1900. The shareholders are aware that the directors are not responsible for the delay. It was due to the necessity of applying to Parliament for power to obtain a leasehold site, owing to the refusal of the freeholder to permit its transfer to this Company. In May, 1901, terms were arranged by which the freeholder withdrew his opposition, and the Bill become law on July 26, 1901, too late, however, to permit of the works being completed before the winter period. The sub-stations, in Holland-mews in the south and in Lancaster-road in the north, are complete, and arrangements are now made to run distributing mains as and where the demand for current arises. Under the powers granted by Parliament the freehold interest in the property in Bulmer-place, adjoining the station, has been acquired. It will be recollected that this property was previously held on a short lease. The generating station at Wood-lane, erected jointly by this Company and the Kensington and Knightsbridge Electric Lighting Company, Limited, after being worked tentatively for the first few months of the year, is now supplying a large proportion of the current required by our Company, the result being highly satisfactory. Joint debenture stock amounting to £115,000 has been issued to supply capital for this undertaking, and the cumulative sinking fund now amounts to £3,750. 7s. 8d. Negotiations are proceeding with the Royal borough of Kensington for supplying current for the purpose of street-lighting. The premium arising from the issue of shares during the year amounted, after deducting expenses, to £4,330. 15s. 8d., and this amount has been transferred to the depreciation, renewal, and reserve fund, together with a sum of £250 received as a contribution towards an extension of a main, and £1,419. 4s. 4d. out of the net revenue, making a total of £6,000. In addition to this sum, £907. 16s. 3d. has been paid over to the trustees of the cumulative sinking fund of the Wood-lane joint debenture stock. From the remaining net profit is to be deducted the interest on the debentures, amounting to £2,000, the interest on the Wood-lane joint debenture stock £1,593. 9s. 5d., etc., leaving £7,281. 3s. 1d. available for dividend. The preference shares have already received their full 6 per cent., and the directors now recommend the payment of the usual dividend of 6 per cent. on the ordinary shares, amounting together to £6,990, and the balance of £291. 3s. 1d. will be divided, one-half being credited to the founders' shares undivided profit account and the remainder to the other classes of shares. An interim dividend of 3 per cent. was paid on July 1, and the balance of 3 per cent. will be paid forthwith. The directors desire to place on record their appreciation of the services of the engineer and manager, secretary, and staff generally. The work in connection with the construction of the subsidiary stations has been very large, and has been ably carried out. The directors regret to announce the death of Mr. Alexander Howden, one of the original directors of the Company, whose ripe experience and wide business knowledge contributed so greatly to its progress. To fill the vacancy thereby created they elected Mr. William Henry Willans, of 23, Holland-park, W. The directors retiring in rotation are Sir William Crookes, F.R.S., and Mr. A. E. Franklin, who, being eligible, offer themselves for re-election.

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REVENUE ACCOUNT.

Dr. Generation of Electricity.	£	s.	d.
Coal or other fuel, carriage, etc. £1,909 17 1			
Oil, waste, water, and stores 257 17 10			
Wages and gratuities..... 885 16 1			
Repairs and maintenance of plant.....	4,111	9	5
Electricity supplied from Wood-lane works	2,379	10	11
Distribution of Electricity.			
Repairs, maintenance, etc., of mains... 158 16 5			
Wages of meter readers, etc..... 220 9 8			
	379	6	1
Rates and taxes	1,139	3	1
Management Expenses.			
Fees to directors and salaries 2,572 12 1			
Stationery, etc., and general charges... 309 6 5			
Auditors of Company 52 10 0			
Auditor appointed by the Board of Trade 41 0 0			
	2,975	8	6
Special Charges.			
Insurances 97 7 8			
Law costs..... 66 19 9			
	164	7	5
	11,149	5	5
Balance carried to net revenue account	13,046	4	9
	£24,195	10	2

Cr.	£	s.	d.
Sale of current (947,491 units), less discounts	22,539	2	7
Rental of meters and other apparatus	949	11	0
Connecting installations, sale of stores, etc.	347	15	1
Rents receivable	344	16	6
Transfer fees, etc.	14	5	0
	£24,195	10	2

Dr. GENERAL BALANCE SHEET.	£	s.	d.
Capital account—amount received	181,136	0	0
Sundry tradesmen and others	4,889	14	1
Sundry creditors	1,283	4	3
Depreciation, renewal, and reserve fund account	17,000	0	0
Founders' shares undivided profit account	27	2	1
Preference and ordinary shares undivided profit account	7	2	1
Credit of net revenue account	3,786	3	1
	£208,129	5	7

Cr.	£	s.	d.
Capital account—amount expended for works	196,480	1	3
Sundry debtors for current supplied, etc.....	9,296	16	5
Other debtors	169	9	2
Stores on hand.	400	14	5
Stock—movable plant and tools	346	19	0
Cash at bankers and in hand.....	435	5	4
Preliminary expenses, compensation, etc.	1,000	0	0
	£208,129	5	7

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of those answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

463. It is found that the iron loss in the core of a dynamo due to hysteresis and eddy currents is from 1½ to 3½ times that calculated on the basis of even flux distribution in the teeth and core. On full load the loss is still greater. Can any of your readers give a formula for this which will give something like accurate results, or give some reason for this extra loss?—A. W. M.

464. Describe, in detail, a suitable resistance and other necessary gear for milking a weak cell from two hospital cells of same size. Normal charging current, 120 amperes; cell capacity, 900 ampere-hours.—Q. E. I.

ANSWERS.

[The answers to Question No. 456, which were omitted from last week's issue, will be found in this week's supplement.—ED. *E. E.*]

Question No. 457.—(*a*) Say how the position of points for connecting return cables to rails of an electric tramway is best determined. (*b*) What percentage increase of resistance over and above that of the rail itself is due to the bonding of, say, 90lb. rails in 45ft. lengths with ordinary 24in. six-bolt fishplates, two 4/0 bonds, each 30in. long, being used at each joint?

Best Answer to No. 457 (*awarded* 10*s.*).—(*a*) The number and position of the return cables from the track is determined by the condition that at the largest working current which has to be returned to the station, the difference of potential between any part of the track and the negative 'bus bar at the generating station shall not exceed the Board of Trade limit of seven volts, in order to prevent any bad electrolytic action. In towns, where the effects of electrolysis are much to be feared, it is better to keep it even lower than this, say four volts. The corrosion of water and gas pipes is often unjustly laid to the charge of the stray currents from electric tramways. Undoubtedly this is so to some extent, but that considerable currents may exist in pipes which are not in the vicinity of electric tramways has been proved by Dr. Leybold, of Hamburg (see *Electrical Engineer*, Sept. 13, 1901). It appears that cast-iron pipes are very little affected, but lead and wrought-iron pipes soon become corroded.

In an electrolytic cell corrosive action is always confined to the anode—*i.e.*, the plate which the current leaves. Now, a pipe line usually runs parallel to the track only for a short distances and then branches off. The joints between the pipe lengths may be of comparatively high resistance, and at all such places electricity will leave the pipe and seek the earth, thus causing corrosion. In other words, while there is not the slightest objection to the flow of an indefinite amount of current *into* the underground piping, there is the most serious objection to its getting out again, as it has to do further on. We must, therefore, aim at keeping the return current away from underground structures altogether, and these underground structures all electro-negative to the track. This is done by providing return insulated feeders connected to the track at frequent intervals, so that all paths to the station are of equal resistance. The spacing is entirely a matter of judgment, but is usually about every half mile. The dynamos would be connected to these cables alone, the only earth being that of the track itself. Then the rails would carry current merely to the nearest return cable, and by making these sufficiently frequent, and by paying attention to good rail-bonding and adequate insulation, earth leakage may be almost entirely avoided. The earth would be then slightly electro-negative to the track, hence no current can leave it and return to the rails. In order to determine the number and size of these return cables we must know the general particulars of the line: the length, if single or double track; the maximum number of cars which will be running at once; and also the grades, and on what part of the line they are situated. Having all these data, we should then calculate out an extreme case. Take the maximum number of cars running, and of these a greater percentage than usual running on the stiff grades of the line, and at the end of the line furthest from the generating station. We know the mean current taken per car. This varies with the weight of car, speed, efficiency of motors and gearing, and the grade, but a good estimate can be made from the results obtained from similar tramway systems. Thus, if each car has two 25-b.h.p. motors, the current will probably be from nine to fourteen amperes at the standard voltage of 500/550.

Knowing the length of track served by each return feeder, we can calculate the maximum current it will have to carry, and we can then fix its section so that the drop of potential shall not exceed the limits given above. On some lines, where the traffic is heavy, it is cheaper to use negative boosters to "pump" the current out of the rails, in order to keep within the limit of voltage drop, than to provide sufficient heavy cables, but this can only be determined by carefully calculating out the cost of each for the particular scheme considered.

(*b*) We can easily calculate the resistance of the track assuming the rails continuous. We have: Weight per cubic inch of rail steel = ·284lb. ∴ number of cubic inches in 90lb.—*i.e.*, a yard = $\frac{90}{\cdot 284} = 317$. Hence section

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of rail $= \frac{317}{36} = 8{\cdot}8$ square inches. Now, the resistance of a rail one mile long and one square inch section = ·264 ohm. ∴ Resistance of our rails if double track = $\frac{{\cdot}264}{8{\cdot}8 \times 4} = {\cdot}0075$ ohm per mile.

Now, in perfect bonding we should not only have the total cross-section of bonds equivalent to that of the rails, but also, what is much more important, the area of contact surface between the bonds and the rails large enough to give no appreciable increase of resistance above that which would obtain if the rails were continuous. It is here that most of the drop occurs, and these joints are very liable to deteriorate after being in use a little time.

Now, the ratio of conductivity of $\frac{\text{copper}}{\text{steel rail}}$ = about 7·5.

∴ section of Cu equivalent to one rail $= \frac{8{\cdot}8}{7{\cdot}5} = 1{\cdot}175$ square inches. For this we have two 4/0 bonds, whose section = ·4 × 2 = ·8 square inch. Hence the bond has $\frac{1{\cdot}175}{{\cdot}8}$ = 47 per cent. higher resistance than the same length of rail. But the bonded length is only 30in. in 45ft. = $\frac{30}{540} = \frac{1}{55{\cdot}5}$th of the whole track. Hence the increase of resistance of the whole track only equals $\frac{47}{55{\cdot}5} = {\cdot}85$ per cent., which is negligible.

The only thing remaining is the contact resistance mentioned above. This is very hard to calculate, as it depends so much on the make of bond used and the way it has been fitted. However, with a good make of bond the total resistance of the track is never increased more than 5 to 8 per cent., so that our final resistance for double track becomes, taking 6 per cent. as a mean:

$$= {\cdot}0075 \times 1{\cdot}0085 \times 1{\cdot}06 = {\cdot}008 \text{ ohm per mile.}$$

The fishplates are never relied upon to carry any of the current.—S. H.

Answer to No. 457 (*awarded* 5*s.*).—(*a*) A tramway power station is usually situated at about the centre of the line, and the return cable in this case is connected to the nearest point of the rails passing the station. Should the return current, however, be more than the rails can carry (with due regard to the seven volts maximum drop, Board of Trade regulation), then another return feeder should be laid along the track and tapped on to the rails at a suitable distance, this being usually at the nearest junction where the return currents from three or four routes converge on to the main line.

(*b*) The increase of resistance under the given conditions due to the bonding of the joints is about 100 per cent., but this does not take into account the conductivity of the fishplates, which (whatever they may be at first) in time, according to foundation, situation, and nature of traffic, possess a conductance too uncertain to be relied upon. This percentage is based upon the 45lb. rail having a resistance of ·0067 ohm per mile, and the pair of 0000 B. & S. 30in. bonds (at 28in. centres with 116 joints per mile), measuring ·12 ohm per mile. Therefore the (116in. by 28in.) 270ft. of bonds bridging the rail joints will show an increased resistance of ·006 ohm in the mile run of track. The 270ft. to be deducted from the rail resistance only makes a difference in the fourth place of decimals. It will thus be seen that the total resistance per mile of single rail, including bonds, may be reckoned as ·012 ohm, the fishplate conductivity being balanced against chance of increased resistance in bonds owing to greasy holes or loose contacts. In extremes of temperature the conductivity will rise owing to the pull of the rails upon the fishbolts, and the consequently increased contact pressure.—B. C. H. J.

Question No. 458.—At a 100-volt installation it is required that the accumulators (56 cells) shall be charged at the same time as motors and lights (200 amperes) are being supplied. The dynamo is a 50-kw. machine, and can be run at 100 to 150 volts. When used for charging, the current for the motors and lights is taken off the fortieth cell. An ordinary charge and discharge switch is provided for the battery, but the cells from 1 to 40 do not appear to get properly charged. How can this be remedied, having in mind that 200 amperes are being used day and night? No further expense can be incurred.

Answer to No. 458 (*awarded* 7*s.* 6*d.*).—In answering this question we must first consider what is taking place in the battery. From Fig. 1, which gives the probable connections of switchboard, we find that there are two circuits

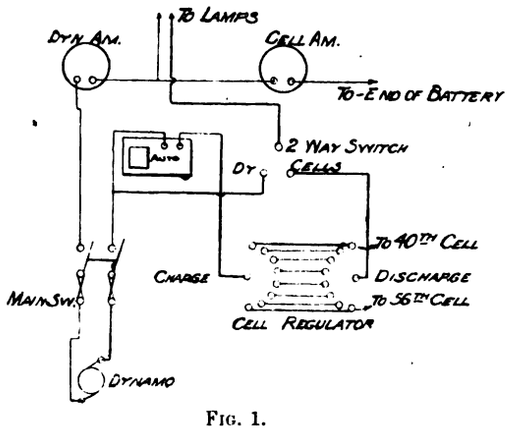

Fig. 1.

going into battery—namely: (1) the battery circuit (which is probably 100 amperes)—*i.e.*, charging current which is passing through battery from end to end; and (2) the lighting circuit, which is 200 amperes. This lighting circuit, it will be seen from diagram No. 1, enters battery at fifty-sixth or end cell, as in (1), but leaves battery again at the fortieth cell, and passes through the discharge side of cell regulator to the lamps, these 16 cells being in series with the lamps and motors; thus the total current passing through the end 16 cells is charging current of battery plus current going to lamps and motors = 300 amperes, as compared with the 100 amperes passing through the remaining 40 cells, consequently the end 16 (regulating) cells will evolve gas long before the remainder of the battery is any way near fully charged. The gassing of these cells so freely is partly due to their being fully charged, and partly due to the large current passing through them being in excess of the proper charging rate, and this being so, there is a considerable waste of energy, as a large amount of the excess current is wasted in the decomposition of the water molecules in solution and the premature evolution of oxygen gas from the surface of the positive plate. From above it will be easily seen why the cells from 1 to 40 are not properly charged, the simple reason being that they are not being charged at the same rate as the regulating 16 cells, and probably the whole battery will be switched out of circuit when the end cells begin to gas; the cells from 1 to 40 will at that time only be about one-third charged. To remedy this state of affairs without incurring any expense would be as follows: When end cells—*i.e.*, 56 to 40—have been gassing for about half an hour we may take it that they are fully charged. This being the case, we can switch them out of circuit by bringing the charge lever back to the stop connected to fortieth cell, meanwhile reducing the voltage of dynamo from 150 volts to 100 volts, the discharge lever of regulator still being kept on fortieth cell stop. Thus the cells from 1 to 40 are now being charged at 100 volts, and are in parallel with lighting circuit. Continue running thus till the cells 1 to 40 gas freely; the whole battery will then be fully charged and be ready for discharging to lights and motors.

The remedy is not an ideal one, as there is always the risk that in the first part of charge the powerful current passing through the end 16 cells will cause the plates of these cells to buckle; but this, of course, depends greatly on the type of cell used. The ideal remedy for above would be to instal a booster. Fig. 2 gives a diagram for connecting up booster to present switchboard, from which it will be seen that the additions required are a booster having an output of 100 amperes at 50 volts (but the current, of course, depends on the charging current required for battery), and a switchboard containing two 100-ampere double-pole switches and fuses, one starting switch for

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motor end of booster, and one shunt regulator for dynamo field of booster. The 50-kw. dynamo will now always be run at 100 volts. From Diagram 2 it will be seen that current going to lights and motors is supplied direct from dynamo while battery is being charged. The extra voltage for charging is supplied by the booster, and the whole battery is being charged at the same rate and at same time, this being a most important point in battery working. The charging current should always be regulated by the shunt regulator of booster, and not by cell regulator, as at present. The cell regulator (charge side) should be put on end cell stop, and kept there throughout charge.

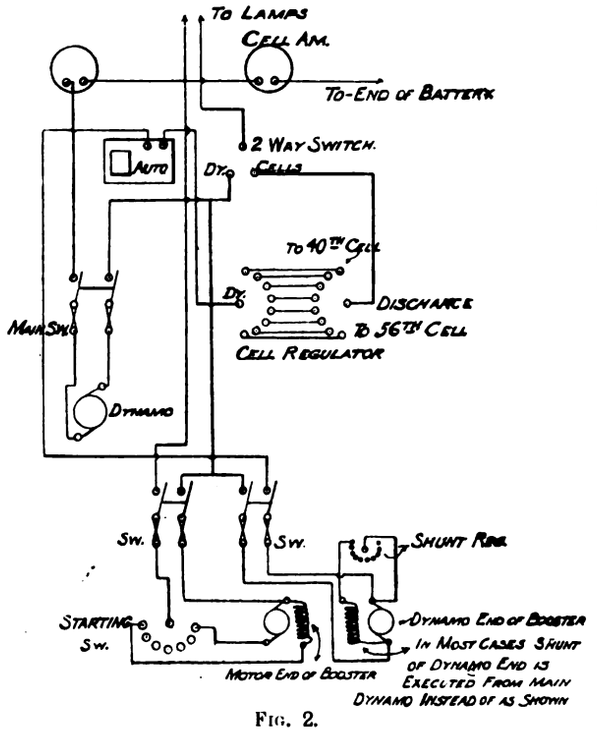

Fig. 2.

The two-way main switch must always be on dynamo stop while dynamo is running. This arrangement is the best where (as in above case) there is a heavy constant load, as the cells are well under control, and the battery circuit being in parallel with lighting and motor circuits, the possibility of any part of the battery getting more fully charged than the remainder is entirely obviated, likewise also the danger of buckling the plates due to excessive current.—G. R.

Answer to No. 458 (*awarded* 7*s.* 6*d.*).—A little consideration of this question will show that without much difficulty or expense the trouble may be overcome. For sake of clearness a "diagram of connections" is given. The writer assumes from the question that the charge and discharge switches can be worked separately over the whole range of cells from the fortieth cell upwards. The best method of charging the battery by such an arrangement would be to commence with the charge switch on the end cell, the voltage of the dynamo being adjusted to give the maximum current (assuming the battery will take this), the discharge switch being regulated to give 100 volts on the lighting and motor mains. As the cells become charged they may be cut out, the voltage (dynamo) and position of the discharge regulator being adjusted as required. In this manner, when all the regulating cells are charged, both the charge and discharge regulator switches will be on the fortieth cell. Thus the remainder of the battery will be simply charged in parallel with the lighting. It may be, however, that 100 volts (the pressure required for the lighting) will not be enough to completely charge the remaining 40 cells; for assuming each cell to give 2·5 volts when fully charged, then $40 \times 2{\cdot}5 = 100$ volts, which would leave no voltage to overcome the resistance of the cells. Probably this is the reason the battery has not been properly charged.

There are several ways of getting over the difficulty, the two simplest and cheapest being here described. (1) A few more stops should be added to the regulating switch, and connected to consecutive cells from and below the fortieth. It would then be possible to have the discharge switch on a lower cell than the charge switch, thus obtaining 100 volts for the lighting mains, and the extra voltage for charging; care should be taken, however, not to overcharge the intermediate cells, or to get the discharge switch on a higher cell than the charge switch. Probably after the fortieth cell it would be best to move both switches together, keeping them on the same stop till the battery was charged. (2) A cheaper though possibly not so advisable a method would be to have a number of cells connected in two's, instead of singly, to the regulating stops; a number of stops would

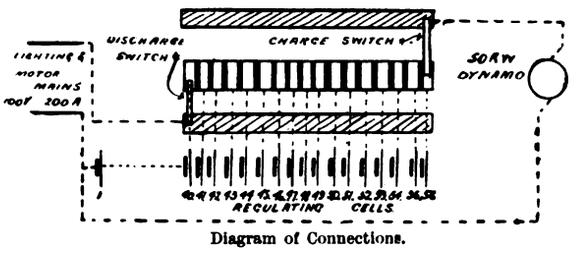

Diagram of Connections.

then be available for use for the lower cells. This would entail some slight alterations to the regulating cables on the battery. For clearness, assume they are connected as follows:

Number of cell ..... =	35	36	37	38	39	40	41	42
Stop on regulating switch =	1	2	3	4	5	6	7	8
Number of cell ..... =	43	44	46	48	50	52	54	56
Stop on regulating switch =	9	10	11	12	13	14	15	16

This would bring into use the whole of the 16 stops on the regulator, and would probably allow of the battery being fully charged. If the conditions are not exactly as taken, this principle should simply be followed out under the existing circumstances.

The writer had experience in charging a central-station battery in the manner described, and found no difficulty in properly charging the whole of the cells. To keep cells in good condition, it is important they should be charged till they gas freely. It would be false economy to risk running a battery for the sake of the small expense necessary to make the regulating gear suitable.—E. T. W.

Answer to No. 458 (*awarded* 5*s.*).—We may put aside all methods involving the direct waste of the superfluous energy (such as the insertion of a resistance between the 150-volt dynamo terminals and the 100-volt lamps) as being altogether too expensive in the long run. The recognised method for charging cells at the same time as supplying the external circuit consists in running the main generator at the lamp voltage (100), and putting as many cells in parallel with it as will allow the correct charging current to pass at that voltage. The remaining cells are then charged by means of a booster giving the necessary additional voltage (50) which is required over and above the lamp voltage. This method is, however, excluded in this case, as the additional expense of purchasing a booster is to be avoided, and the existing dynamo is already arranged to give the full 150 volts. It is, therefore, practically only necessary to consider the possibility of recoupling the cells so as to give the required result—viz., a uniform charge in all the cells, and at the same time a constant delivery of 200 amperes at 100 volts into the external circuit.

Figs. 1 and 2 show two fairly satisfactory methods of doing this. That shown in Fig. 1 is carried out by dividing the battery into two parts—one consisting of 45 cells and the other of the remaining 11 cells, and connecting the 11 cells to the discharge switch, and in opposition to the 45 cells. At the commencement of the charge the 11 cells are entirely cut out of the circuit, and the main generator voltage is made 100, which is, therefore, also the voltage of the lamps. This voltage will pass about the correct charging current of, say, 200 amperes through the cells (if rather too high at first it will soon fall to the right figure as the cells begin to get charged). As the cells charge up the current will gradually drop, and it will become necessary to increase the dynamo voltage, at the same time inserting one or more of the 11 opposition cells in order to maintain the lamp voltage at 100. In this way the 11 cells

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and the 45 cells will become fairly equally charged (the whole of the 11 cells will have been inserted a considerable time before the end of the charge). The output of the dynamo would be about 400 amperes at a voltage varying from 100 to about 115. At the end of the charge, and before discharge, the whole battery must, of course, be again connected up in series.

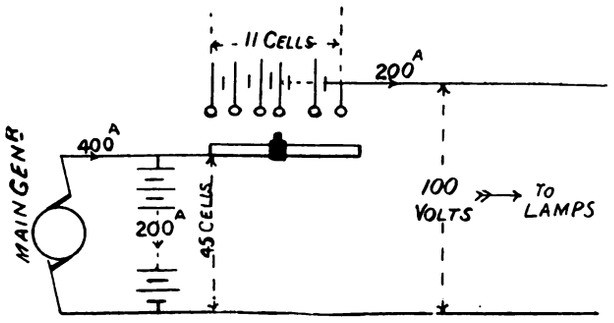

FIG. 1.

The second method consists in connecting a part of the battery to form two parallel circuits (as shown in Fig. 2), and thus getting the charging current in all the cells to be practically the same. The lamp mains should be connected across about 44 cells in series, and the remaining 12 cells should be connected in two parallels of six cells each. At the commencement of the charge the dynamo voltage should

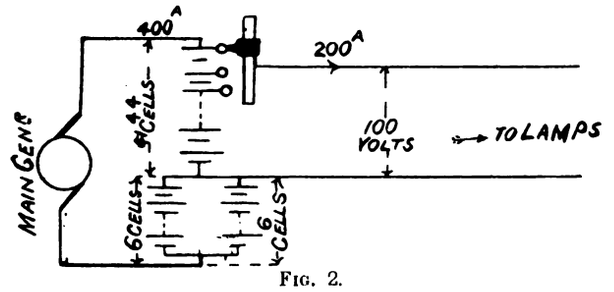

FIG. 2.

be about 112, and this should be gradually increased to about 120 as the charge proceeds, at the same time cutting the 44 cells down to about 40 by means of the discharge switch. The current taken from the dynamo would again be about 400 amperes.—Q.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Sheffield.—The Tramways Committee are inviting tenders for 20 double-deck cars.

Edinburgh.—The Corporation invite tenders for annual supplies from May 15 for the electric supply department.

Brisbane (Queensland).—The Postmaster-General invites tenders for a number of telephones. Tenders by April 14.

Rockhampton (Queensland).—The contract for the municipal tramways, full particulars of which appeared in a former issue, will remain open until March 31.

Stepney.—The Electrical Committee invite tenders for the supply, laying, and jointing of cables and conduits. Tenders by March 20. Details in our advertisement columns.

Madrid.—The Postal Telegraph Department invite tenders for 12 tons 3mm. and 3 tons 4mm. bronze wire. Price per ton not to exceed 2,280 pesetas. Tenders by April 5.

Stoke-upon-Trent.—The Guardians invite tenders for one combined engine and dynamo, one electric motor, and spare armature. Tenders by March 26. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the annual supply of indiarubber-covered cables and cast-iron pipes from April 1, 1902, to March 31, 1903. Tenders by March 26. Details in our advertisement columns.

Rochdale.—The Electricity Committee invite tenders for supply of distributor cables. Specifications, etc., may be obtained from Mr. C. C. Atchison, borough electrical engineer, Rochdale. Tenders by 18th inst.

Leeds.—The Corporation invite tenders for installing electric light in the underground conveniences at Kirkgate Market, Leeds. Particulars may be obtained at the City Engineer's Office, Leeds. Tenders by 17th inst.

Ilford.—The Urban District Council invite tenders for (Contract No. 6) overhead line equipment, poles, etc.; (No. 7) underground feeder cables, etc. Tenders by 27th inst. Details in our advertisement columns.

Ilford.—The Urban District Council invite tenders for motor and trailer cars, trucks, motors, and equipments. Specification, etc., may be obtained from Mr. John W. Benton, clerk, Public Offices, Ilford. Tenders by March 24.

Hackney.—The Electric Lighting Committee invite tenders for the construction and erection of three water-tube boilers and accessories, and water-softening plant. Tenders by April 9. Details in our advertisement columns.

Madrid.—The Public Works Department invite tenders for extensions to the San Sebastian tramways and working the same for not more than 60 years. Particulars may be obtained from the Department. Tenders by April 5.

Wallsend.—Tenders are invited for providing, fixing, and erecting a complete refuse destructor, pug mills, electric lighting machinery, electric crane and motor for driving same. Tenders by March 19. Details in our advertisement columns.

Wigan.—The Corporation invite tenders for a 425-kw. steam generator (Willans or Belliss engine), Korting condenser, extension of switchboard, steam piping, and water main. Tenders by March 24. Details in our advertisement columns.

Ghent.—The Municipality require tenders for installation and working of an electricity undertaking in the town. A deposit of £4,000 will be required. Tenders will be received until and adjudicated at the Town Hall on March 22, at 11 o'clock.

Ilford.—The Urban District Council invite tenders for overhead line equipment, poles, etc., and underground feeder cables, etc. Specifications, etc., may be obtained at the offices of Mr. J. W. Benton, clerk to the Council, Council Offices, Ilford. Tenders by March 27.

Kendal.—The Property Committee invite tenders for wiring certain rooms, etc., in the town hall for electric light. Specification, etc., may be obtained from Mr. T. N. Ritson, A.M.I.C.E., borough electrical engineer, Gas and Electricity Offices, Parkside-road, Kendal. Tenders by 17th inst.

Barrow-in-Furness.—The Corporation invite tenders for the supply of oils, waste, engine-room stores, tools, ironmongery, etc., required at their electricity works from April 1, 1902, to March 31, 1903. Specifications, etc., may be obtained at the Electricity Works. Tenders by 12 noon on 17th inst.

Plymouth.—The Corporation invite tenders for Lancashire boilers, with mechanical stokers, steam, exhaust, and other piping, and ejector condensers, valves, etc. Specification, etc., can be obtained from Mr. E. G. Okell, borough electrical engineer, Prince Rock, Plymouth. Tenders by March 25.

Edinburgh.—The Corporation invite tenders for supply of (1) arc lamp carbons and (2) cast-iron pipes, pavement and road box frames and covers, etc., for the electricity supply department for the year from May 15, 1902. Tenders by March 31 and April 12 respectively. Details in our advertisement columns.

Plymouth.—The Corporation invite tenders for the supply of electricity meters, cables (paper insulated), and transformers during the 12 months ending March 31, 1903. Specifications, etc., can be obtained from Mr. E. G. Okell, borough electrical engineer, Prince Rock, Plymouth. Tenders by March 25.

Halifax.—The Tramways and Electricity Committee invite tenders for water-tube boilers, superheaters, etc., 200-kw. rotary converters, 75-kw. transformers, and high-tension switchboard. Specifications, etc., can be obtained from Mr. W. M. Rogerson, borough electrical engineer, Foundry-street, Halifax. Tenders by March 24.

Madrid.—Tenders are invited by the Spanish Government for the supply of 141 tons of iron wire for the Government telegraph service. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m. Tenders by April 2.

George Town (Penang).—The Municipal Commissioners invite tenders for the supply and delivery, f.o.b., of boilers, etc., ejector condenser, pumps, tanks, etc., pipes, steam dynamos and balancer boosters, switchboards, batteries, cables, junction boxes, &c., and arc and glow lamps, posts, and accessories. Tenders by April 28. Details in our advertisement columns.

Oldham.—The Corporation Electricity Committee invite tenders for supplying the whole of the work and material comprised in Contract No. 4, which includes steam, exhaust, feed and drain pipes, feed pumps, feed heaters, tanks, barometric condensers, condenser pipes, oil separators, motor-driven pumps, tools, etc. Tenders by March 25. Details in our advertisement columns.

Manchester.—The Electricity Committee invite tenders for the supply, delivery, and erection at their Stuart-street generating station of high-pressure steam and other pipes; and low-pressure steam and other pipes and tanks. Specification, etc., may be obtained on application to Mr. F. E. Hughes, secretary, Electricity Department, Town Hall, Manchester. Tenders by March 21.

Manchester.—The Tramways Committee invite tenders for the supply of 6,000 tons of steel girder tramway rails and about 195 tons of steel fishplates, 125 tons of steel tiebars for tramway rails and 36 tons of bolts and nuts for fishplates, and 5,000 tons of granite setts. Specification, etc., may be obtained on application to Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders by March 17.

Brighton.—The Council invite tenders for supplying and laying telephone conduits and cables, erecting telephone poles, standards, arms, etc., fixing subscribers' instruments, supply of creosoted telephone poles, manufacture and supply of telephone insulators, oak arms for telephone poles, ironwork used in telephone construction,

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galvanised iron arm bolts, nuts and washers, hard-drawn, semi-hard, and soft copper wire, silicium bronze wire, iron and steel stay wire, insulated wires, lightning arresters, high-tension guards and test jacks, primary batteries, telephone instruments and telephone switchboard. Tenders by March 24. Details in our advertisement columns.

RESULTS OF TENDERS.

Chester.—The City Council have accepted the tender of Drake and Gorham for altering and exchanging electric lights at £285.

Llandilo.—The Urban District Council have accepted the tender of Thomas Bros. for building electric light station, at £705.

Brighton.—The Town Council have accepted the tender of Witting Bros., London, for the supply of 10 additional electric cars at £576 per cars complete.

Hull.—The City School Board have accepted the tender of King and Co. for providing electric light wires and fittings at the Thoresby-street Schools, at £230.

Battersea.—The Council have accepted the following tenders: W. H. Willcox and Co, engine-room stores; Venner and Co. (Chamberlain and Hookham), meters; and Sloan Electrical Syndicate, carbons for arc lamps.

Salford.—The tender of Mather and Platt for supply of two motors, at £840, has been accepted by the Town Council; also that of Ferranti Limited for remodelling and re-erecting the high-tension switchboard at the Strawberry-road station at £276.

Newcastle.—The Town Council have accepted the tender of Mather and Platt for the supply of a battery booster at the power station at £925, and that of the Electrical Power Storage Company for the supply of a storage battery at the power station at £5,277. 18s.

Nelson.—The Town Council have accepted the following tenders for the supply of motors: J. H. Holmes and Co., Newcastle-on-Tyne, ¾-h.p., ½-h.p., and 2-h.p.; Lancashire Dynamo Company, Manchester, 4-h.p.; Verity, Limited, Manchester, 5-h.p.; D. Bruce Peebles and Co., Edinburgh, 6-h.p.

Colchester.—The Town Council have accepted, subject to the Local Government Board's sanction to the further loan, the tender of Davey, Paxman and Co. for supply and erection, for £920, a steel "Economic" patent steam boiler, capable of evaporating 10,000lb. of water per hour, with 800lb. working pressure.

West Bromwich.—The Town Council have accepted the following tenders in connection with the reconstruction and electrical equipment scheme: Bolckow, Vaughan, and Co., Limited, Middlesbrough, rails; Guest, Keen, and Co., Limited, West Bromwich, tiebars; G. Law, Kidderminster, joints; Hadfields, Limited, Sheffield, points and crossings; G. Law, Kidderminster, permanent way: J. Spencer and Co., Limited, West Bromwich, poles; British Insulated Wire Company, Prescot, overhead equipment and bonds; British Insulated Wire Company, cables.

Hammersmith.—The Borough Council have accepted the following tenders for annual contracts: Johnson and Phillips, arc lamp accessories, £135. 9s. 6d.; City Glass Company, arc lamp globes, £145. 17s. 6d.; Witting Bros., commutator brushes, £44. 6s.; Verity's, Limited, electrical goods, £125. 17s. 10d.; General Electric Company, incandescent lamps, £165. 10s. 3d.; St. Helens Cable Company, insulated wires, £409. 18s. 10d.; Boult Bros. and Co., lubricating oils, £393. 15s.; J. Gibb and Co., metals, £90. 4s. 2d.; C. Angus and Co., packing and jointing, £81. 15s. 11d.

Reading.—The Corporation have received the following tenders for supply of generating plant and rolling-stock for the intended electrical tramways:

Generating plant.

Allgemeine Electric Company, London and Berlin	£16,005
Blackwell and Co., Limited, London (accepted)	17,674
British Schuckert Electric Company, Limited, London	17,313
British Thomson-Houston Company, Limited, London	18,550
British Westinghouse Company, Limited, London	18,082
Brush Electrical Engineering Company, London	17,673
Crompton and Co., Limited, London	18,210
Maxim Electrical Company, Limited, London	19,673

Rolling-stock.

Allgemeine Electric Company	15,238
Blackwell and Co., Limited	17,269
British Schuckert Electric Company, Limited	21,256
British Thomson-Houston Company, Limited	19,234
British Westinghouse Company, Limited	18,879
Brush Electrical Engineering Company	17,081
Crompton and Co., Limited	18,275
Maxim Electrical Company, Limited	18,158
Dick, Kerr, and Co., Limited, London (accepted)	17,322
Witting Bros., Limited, London	16,815
Hurst, Nelson, and Co., Motherwell	17,695

Note.—There were 78 tenders. The above were the largest contractors.

Barnstaple.—We have already noted the tenders accepted by the Town Council. The following is a complete list of the tenders received:

Section A.—Boilers.

Renshaw and Co.	£1,691	16	0
Babcock and Wilcox	1,899	3	0
Reavell and Co.	1,941	0	0
British Insulated Wire Company	1,994	0	0
British Westinghouse Company	2,017	0	0
Anderston Foundry Company	2,121	18	0
J. Thompson	2,299	0	0
Davey, Paxman, and Co.	2,334	15	0
Newton Electrical Company	2,365	5	0
Johnson and Phillips	2,369	0	0
Hornsby and Sons	2,369	0	0
Danks	2,381	15	0
Fraser	2,493	0	0
J. Carter	2,571	15	0
Lancashire Dynamo Company	2,647	0	0
Tinkers, Limited	2,870	0	0
D. Adamson	3,226	0	0
Ruston-Proctor	3,421	0	0

Section B.—Steam and exhaust pipes.

Crompton and Co.	1,080	0	0
J. Thompson	1,097	0	0
Babcock and Wilcox	1,113	0	0
Johnson and Phillips	1,126	0	0
British Westinghouse Company	1,145	0	0
British Insulated Wire Company	1,163	0	0
Lancashire Dynamo Company	1,164	10	0
Anderston Foundry Company	1,167	0	0
J. Carter	1,296	15	0
J. Spencer	1,319	0	0
Wheeler Condenser Company	1,325	0	0
Newton Electrical Company	1,361	12	0
Ashton-Frost	1,375	0	0
Korting	1,651	12	0
Mechan	1,999	0	0
Reavell and Co.	2,111	0	0
Klein	2,128	0	0

Section C.—Engines.

M. Paul	1,561	0	0
Allgemeine Electricitäts-Gesellschaft	1,707	0	0
Allen and Co.	1,755	0	0
Johnson and Phillips	1,768	0	0
Vauxhall Ironworks	1,773	0	0
International Electric Company	1,775	0	0
Royce	1,780	0	0
Crompton and Co.	1,800	0	0
Johnson-Lundell	1,800	0	0
Lahmeyer	1,806	0	0
Schuckert	1,806	0	0
J. Fowler	1,842	0	0
India Rubber Company	1,843	0	0
Witting	1,900	0	0
Davey, Paxman, and Co.	1,920	0	0
Mavor and Coulson	1,922	0	0
British Westinghouse Company	1,955	0	0
Howden	1,980	0	0
Lancashire Dynamo Company	1,992	0	0
Anderston Foundry Company	2,000	0	0
P. R. Jackson	2,014	0	0
British Insulated Wire Company	2,060	0	0
B. Thomas	2,065	0	0
T. Parker	2,065	0	0
Electric Construction Corporation	2,169	0	0
Belliss and Morcom	2,218	0	0
Sunderland Engineering Company	2,263	0	0
Howden	2,250	0	0
Scott and Mountain	2,275	0	0
Thames Electrical Engineering Company	2,286	0	0
Reavell	2,316	0	0
Holmes	2,358	0	0
Willans and Robinson	2,627	0	0
Cannock Chase	2,636	0	0
Mather and Platt	2,650	0	0
Ashton-Frost	3,600	0	0
Vereinigte	3,640	0	0

Section D.—Dynamos.

Howden	1,260	0	0
Allgemeine Electricitäts-Gesellschaft	1,441	18	0
Howden	1,550	0	0
Reavell	1,563	0	0
Broadbent	1,589	0	0
Mavor and Coulson	1,678	10	0
Witting	1,730	0	0
Lahmeyer	1,736	0	0
Lancashire Dynamo Company	1,763	10	0
B. Thomas	1,817	5	0
Verity	1,839	0	0
Royce	1,870	0	0
Thames Electrical Engineering Company	1,878	0	0
Johnson-Lundell	1,978	0	0
J. Fowler	1,988	0	0
International Electric Company	2,030	5	0
Crompton and Co.	2,119	0	0
Siemens Bros.	2,160	0	0
Schuckert Company	2,161	11	0
British Insulated Wire Company	2,226	5	0
T. Parker	2,259	0	0
J. H. Holmes	2,287	10.	0
Allen and Co.	2,294	0	0
India Rubber Company	2,328	0	0
Bruce Peebles	2,378	0	0
Electric Construction Company	2,419	10	0
Johnson and Phillips	2,449	0	0
Jackson	2,483	5	0
British Westinghouse Company	2,486	0	0
Anderston Foundry	2,588	0	0
Sunderland Forge Company	2,629	0	0
Armstrong, Mitchell, and Co.	4,329	0	0

Combined sets.

Newton Electric Company	3,809	2	0
Parsons	4,790	2	0
Mather and Platt	1,877	0	0

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Section E.

Fryer	625	0	0
Schuckert	629	15	0
Newton Electric Company	649	5	0
Statter and Co.	655	3	9
British Insulated Wire Company	661	5	0
British Westinghouse Company	665	0	0
Nalder and Thompson	684	7	6
J. Fowler	690	0	0
Crompton and Co.	692	0	0
Veritys	703	10	0
Lancashire Dynamo Company	707	0	0
Brook-Hirst	713	0	0
B. Thomas	713	19	0
Clayton and Co.	737	10	0
Edison Company	797	0	0
Dorman and Smith	809	0	0
General Electric Company	811	0	0
Johnson and Phillips	816	0	0
Elliott Bros.	848	10	0
Williamson and Joseph	850	9	0
Blackwell	891	0	0
Siemens Bros.	900	0	0
Allgemeine Electricitäts-Gesellschaft	901	0	0
Kelvin	927	11	0
Witting	960	0	0
Armstrong, Mitchell, and Co.	967	0	0
Mechan	1,105	0	0

Section F.

Anchor Cable Company	2,000	0	0
St. Helens Cable Company	2,001	11	6
Johnson and Phillips	2,141	4	11
British Westinghouse Company	2,199	0	0
Henley	2,238	1	0
Western Electric Company	2,262	17	9
Callender's Cable Company	2,267	17	0
Allgemeine Electricitats-Gesellschaft	2,291	16	0
Telegraph Manufacturing Company	2,374	6	7
British Insulated Wire Company	2,514	13	0
Newton Electric Company	2,514	13	0
Glover and Co.	2,681	16	2

Section H.—Accumulators.

Schultz	960	0	0
Ashmore-Benson	1,031	10	0
Johnson and Phillips	1,111	0	0
Hart Battery Company	1,142	11	0
British Insulated Wire Company	1,200	0	0
Lancashire Dynamo Company	1,200	0	0
Power Traction Company	1,215	5	6
Veritys	1,265	0	0
D.P. Battery Company	1,319	0	0
Electrical Power Storage Company	1,427	18	0
Newton Electric Company	1,423	0	0
Tudor Company	1,436	0	0
Allgemeine Company	1,472	0	0
E. Lomer	1,500	0	0
British Westinghouse Company	1,520	0	0
Chloride Company	1,624	0	0

Section I.—Crane.

Chatteris	115	0	0
Johnson and Phillips	123	0	0
British Insulated Wire Company	125	0	0
Marshall-Fleming	138	0	0
Allgemeine Company	142	10	0
Isles	144	0	0
J. Spencer	145	0	0
Lancashire Dynamo Company	152	0	0
Carrick and Sons	154	0	0
Carrick and Ritchie	159	0	0
British Westinghouse Company	174	0	0
Vereinigte	175	0	0
Broadbent and Sons	190	0	0
Witting	203	0	0
Stothert and Pitt	215	0	0
Newton	220	0	0
J. Thorne	315	10	0

Section K.—Well.

British Insulated Wire Company	340	0	0
Lancashire Dynamo Company	329	0	0
Newton	404	15	0
Johnson and Phillips	264	0	0
British Westinghouse Company	354	0	0
Calyx Boring	392	10	0
Merryweather	502	0	0
Mather and Platt	647	0	0
Isler	325	0	0
Neal	460	0	0

Walsall.—The Town Council have accepted the following tenders with respect to the construction and equipment of the tramway extensions to Walsall Wood, to the Bell Inn, Birmingham-road, to the Walsall-road Board Schools, Willenhall, and to Bell-lane, Bloxwich—viz.: W. Griffiths and Co., London, construction of the permanent way of the tramways, £35,827. 9s. 9d.; R. Blackwell and Co., London, constructing the overhead equipment of the tramways (except the Bloxwich extension), and also for the re-equipment of so much of the existing lines in the borough as extend from the top of Park-street to Mellish-road, £7,480. 7s. 3d.; Callender's Cable and Construction Company, supply and laying of the high-tension cable and tramway feeder cables required for the tramways (except the Bloxwich extension), £6,444. 12s. 1d.

Aberdeen.—The Town Council have accepted the following tenders for the electrical equipment of the Rosemount section of the tramways: British Insulated Wire Company, overhead work, £819. 18s. 4d.; Anchor Cable Company, cables, £1,412. 10s. 1d.; British Electric Car Company, 12 additional electric cars, with their necessary separate parts, £6,710.

BUSINESS NOTES.

TRACTION.

West Ham.—The District Council propose to spend £672,000 on their electric tramway scheme.

Ayr.—A *plébiscite* of the town is to be taken on the question of Sunday traffic on the tramways.

Brighton.—The Corporation have withdrawn their opposition to the Rottingdean Seashore Electric Tramroad Bill.

Salford.—The Tramways Committee recommend the Town Council to appoint a traffic superintendent of the tramways.

Bury.—A petition signed by 198 persons in opposition to the tramway scheme has been presented to the Town Council.

Hyde. This place is shortly to be connected with Woodley by a tramway, the company having agreed to carry out the work.

Private Bills.—In the House of Commons the Manchester and Liverpool Electric Express Railway Bill has been read a second time.

Llandudno.—The Prince of Wales has been invited to formally open the Great Orme's Head tramway during his approaching visit to Wales.

Leeds.—The electric cars commenced to run on the section from the junction of Accommodation-road with York-road to Easy-road on Monday.

Horsforth.—A syndicate has notified the District Council of its intention to apply for a provisional order to run tramways through the borough.

Cardiff.—It is proposed to follow the precedent adopted on the horse tramways and run special workmen's cars on the electric system morning and evening.

Shields Electric Railway Bill.—The Select Committee of the House of Lords presided over by Lord Elgin have now passed the clauses in the above Bill.

Darlington.—Dr. Kennedy's report on the tramways is expected to be received some time this week. It will immediately be considered by the Tramways Committee.

Wigan.—It is expected that in about six weeks' time the Board of Trade inspectors will be invited to inspect the new routes and extensions of the tramway system.

Alfreton.—While the Urban District Council are strongly in favour of a light railway through the district, they have declined to pledge themselves to either of the two schemes proposed.

Rochdale.—The Town Council have decided to apply to the Board of Trade for sanction to borrow £32,000 for the purpose of the erection of a car depôt and works in connection therewith.

Torquay.—The Town Council have decided to defer the question as to whether the Corporation should apply for a provisional order themselves or negotiate with a company or companies.

Nelson.—Plans and sections of the Nelson sections of the light railways to Barrowford and Colne have been approved by the Town Council and submitted to the Board of Trade for their sanction.

Grimsby.—Owing to several complaints that the speed of the tramcars is excessive—sometimes reaching 20 miles an hour—a meeting of the Tramways Committee has been called to consider the matter.

Greenock.—In view of the opinion of counsel that Sunday cars cannot be interfered with, the Law Committee of the Corporation recommend that no further action regarding Sunday trams be taken.

Wallasey.—There is now every probability that the new electric tramways system will be opened before Easter. Several trial trips along the whole of the routes have been made, the result being satisfactory.

Hull.—A deputation of members of the Corporation visited Newcastle on Wednesday, and inspected the working of the tramway system, more especially in reference to the life-guard attached to the cars.

Rhondda Tramways Bill.—In the face of considerable opposition this Bill has passed the Select Committee of the House of Lords presided over by Lord Elgin. The Bill will be now reported to the House.

Burton.—Tenders will shortly be invited for the construction of the permanent way of the proposed electric tramways. The work will be proceeded with as soon as the Finance Committee provide the £50,000 required.

Kirkcaldy.—The permanent way of the electric tramways now in course of construction is expected to be ready about Midsummer. Some two miles of the rails have been already laid. The cars are expected to be running by the close of the year.

Hartlepool.—It has been resolved that before coming to any agreement with the tramways company in regard to the question of waiving the Corporation's right of purchase, a committee should confer with a committee of the West Hartlepool Corporation.

Mid-Suffolk Light Railway.—The Duke of Cambridge having accepted the invitation of the chairman and directors of the Mid-Suffolk Light Railway to cut the first sod of the new line, the ceremony will take place at Westerfield on Saturday, May 3.

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Southampton.—At Wednesday's meeting of the Town Council it was announced that the net profit for the year ending March 31 on the working of the electric tramways was estimated at £10,236, and it was proposed to hand over £5,000 to the borough rate.

Scarborough.—The Town Council have confirmed the decision o the Tramways Committee to substitute single or interlacing lines for double lines on the new tramways from Huntriss-row to Vernon-place, and a single line from St. Nicholas-street to Huntriss-row.

Aberdare.—Major Drewit has held an enquiry with reference to the application of the Urban District Council to construct an electric tramway from the top of Trecynon to Aberewmboy, at the boundary of the urban district. The cost of the scheme is put at £57,000.

Oxford.—A public meeting on Friday passed a resolution requesting the City Council to refuse any application from the Oxford Tramways Company for extending their term of tenure, and to obtain the ownership of the tramways for the citizens at the earliest opportunity.

Ilkeston.—The construction of the electric tramways at this place is making considerable headway. The Corporation have recently concluded an arrangement by which they will obtain current for the tramways from the Derbyshire and Nottinghamshire Electric Power Company.

Flamborough and Bridlington Light Railway.—The order for this railway, which was originally obtained in 1897, came before Sir H. Jekyll at the Board of Trade this week on an application for an extension of time for a year. The decision of the Board will be ommunicated.

Oldbury.—It is probable, owing to the conditions which the District Council have placed on their consent to the proposal of the Midland Tramways Company to promote a Bill in Parliament for powers to construct tramways from Oldbury to Langley and Black Heath, that the scheme will be abandoned.

Bakewell.—There are now two schemes proposed for a light railway or tramway to this place. The first proposes to start from Sheffield and pass through Baslow and so on to Bakewell, while the other suggests that Grindleford should be the starting place. The Urban District Council have the two schemes under consideration.

Hales Owen.—Colonel G. F. O. Boughey and Mr. H. A. Steward have held a public enquiry on behalf of the Light Railway Commissioners into the application by the District Council for sanction to construct additional light railways in the district. After hearing evidence the Commissioners intimated that they would report upon the matter.

Halifax.—The Town Council have decided to adhere to the present system of issuing transfer tickets on the trams from the railway station to the end of the penny section and *vice versa*. The proposed extension of the electric tramways from the boundary of the Hebden Bridge District Council to the boundary of the Todmorden Corporation has been abandoned.

Sunderland.—The Tramways Committee have decided against extending the tramways to the east end of the town. It was shown that the original estimate would be exceeded by over £1,000, and figures were also given to shown that the earnings on the section would have to be greater than on the remainder of the system in order for a profit to be made.

London-Brighton Electric Express.—A special meeting of the Brighton Town Council has adopted a petition to the House of Lords in favour of a suspension of the Standing Orders of Parliament in respect of the London and Brighton Electric Railway Bill. Several other local authorities concerned have agreed to take similar action, notably the Hove Corporation.

Kent Electrical Canal.—A Select Committee of the House of Lords has passed a Bill authorising the construction of a canal from the Medway at Chatham to the Thames a little below Greenwich, which will save the lengthened journey round the Nore. The canal is for sailing barges, which will be propelled along its course by electricity on the overhead trolley principle.

Shipley.—A strong effort is being made to redeem the promise that the tramway line from the Saltaire terminus to the city boundary at Frizinghall shall be ready for the introduction of electric traction by May 1 next. Close upon 300 workmen are engaged day by day in the various operations involved in the conversion of the line from the steam to the electric system of working.

Hammersmith.—The Parliamentary Committee report that in order to minimise the disturbance created by the running of the electric cars during divine service on Sunday, the London United Tramways Company have promised to diminish the speed of the cars during these hours, to cause a cessation in gong ringing, and to water the rails whilst passing places of worship.

London County Council Subways.—The Highways Committee reported at Tuesday's meeting of the London County Council with reference to the scheme for the construction of a subway for tramways between Victoria-embankment and Southampton-row, that as the result of negotiations an agreement had been come to for the protection of the property of the Duchy of Lancaster near Waterloo Bridge.

Gloucester.—Almost unanimously the City Council on Wednesday agreed to acquire the concern of the Gloucester Tramways Company, and apply to the Light Railway Commissioners for an order authorising the Council to construct light railways employing electric traction in place of the system of horse trams, at a total expenditure of about £100,000. The purchase price for the existing undertaking is £26,000.

Liverpool.—A proposal was brought forward at the last meeting of the Tramways Committee to adopt a universal 1d. fare on the tramcars within the city boundaries. After discussion the motion was withdrawn, the general opinion being that the present time was inopportune. Some 70 pieces of iron placed maliciously on the electric tramway track within the past few weeks have led to 76 car wheels being damaged. The Corporation offers a reward of £25 for information as to those responsible.

Middleton.—It is reported that under their agreement the Manchester Corporation have commenced laying the rails for tramways between Blackley and Middleton, thus affording a through connection to the city. It is hoped to finish this work in three months, and Middleton has undertaken to provide the electric power until such time as Manchester is in a position to do so. The electricity works are now complete, and power for both traction and light will be available this week-end.

Bradford.—The City Council on Tuesday approved a recommendation that the fare-box system as at present in use in combination with way-bills be used on the whole of the city tramways. It was stated that the Bradford and Shelf Tramway Company, Limited, had been given notice to terminate on March 14 the arrangement whereby the company's engines and cars were used by the Corporation on the steam sections of the city tramways, but on appeal by the company the time had been extended to April 7.

The Post Office and Electric Traction.—A deputation from the London Chamber of Commerce and the Tramways and Light Railways Association was received by Lord Morley, chairman of committees in the House of Lords, on Wednesday. The members urged upon his Lordship their objections to the proposed action of the Postmaster-General both as regards electrical interference and wire guards, and expressed their wish to be subject to the ruling of the Board of Trade only in these matters.

Brighton and Shoreham Tramways Bill.—The Standing Orders Committee of the House of Commons have decided not to dispense with the Standing Orders that have not been complied with by the Brighton and Shoreham Tramways Company in the promotion of their Bill this session. This decision is equivalent to the rejection of the Bill, and brings to an end a scheme calculated to involve an expenditure of £213,612 for the construction of a line of electrical tramways from Brighton through Hove and Shoreham to Worthing.

Brussels.—The scheme for the construction of an electric railway between Brussels and Antwerp has now been revived, and a definite proposal presented to the Government. It is proposed to build an elevated railway on viaducts 23ft. above the ground level. There will be a 10 minutes' service of trains travelling at the rate of 84 miles an hour, and the journey between the two towns will be accomplished in from 20 to 25 minutes. It is estimated that the cost of construction will amount to £1,000,000, and the railway will be ready for traffic within two years.

Precautions on the "Tube."—An elderly man on Wednesday attempted to commit suicide on the Central London Railway by throwing himself in front of an approaching train. His object was, however, fortunately frustrated by his falling into the "invert" between the rails, and the train passed over the spot without touching him. He was, however, severely injured about the head by coming in contact with the third rail. It was only after the recent suicide at the Shepherd's Bush Station that the company decided to remove the boards covering the "invert" and leave the space open.

Bournemouth.—On Monday a public enquiry was held here respecting the application of the Poole and Bournemouth Electric Tramway Company to construct an electric tramway through the village of Parkstone, which would give more direct communication between Poole and Bournemouth than exists by the present tramway along a different route. Strong opposition was offered by the London and South-Western Railway Company and influential residents at Parkstone, who declared the tramways would drive the better-class population away from the district. The court reserved its decision.

Walsall.—The Tramways Committee's scheme for working and extending the tramways, which is estimated to cost £139,000, was approved at the meeting of the Council on Monday; also a proposal to erect a central tramway depôt at a cost of £11,600. As to the probable financial result of the lines being worked by the Corporation, the committee anticipate an income of £18,700, and an expenditure of £13,021. This will leave a balance of £5,729, and after paying £5,474 in respect of capital outlay and interest, there will remain a net profit of £225 per annum. As reported in another column, the Town Council have placed the contracts for the work.

London United Tramways.—At Tuesday's meeting of the London County Council the Highways Committee were confirmed in their recommendation, "That, on the promoters of the London United Tramways Bill giving the Council an undertaking to so amend the Bill as to provide that the tramways proposed for Hammersmith shall be constructed by the Council and leased to the London United Tramways Company till 1909, when the company's system within the county of London becomes purchasable by the Council, the consent of the Council be given to the Bill so far as it relates to the tramways in question." The full report of the committee on the subject appeared in our last issue.

Cambridge.—The question of electric traction was discussed at the meeting of the Street Tramways Company last week, the chairman referring to the Lorain system which is being laid down at Wolverhampton. A shareholder expressed the opinion that as the company were under an absolute covenant with the British Electric Traction Company, they should not go "coquetting" with any other company. The Chairman explained that the agreement with the British Electric Traction Company was only binding if that company got a long lease from the Corporation, and also obtained permission to lay down electric traction, which permission the Council had refused. The subject shortly afterwards dropped.

Durban (S.A.).—We hear that the application made by a syndicate for a concession for an electric tramway system connecting the Greyville suburb of Durban with Umgeni has been refused, the Town

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Council having decided to construct all tramways themselves within their own boundaries. Progress is being made with the construction of the borough electric tramways, 10 miles of track having already been made and preparations advanced for an early start. Completion of the work is being delayed by the non-receipt of material, some of which, and in particular the iron frames of the cars, has been lying for months on vessels in Cape ports awaiting discharge. The cars are all on hand and erected, their frames excepted.

Richmond.—It is announced that an agreement has been come to between the Corporation and the London United Tramways Company with reference to the introduction of electric tramways in the town by the company. The principal points in the agreement are that there shall be no overhead wires in the Kew-road, that the fares and workmen's cars shall be as suggested by the committee, that there shall be no extension across Kew Bridge save at the request of the Corporation, that certain widenings shall be carried out, that the period for purchase shall be 30 years, and that the company shall pay a way-lease of £1,250 per annum to the Corporation, and pave with hardwood the tramway area of the roads. General satisfaction is felt at this happy turn of affairs.

District Railway Bill.—The Metropolitan District Railway Company have presented a petition for leave to introduce into its Bill now before Parliament three additional provisions, of which no notice was given last November. The first is for powers to acquire further lands abutting on the Thames at Lots-road, Chelsea, for the purpose of erecting a generating station of sufficient size, not only for supplying electricity to the company, but also to the Brompton and Piccadilly-circus Railway Company. The second is to authorise the application of moneys received from the sale of superfluous lands to the general purposes of the company's undertaking, and by the third new provision parliamentary confirmation is sought to the Board of Trade award as to the system to be used in working by electrical power the undertakings of the company and the Metropolitan Railway Company.

Wolverhampton.—At the monthly meeting of the Town Council on Monday a letter was read from Mr. Henry Lea, electrical engineer, of Birmingham, who enclosed a report relating to his inspection of the electrical test tramway in the borough. He stated in the document that he had been unable to discover any inherent defects in the Lorain system such as should prevent the Corporation from giving the contractor official notice to proceed with the equipment of the remainder of the 11·375 miles of single track under Clause 8 of the contract between the Corporation and the Lorain Steel Company. Mr. Lea has also submitted a full report to the Tramways Committee on the subject, which will shortly be considered, together with a report by Mr. Shawfield, the borough electrical engineer. The Council have decided to order six new double-decked cars for the tramways from Messrs. Dick, Kerr, and Co.

Middlesex.—The County Council have resolved to again promote the line of tramways through Hendon which the Light Railway Commissioners refused at the end of last year. The Herts County Council are promoting a similar scheme from Harrow Weald to Watford. A Select Committee on Wednesday passed the County Council Tramways Bill. The object of the Bill is to empower the County Council to acquire any of the tramways in the county. It was stated that the promoters of the Bill had made an arrangement with the London United Tramways Company, who own a large tramway system in the southern part of the county, that they should not interfere with them so far as new construction was concerned. The committee passed the preamble, subject to the insertion in the Bill of a clause providing that the power of purchase should only be exercised with the consent in writing of the local authority of the district concerned. The Bill was ordered for third reading.

Newcastle.—Last week's receipts were the highest taken since the electric tramways were opened a few months ago. They amounted to £1,899, being 12·18d. per car mile. The Tramways Extensions Bill promoted by the Corporation has been before Mr. Campion, one of the examiners of Standing Orders in Parliament. In some particulars the Bill did not comply with the requirements, and it will therefore have to be submitted to the Standing Orders Committee. In reply to a deputation to the Tramways Committee with reference to the extension of the tramways from Raby-street, Byker, to Walker Toll Gate, it was stated that the committee had already passed a resolution instructing the engineer to get out bills of quantities at once with a view to extending the tramways in accordance with the wishes of the deputation. It was added that the committee had received word that their Bill, which included the Walker extension, had passed the Standing Orders Committee.

Dunedin.—The Dunedin City Council have, after considerable discussion, determined to place the order for their complete tramway system with one firm without calling for tenders. From the information before us we gather that this firm (Messrs. Noyes Bros.) are the agents in New Zealand for the Westinghouse Company. In the first place, the Council obtained expert advice from this firm on a 2½ per cent. commission, but it was afterwards decided to purchase all their materials through them as agents, paying them 10 per cent. on the cost of materials and on the carrying out of the work. This seems a somewhat new procedure, the only advantage of which is that the Council obtain expert advice as to the specialities of the goods of the Westinghouse Company. The scheme includes, we believe, a power transmission over a considerable distance from a waterfall, for which three-phase currents are to be employed. It seems to us that in this case the result would have been better if independent expert advice and competitive tenders on a firm's specification had been obtained.

East Ham.—A statement showing the financial results derived from the first half-year's working of the tramways shows that the total receipts amounted to £11,022. 12s. 4d., and the total outgoings for working expenses £7,342. 9s. 4d., realising a gross profit of £3,680. 3s. In the net revenue account the capital charges were £2,442. 4s. 4d., which together with a sum of £620 to be set aside as a reserve for renewals and depreciation leaves a net profit for the half-year of £617. 18s. 8d., which has been carried to the general revenue account. The accrued deficiency at the opening date has amounted to £2,644. 6s.; the realised profit of £617. 18s. 8d. therefore leaves a net deficiency on the tramways fund to December of £2,026. 7s. 4d. The working costs amounted to £38. 4s. 10d. per day, or 7·19d. per car mile; the capital charges amounted to £12 14s. 5d. per day, and the reserves for renewals to £3. 4s. 7d. per day, making a total charge of £54. 3s. 10d. per day, whereas the average receipts were £57. 8s. 2d. per day, the net profits representing £3. 4s. 4d. per day, and 60d. per car mile. The total car mileage for the half-year was 245,047, and the total number of passengers carried was 3,687,256, equal to a daily average of 1,276 and 19,204 respectively.

Blackburn.—The Electricity and Tramways Committee presented a report at the last meeting of the Town Council on the tramways. In this report the committee justify the adoption of the four-motor instead of the two-motor type of car, for the reason that the latter do not provide the most satisfactory means of propulsion. The four-motor principle secures even driving, safety—a matter of paramount importance—greater speed, and better starting, a more even distribution of driving and brake power, and consequently less wear and tear on brake shoes and wheels. With regard to the comparative weight and horse-power of the Blackburn and Darwen cars, it is stated that the former weigh 13 tons and the latter 11 tons (both unloaded), the additional motors and cab-ends accounting for the extra weight of the Blackburn cars. The horse-power of the Blackburn car motors is 80, compared with 54·70 h.p. and 80 h.p. on the Darwen cars. The committee consider it would be unwise to have varying types of machinery, and add that if there be any increase in the energy consumed by the four-motor cars, it is trifling, and not worth consideration in comparison with the advantages gained. The committee justify the use of the larger type of car such as they have adopted as being more suitable for the irregular kind of passenger traffic experienced in Blackburn, and they consider the 48 cars now in stock as quite the right equipment for the service which has to be run. The report also contained a recommendation that the Audley and Revidge extensions be postponed, and the cemetery line carried to the Bull's Head, Wilpshire, and was adopted.

West Bromwich.—A report was issued on Saturday by the Highways Committee of the Corporation relating to the reconstruction and electrical equipment of the tramways within the borough. In accordance with the agreement entered into between the Corporation and the tramways companies—the South Staffordshire Tramways Lessee Company, Limited, and the Birmingham and Midland Tramways Company, Limited—the plans, details, specifications, and estimates had to be submitted to and reasonably approved by those companies, and they were submitted to them for that purpose. Mr. Sellon, chief engineer of the British Electric Traction Company, acting on behalf of the tramways companies raised certain objections to the plans and specifications on the ground that the expenditure involved was too high. In order to get rid of these objections the committee decided to try and fix a lump sum for the work. After some negotiating Mr. Sellon offered to agree to the sum of £100,000 as the cost of reconstructing and equipping the lines in West Bromwich, provided that the paving of the permanent way in the High-street between the General Post Office and Spon-lane, and in Great Bridge between Whitehall-road and Brickhouse-lane with hard wood be given up, and that Mr. Quin's safety device, if used, be attended to and set for the commencement of service each day by employés of the Corporation at the Corporation's expense. The committee are assured by the engineers that the work can be satisfactorily carried out for the sum of £100,000, and recommend that the offer be accepted on the conditions named, with the exception of that as regards the safety device, which they are of opinion should be attended to by the employés of the company. The above report was adopted at a special meeting of the Town Council on Wednesday.

LIGHTING AND GENERAL.

Wolverhampton.—The electric mains are to be extended at a cost of £2,500.

Longton.—The equivalent of 87 16-c.p. lamps have been connected since Dec. 31, 1901.

Mundesley (near Cromer).—The local Parish Council have decided to instal the electric light.

Nuneaton.—An enquiry will be held to-day into the proposed loan of £5,000 for electric purposes.

Warwickshire and Leicestershire Electric Power Bill.—This Bill has been reported for third reading.

Derbyshire and Nottingham Electric Power Bill.—This Bill has been read a third time in the House of Commons.

Mexican Electric Works.—The directors have declared a dividend at the rate of 8 per cent. for the year ended Sept. 30, 1901.

Gloucestershire Electric Power Bill.—The Urban District Council of Stroud has withdrawn its opposition to this Bill.

Eccles.—The Town Council intend to apply for a loan of £200 for the provision of six arc lamps, including two already erected.

Cardiff Telephones.—The municipal telephone question will be again considered by the Parliamentary Committee of the Corporation to-day.

Banbury.—A committee is discussing an application from Messrs. Hopcraft and Norrie to carry a telephone wire across certain public streets.

West Hartlepool.—During the past month 25,000 units were sold to consumers, the total number of 8-c.p. lamps connected being 22,707.

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Cornish Electric Power Co.—This company's Bill passed the Unopposed Bill Committee of the House of Commons (with amendments) on Wednesday.

Alnwick.—The Council are in communication with the Northern Counties Electricity Supply Company with reference to the lighting of the streets by electricity.

Edinburgh.—The Town Council have confirmed a resolution to spend £250 in furnishing a house for the assistant electrical engineer in the Dewar-place station.

Sleaford.—Although the Urban District Council's electric light undertaking has only been working for a year, the receipts already meet the expenditure by £158.

Reading.—The Highways and Lighting Committee are taking immediate steps to improve the street-lighting in the borough in connection with the tramways.

Lowestoft.—The Electric Lighting Committee's last report shows that the number of lamps keeps increasing. An extension of the cable to Yarmouth-road is to be made.

Newport (Mon.).—The Electricity Committee have been authorised to lay down plant for the supply of electrical power to the different manufacturers of the borough.

Swinton and Pendlebury,—The District Council have decided to enter into negotiations with the Lancashire Electric Power Company with the view of purchasing electricity in bulk.

Criccieth. — The Ynyscynhaiarn Council have appointed two members to meet representatives of the Criccieth Council to confer with respect to the consideration of the Electric Lighting Bill.

Cantorbury.—The town clerk has been instructed to defend any proceedings issued by the National Electric Company, Limited, in respect to their free-wiring installation removed from the Rose Tap.

Ayr.—The Town Council on Tuesday adopted a recommendation of the Lighting Committee to charge 2d. per unit for street-lightlng in place of the present charge, which was £20 per arc lamp per annum.

Felixstowe.—The District Council have resolved to retain their electric lighting order, and expressed an opinion that if the present company wanted to make terms they should be left to approach the Council.

Mold.—The Lighting Committee of the Urban District Council are collecting information with regard to the installation of electricity, and are of opinion that such a system of lighting would be highly beneficial to the town of Mold.

Glasgow.—The Secretary for Scotland has consented to the borrowing by the Corporation of £100,000 for the municipal telephone system, raising the total sum authorised to be borrowed to defray the capital expenditure to £220,000.

Bangor.—The City Council find that the consumption of gas is increasing, despite the installation of the electric light. They have received sanction to the borrowing of £12,008 for electric light and refuse destructor purposes.

Tiverton.—The town is to be canvassed to ascertain how many ratepayers would undertake to take the electric light for private consumption at the prices mentioned in the reports which have been presented to the Council.

Nelson.—A draft of the agreement proposed to be entered into with the Brierfield Urban District Council with respect to the supply of electricity to their district, has been approved and forwarded to the clerk to the Brierfield Council.

Aylesbury.—The Urban District Council have approved a draft contract with the North Metropolitan Electric Power Distribution Company. We understand that by the terms of the document the Council are not bound to take the electric light.

Brighton.—The charge for the hire of prepayment meters is to be 12s. per annum, with a minimum charge of 30s. per annum for electricity supplied, and the engineer has been authorised to insure motors lent on hire against electrical and mechanical damage.

Newcastle.—Upon closer scrutiny of our last issue, we find that the paragraph inserted under this heading has been headed misadvertently Newcastle. It certainly does not refer to Newcastle-on-Tyne, and we cannot at the moment trace its proper designation.

Direct Spanish Telegraph Co.—The directors have decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, a dividend at the rate of 4 per cent. on the ordinary shares, both for the half-year ended Dec. 31, 1901.

Tunbridge Wells.—The General Purposes and Telephone Committee have appointed Mr. G. S. Wallace, of Halifax, telephone manager at a salary of £200, rising by annual increments of £20 to £260, his whole time to be devoted to the service of the Council.

Kingston (Surrey).—A petition has been presented by the committee of the Kingston Municipal Society asking the Mayor to call a public meeting to consider (1) the present position of the Corporation electric lighting undertaking; (2) the extension of the arc lighting system.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the Isle of Thanet Electric Tramways and Lighting Company's 30,000 5 per cent. cumulative preference shares of £5 each fully paid.

National Telephone Vocal Society. — This society's second subscription concert of the season was given last week at the Newcastle Town Hall. The opening item was Sir J. Frederick Bridge's choral setting of Rudyard Kipling's "The Ballad of the Clampherdown."

Obituary.—Mr. James Dick, said to have been the largest importer of guttapercha in this country, died at his residence in Glasgow last week at the age of 87. Some years ago he presented public parks to Glasgow and Kilmarnock, and he has, it is reported, left £100,000 to Glasgow charities.

Whitby.—The inaugural ceremony of switching on the Urban District Council's electric light, which is being installed at a cost of £18,500, was performed on Wednesday last week at the works in Church-street by Mrs. E. H. Smales, wife of Councillor E. H. Smales, chairman of the Electric Lighting Committee, in the presence of a large gathering. Mr. W. Brown, J.P., chairman of the Council, presided.

Middlesbrough.—The lighting of the town hall with electricity is being considered. It is estimated that £418. 13s. would be required to efficiently illuminate the hall, the entrance, and the dressing-rooms; £94. 10s. 6d. for the crypt and carriageway; and £153. 10s. for the ventilating motor, organ motor, and clock—making a total of £666. 13s. 6d. The first part of the scheme has been adopted, and a ventilating motor will be obtained.

Dorchester.—At the last meeting of the Town Council, the Mayor, referring to the resolution of the electric lighting of the borough, said the idea was that the Council should advertise for an electrical engineer to come down and make a report upon the best way of lighting the borough by electricity; but the report of their intention appearing not only in the local Press, but also in other papers further afield, spread so rapidly that the Council soon received a number of applications without the Council being put to the expense of advertising.

Harrogate.—Mr. W. Duncan, of Starbeck, has been appointed switchboard attendant at 30s. a week. The engineer having reported that there was a probability of another vacancy as switchboard attendant, in the event of a second vacancy occurring, Mr. H. W. Ashton, Starbeck, is to be appointed at 30s. a week. Mr. R. McCourt, of Kendal, has been appointed mains superintendent at a salary of £150 per annum. The Sanitary Committee have obtained a reduction in the cost of electrical energy for sewage pumping from 2½d. to 2d.

Morecambe.—The engineer having suggested the purchase of an electric motor or engine in connection with the working of the economiser, the Urban District Council on Monday decided that a steam-engine should be obtained for the work. Sanction has been obtained to the borrowing of a further £5,000 for electric lighting, to be repaid within 25 years. The quotation of the Electrical Power Storage Company for the renewal of negative plates, and putting in complete working order the battery at East-street sub-station, has been accepted.

East Ham.—An enquiry will be held into the application of the Council for sanction to borrow £24,880 for purposes of electric lighting extensions as soon as possible. The electric lighting revenue account presented at the last meeting showed a total income derived solely from the sale of current amounting to £4,663. 5s. 4d. The working costs were £2,794. 5s. 9d., realising a gross profit of £1,868. 19s. 7d. In the net revenue account the capital charges and the reserve for renewals amounted to £2,134. 2s. 4d., showing a net loss for the half-year of £265. 2s. 9d.

Southport.—Colonel Durnford has held an enquiry into the Council's application for sanction to borrow £32,000 for electric lighting purposes. The money is mainly required to meet the expected needs of the town for the next two years, including the working of the pier tramway by electricity, and two sections of street tramways, and also the lighting of Chapel-street railway station. Rather more than one-quarter of the whole, however, has already been expended. The capital expenditure on the electricity estate so far is £158,000. There was no opposition.

Bermondsey.—An enquiry was held on Wednesday at the Electrical Department of the Board of Trade, before the Hon. T. H. W. Pelham, assistant secretary, into an application of the Borough Council for an extended order under the Electric Lighting Acts affecting the parishes of the borough acquired under the London Government Act, 1899—namely, Rotherhithe, St. Olave, St. Thomas, and St. John, Horselydown—the Council already possessing an order to supply electricity in part of their area, the old parish of Bermondsey, which is about half the size of the new borough. After hearing counsel, Mr. Pelham intimated that he would reserve his decision.

Opening of Nelson Station.—Mr. Reed, chairman of the Electricity Committee of the Town Council, on Wednesday performed the ceremony of opening the new electricity station which has been erected and equipped by the Nelson Corporation at a cost of £30,000 from designs and under the superintendence of Mr. Fraser, the Nelson borough electrical engineer. The installation includes three engines and dynamos, the motive power being supplied by steam obtained from an adjoining refuse destructor. The dynamos will generate current for lighting purposes in Nelson and Brierfield, and for traction purposes for Brierfield and Nelson, lengths of the Burnley Corporation tramways, and a light railway from Nelson to Barrowford and Colne

London Gazette.—The partnership existing between M. Walker and W. H. Collingham, electrical engineers (trading as the Airedale Motor and Accessories Company), Parsons-street, Keighley, has been dissolved by mutual consent.—A receiving order has been made out in the estate of J. H. Redgrave, electrical engineer, lately carrying on business at 53, Regent House, Regent-street, London, but present address unknown, on creditors' petition. The first meeting in the estate of the above will be held on March 17, at 12 noon, at Bankruptcy-buildings, Carey-street, W.C., and the public examination on April 11, at 12 noon, at Bankruptcy-buildings, Carey-street, W.C.—A first and final dividend of 20s. in the £ and interest at 4 per cent. from date of receiving order has been declared in the estate of C. A. Church, manufacturing electrical engineer (trading as H. Conolly and Co.), 42, Hampstead-road and 120, Kentish Town-road, London. Payable from March 19 at Mr. L. H. Lemon's, 32, King-street, Cheapside, E.C.—The estate of G. H. Bently, 63, Cross-lane, Earlestown, Lancashire, has been released from trusteeship.

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Wellingborough.—The assistant surveyor has laid before the Highway and Lighting Committee a plan and section of the engine-house at the destructor works, also a map showing positions of proposed lamps.

Hammersmith.—Since the last Council meeting three additional consumers have been connected, representing a maximum of 90 8-cp. lamps, and during the same period four consumers have been disconnected. The present number of consumers taking current from the mains is 974.

Bacup.—A copy of the draft agreement between the Lancashire Electric Power Company and the Corporation has been forwarded to the Board with necessary explanations. The Mayor and vice-chairman have been appointed to obtain the opinion of a suitable electric engineer on the provisions of the agreement.

Hastings.—At the request of the Electric Light (Management) Committee of the Town Council, Prof. Kennedy, the consulting electrical engineer to the Corporation, paid a visit to the electric light works a few days ago. We understand that he passed some very complimentary remarks upon what he saw.

Caversham.—The committee of the whole Council have again considered the question of supplying the district with electricity, and are of opinion that it is desirable that steps should be taken to obtain a provisional order authorising them to supply electricity for any public or private purposes within the urban district of Caversham.

Stepney.—The Borough Council have received sanction to borrow £24,750 for initial cost of electric light within the area of the late District Board of Works for Whitechapel (£20,000 of which has already been borrowed), and £18,703 for initial cost of extending the electric light in the districts of Mile End, Limehouse, and St. George's (East).

Newcastle.—At a meeting of the Watch Committee of the Corporation last week it was decided that 20 additional electric lamps be lighted in the neighbourhood of St. Nicholas-square, New Bridge-street, and the top of Arthur's-hill. It is expected that the lamps will be ready in the course of a few days. This will make about 120 lamps in use.

Leith.—The accounts of the electric lighting station to date show a loss of £104, as compared with £728 over the corresponding period of the previous year; and it is anticipated that with the extra number of consumers who have taken on the light there will be no deficit on the account for the year ending May 15 by the time the accounts are closed.

Heanor.—At the last meeting of the Council a letter was read by the clerk with reference to the supply of electricity to Heanor district by the Derbyshire and Notts Electric Power Company, and offering to send a deputation to the Council. It was decided to hold a special meeting of the Council at an early date for the purpose of discussing the matter.

Ramsgate.—The Town Council have approved draft of the license proposed to be granted to the Reno Electric Stairways and Conveyors, Limited, for the erection of an elevator and stairs on the East Cliff. The Marina Pier Company have transferred their rights to the Reno Company. The promoters of the Kent Electric Power Bill have withdrawn the clauses objected to by the local authorities.

Barnsley.—A new electricity main is to be laid to the proposed works of the Summer Lane Brickworks Company, Limited, on the condition that the brickworks company use electricity for both light and power, and that if they discontinue using it before the expiration of one year after commencing, they shall repay to the Corporation the cost, not exceeding £25, of the labour connected with the laying of the main.

Leicester.—The Electric Lighting Committee's last report shows a total profit for the year of £1,906. 12s. 7d., and a total net profit on the working of the department since its commencement of £3,556. 3s. 7d. Out of this a sum of £2,311, which had been disallowed by the Local Government Board on capital expenditure has been paid, which leaves a net profit of £1,245. 3s. 7d., which sum it is proposed to carry forward.

Wolverhampton Exhibition.—The London Committee of the Wolverhampton Arts and Industrial Exhibition held a meeting at the Mansion House on Monday, the Lord Mayor presiding. It was stated that the guarantee fund had already reached £40,000, and also that the Duke of Connaught would open the exhibition on May 1. Its electrical section, said one of the speakers, will be one of the finest ever seen in this country.

Warwickshire and Leicestershire Electric Power Bill.—Petitions in favour of this Bill have been deposited in the Private Bill Office of the House of Commons by, among others, Messrs. Rollason and Jones, Nuneaton; George Dewis and John Cotton, Bulkington; Hall and Phillips; Alfred Hickman, Haunchwood; Glascote Colliery Company; Lister and Co.; the Nuneaton Leather Company; and ratepayers of the parish of Nuneaton, etc.

Stockton.—We understand that the resignation of Mr. Ford is to take effect at the end of the financial year (31st inst.). The committee felt they should release him, so as to allow him to devote himself exclusively to the gasworks. This will naturally bring under consideration the question of management of the electrical work—whether a manager or assistant manager should be appointed. A small committee is investigating the application for electric light for exchange hall.

County of London and Brush Provincial Electric Co.—The directors recommend payments of a final dividend upon the ordinary shares at the rate of 4 per cent. per annum for the half-year ended Dec. 31, 1901, making 4 per cent. for the year, carrying forward about £4,000, and a dividend on the preference shares at the rate of 6 per cent. per annum for the half-year to Dec. 31, 1901. The transfer books and register of members will be closed from the 14th to the 24th inst., both days inclusive.

Aldershot.—Tenders have been received for meters, and recommendation as to acceptance will be submitted to the Council on March 19. Messrs. Parker are to lay the house services up to the meter point at their schedule prices. The excavation work will be done by the Council's workmen. The question as to the hiring of motors, and also as to the taking over of the electric light station by the Council, is still under discussion.

Cardiff.—An estimate of the cost of street-lighting for the year ended March 31, 1903, was placed before the Cardiff Electrical and Lighting Committee last week. The amount put down for gas was £7,170, as against £7,400, the estimate for the current year—a decrease of £230. Electric light, on the other hand, is expected to cost £2,425, compared with this year an increase of £500. Mr. Harpur, the borough engineer, explained that the differences were caused by electricity being more generally used in place of gas and the extension of the town.

Bermondsey.—The three-day exhibition which has been held at the Town Hall, Spa-road, by the Bermondsey Borough Council to demonstrate to the ratepayers the various adaptations of electricity to modern requirements has proved a great success, and has resulted in a number of new customers being secured for the municipal light. It is reported that many small shopkeepers have been enabled to take advantage of the electric light through the arrangement by which the Council themselves wire the premises and accept payment on the instalment principle.

Spondon.—The Derbyshire and Nottinghamshire Electric Power Company intend to erect a power station in the neighbourhood. Mr. Ford, their engineer, attended the last meeting of the Parish Council, and explained that if the Council desired to use electricity for lighting purposes the company would merely supply the electric power, and the Council would have to lay and maintain their own mains, and before doing this an order from the Local Government Board would be required, which would entail a local enquiry; it further appeared that the cost of laying the main would be from 10s. to 50s. per yard.

Scarborough Telephones.—At the last meeting of the Town Council the Chairman of the Telephones Sub-Committee explained the scheme for municipal telephones which is proposed under the advice of Mr. Bennett, and said it was suggested to charge £5. 17s. 6d. for an unlimited service, with a lower fixed charge plus 1d. or ½d. per call, and this could be easily done if they could get 600 subscribers. They hoped to include Filey, as well as some of the villages round Scarborough, and pending definite arrangements, he appealed to the Scarborough people not to enter into fresh contracts for a telephone service.

Halifax.—The Board of Trade record of the boiler explosions which occurred during the 12 months ending June 30, 1901, is just to hand. There was only one explosion in this district—that at the Corporation electricity works on Dec. 10, 1900, when a Southowram man was scalded to death. From the Board of Trade report it seems that the cast-iron steam-pipe which exploded was used for conveying steam to engines, and was six years old. The part which gave way was the flange. The pipe had not been inspected or insured by any company or association. The cause of the explosion is given as follows: "Insufficient provision for the prevention of strains, aided probably by the impact of water."

Watford.—At a recent meeting of the local tradesmen's association Mr. Charles Brightman read a paper on the electric lighting of Watford. An interesting discussion followed, and it was decided to forward a copy of the following resolution to the Urban District Council: "That in the opinion of this meeting it is desirable to abolish the maximum demand indicator system charge, a fixed rate of 5d. per unit to be substituted, which we think will tend to popularise the light; and that further consideration be given to the question of day loads; also, in view of the present financial position with regard to public lighting by electricity, you should consider the advisability of curtailing further extension."

Frinton-on-Sea.—The Urban District Council have consented to the application of the Frinton-on-Sea and District Electric Light and Power Company, Limited, to the Board of Trade for a provisional order to be granted in the session of 1902 for public and private purposes within the district of the Council, subject to the draft order deposited by the company being amended in the following particulars—viz., provision to be made for the purchase by the Council after 30 years and five years, in lieu of 42 years and 10 years, as provided by the Acts. No roads within the area of supply are to be broken up for laying distributing main during the months of July, August, and September in any year. The deposit by the company has been fixed at £250.

Taunton.—On Tuesday the Electric Lighting Committee presented their annual statement of accounts showing a credit balance of £325, of which they had decided to place £250 to the reserve fund, the balance to be carried forward. The Chairman of the Committee said there had been an increased demand for electric motors, and the committee had earned £114 for hire. They had already received £204 from the tramways company for current. In many other towns electric light undertakings had been obliged to raise the price owing to the increased cost of coal, and it was very satisfactory that they should have been able to make a clear profit without increasing their charges. Now that coal was cheapening they hoped to be able to increase their credit balance.

Whitby.—The Urban District Council have decided to apply for a loan of £750 for wiring and supplying with fittings the premises of private consumers of electrical energy. The resident electrical engineer, Mr. C. W. Kennaway, has submitted the following rates for the public lighting of the streets with arc and incandescent lamps, which have been approved: 31 arc lamps from sunset to 11 p.m., and two incandescent lamps from 11 p.m. till sunrise, £465 per annum, or an average of £15 per post per annum; lamps in Golden Lion Bank,

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Haggersgate, and Grape-lane, £6 per annum each; lamps behind Royal Hotel and in Prospect-hill, £12 per annum each. This gives a total of £507 per annum. Against this must be set off the cost of gas lighting replaced, which comes to £200 per annum.

Hove.—With reference to the provision of a new telephone trunk line between Brighton and Chichester, the Postmaster-General has renewed his application to the Hove Corporation for permission to erect a line for poles, wires, etc., at the side of the Old Shoreham-road, from the bridge over the Dyke railway westwards, to the boundary with the Portslade Urban District Council. This is only a portion of the route for which application was originally made. The Works Committee, before whom the application came, decided to recommend to the Council at their meeting on Thursday that consent be given to the application, provided the Postmaster-General will erect ornamental iron poles, and in the event of the Old Shoreham-road being widened, will shift the poles to other positions.

Middlesbrough.—During the past month 33,355 units were sold, the total revenue being £521. 6s. 6d., and the cost £259. 13s. 1d. There are now 180 consumers with a total of 17,761 lights, and 8 new consumers for a total of 966 lights, making the actual total 18,727 lights. Two consumers, using 80 lights, have been disconnected, leaving the total 18,647. There were 47 applications for a total of 3,534 lights, making the total connected and applied for 22,181. The total load is now 560 kw. Mr. H. W. Clayden, the electrical engineer, has resigned his position consequent upon accepting an appointment in South Africa. The resignation has been accepted and wishes for Mr. Clayden's future success expressed. The vacancy is being advertised at a commencing salary of £250 per annum.

Bath.—A further report of the Electric Light Enquiry Committee has been presented to the Council. The summarised recommendations of the committee are as follows: "(1) That Mr. Manville's scheme of reconstruction be not undertaken at the present time; (2) that immediate steps be taken to obtain the consent of the Local Government Board to carry out the works described in the joint report of Mr. Manville and Mr. Teague, at an estimated cost of £13,371, so as to provide for next winter's load, and to guard against the risk of another breakdown; (3) that meanwhile, in consequence of the applications which have been received, we be authorised to receive detailed tenders for the purchase or hire of the works; (4) that, pending the decision of the Council as to the future of the undertaking, no reduction be made in the number of public arc lamps, but that the charge per lamp be reduced to £24 per annum."

Aberdeen.—An important development in the use of electricity for power purposes has taken place in Aberdeen in the laying of a cable from the new electrical station at Dee Village to the engineering works of Harpers, Limited, Craiginches, with a branch to the works of Messrs. Abernethy. The cable is about a mile in length, and is carried across the River Dee under the Wellington Suspension Bridge by a very clever and ingenious arrangement, which reflects the greatest credit on the skill of the city electrical engineer, Mr. Bell. The cable is conveyed in metal pipes, which are carried on the open work of the cross beams under the roadway of the bridge. The current will be utilised, in the first place, for the working of a 20-ton overhead travelling crane which the firm are introducing. The crane has a span of 35ft. between the rails. It is understood that Harpers, Limited, contemplate gradually extending the use of electricity in the driving of their machinery.

Walmer.—At the last monthly meeting of the Urban District Council a letter from the Kent Electrical Power Company was read intimating that the provisions of the principal amendment secured by the representatives of Kentish authorities would be extended to Walmer, and another from the town clerk of Dover stating that the opposition to the Bill by local authorities had been withdrawn. The Joint Electric Lighting Committee reported that they had discussed the Kent Electric Power Bill and considered its probable bearing upon Deal and Walmer, and it was thought inadvisable that the two towns should join in a petition, as, if certain amendments prepared by the various Kent Councils were passed by the company, the Bill would not injuriously affect the two towns, but, on the contrary, might be of some benefit. With regard to the electric lighting, the committee had received replies from seven electrical engineers stating the fees they required for surveying Deal and Walmer and furnishing a report, and enquiries were being made as to a selected firm. The question of making application to the Board of Trade for a provisional order for electric lighting, etc., was discussed, and it was arranged that the question should be further gone into at the next meeting.

South Africa.—We gather from the *British and South African Export Gazette* that the East London (Cape Colony) Town Council have placed an order for an alternator and engine. The plant for the new power station of the Cape Peninsula Lighting Company, Limited, in course of erection at Claremont, is wholly of British manufacture. The equipment will comprise three turbine-dynamos, the order for which has been entrusted to Messrs. C. A. Parsons and Co., Newcastle-on-Tyne; switchboards, to be supplied by Messrs. Kelvin and White, Limited, London, S.W., and complementary material. The Kimberley Town Council have on order a 80-kw. Belliss-Parker set for the projected extension of their lighting installation. The electric lighting plant of the Red and White Rose mine, Rhodesia, includes, among other items, a 60-kw. generator. Tenders for a large electric power generating plant have been called for for the transmission of power in the railway workshops at Durban of the Natal Government Railways. The Town Council of Johannesburg have been vested with the necessary power to construct and work an electric tramway within the municipal area. We understand the orders for the necessary plant will be placed as soon as the plans are drafted. An automatic feed granite and stone-sawing machine, with two 6-h.p. electric motors, are among the new equipment of the recently enlarged works of Mr. J. McAuslin, Longmarket-street, Maritzburg.

Southport.—The Town Council have resolved that the Postmaster-General be requested to fix the period for the municipal telephone license to expire on Dec. 31, 1912, and to fix the maximum and minimum charges under the license as follows: Service—(I.) For the establishment of telephonic communication between any exchange and the office of any exchange subscriber, and the transmission of an unlimited number of messages of the subscriber to any office on an exchange in the exchange system of the local authority—(*a*) where the office of the subscriber is situate within one mile of the exchange with which such office is immediately connected, maximum £10, minimum £4; (*b*) where the office of the subscriber is situate more than one mile from the exchange with which such office is immediately connected, for every additional quarter mile an additional charge of 10s. (II) (1) For the establishment of telephonic communication between any exchange and the office of any exchange subscriber, exclusive of charges for the transmission of messages—(*a*) where the office of the subscriber is situate within one mile of the exchange with which such office is immediately connected, maximum £4, minimum £1. 10s.; (*b*) where the office of the subscriber is situate more than mile from the exchange with which such office is immediately connected for every additional quarter mile an additional charge of 10s.; (2) where the transmission of messages is not included in the charge for establishing communication, for the transmission of each message of the subscriber to any office on an exchange in the exchange system of the local authority, maximum 1d. per call, minimum ½d. per call. (III.) For the transmission of a message from a call office to any other office on an exchange in the exchange system of the local authority, maximum 2d. per call, minimum 1d. per call.

London County Council.—At Tuesday's meeting of the Council it was agreed to lend the Woolwich Borough Council £1,350 for electric light installation. The following notices under Electric Lighting Acts and orders were agreed to: the Brompton and Kensington Electricity Supply Company, under the House-to-House Order, 1889, of intention to lay mains of high and low tension along a portion of Stratford-road; the London Electric Supply Corporation, under its order of 1899, to lay high and low tension distributing mains across St. Thomas's-street in three places, and along portions of Joiner-street and Dean-street, and to construct underground converter boxes in Joiner-street and Dean-street; the Metropolitan Electric Supply Company, under the Paddington Order, 1890, of intention to lay high-tension mains along a portion of Randolph-gardens; the Mid-London Order, 1889, of intention to lay low-tension mains along Chenies-street, from Tottenham Court-road to Ridgemount-gardens; the St. Pancras Borough Council, under the St. Pancras (Middlesex) Order, 1883, of intention to lay mains along a portion of York-road. Notices under orders granted to local authorities were received as follows: (*a*) dated Feb. 25, 1902, from the Battersea Borough Council, under the Battersea Order, 1896, of intention to lay mains along Wellington-road; and (*b*) dated Feb. 25, 1902, from the Hampstead Borough Council, under the Hampstead Order, 1893, to lay mains along portions of Broadhurst-gardens, Lancaster-road, Goldhurst-terrace, Compayne-gardens, Canfield-gardens, Heath-street, Arkwright-road, Minster-road, Eton-road, Belsize-park, Fitzjohn's-avenue, Lithos-road, Finchley-road, Frognal-lane, Honeybourne-road, Crediton-road. Central-parade, West End-lane and Eton-avenue, and to construct sub-stations in Lancaster-road, Eton-road, and Broadhurst-gardens (12 plans). The course taken by the Historical Records and Buildings Committee in having the necessary works carried out in connection with the defects in the electric light installation at the Horniman Museum, at a cost of £71. 10s. 2d., was approved, and a further expenditure of £15 authorised in connection with the work. Subject to the passing of the annual maintenance estimates for 1902-3, an expenditure of £570 was authorised in connection with the carrying out of certain alterations in the installation of electric light at the Horniman Museum, the work to be carried out under the direction of the chief engineer.

PROVISIONAL PATENTS, 1902.

MARCH 3.

5228. Improvements in continuous-current dynamos, motors, and converters. James Atkinson, Benavie, Marple, Cheshire.

5245. Enclosed arc lamp with four carbons placed vertically and in series, also mechanism. John Gray, 30, Lewisham-road, Dartmouth Park, London.

5263. A portable electric light for sanitary engineers and others to examine drains, tubes, and pipes with. Joseph Edward Doughty, 20, Silchester-road, North Kensington, London.

5290. Improved apparatus for preparing flattened metallic coils for electrical magnets, solenoids, and other purposes. Rookes Evelyn Bell Crompton, 55, Chancery-lane, London.

5292. Improvements in electric igniting devices for miners' and like lamps. Robert Feilendorf, 45, Southampton-buildings, Chancery-lane, London.

5294. Electric rammer for foundry and other use. Denis Arthur Caspar, 53, Chancery-lane, London.

5296. Improvements in automatic checking devices applicable to electric meters. Raphael Chauvin and René Arnoux, 11, Southampton-buildings, Chancery-lane, London.

5312. An improved instrument for measuring differences of temperature, electrical potential, electrical current, atmospheric dryness, and the like. Raphael Chauvin and René Arnoux, 11, Southampton-buildings, Chancery-lane, London.

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5301. Improved lubricant for electrical purposes. Alfred Julius Boult, 111, Hatton-garden, London. (Carl Ulbrich, Germany, and Gustav Pommerhanz, Austria.)

MARCH 4.

5320. Improvements in swivelling contacts for cables used in trolleys or collectors used in connection with electrically-propelled vehicles. Edward May Munro, Henry Brecknell, and Hugh Innes Rogers, Thrissell-street, Bristol.

5323. Improved apparatus for automatically reversing trolley or other current-conducting poles in overhead and underground electrical tramways and railways. Francis Ernest Ward, 11, Burlington-chambers, New-street, Birmingham.

5341. Improved electricity mains. Frederick James Cooper, 100, Wellington-street, Glasgow.

5366. Improvements relating to electric accumulators. Jean Emmanuel Georges Méran, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

5374. Improvements in dynamos, motors, and the like. The Hon. Charles Algernon Parsons, 18, Southampton-buildings, Chancery-lane, London.

5375. Improvements in and relating to the winding of the field magnets of dynamo-electric machines and other apparatus. Francis Lauder Muirhead and John Parr, 323, High Holborn, London.

5425. An improved trolley pole harp for use in electric overhead traction systems. John Henry Walker, 53, Chancery-lane, London.

MARCH 5.

5464. An improved device for all kinds of regulating switches with single or double contacts, accumulator or shunt switches of every description which provide an instantaneous motion from stud to stud. Albert Reame, 48, George-street, Hull.

5468. Improvements in trolley heads for electric tramcars. Wilhelm Willenbücher, 70, Market-street, Manchester. (Complete specification.)

5483. The combination of electric, magnetic, and carbon microphones. Thomas James Howell, 61, Upper Ground-street, Blackfriars, London.

5505. Improved system of electric lighting for trains or trams, applicable also to other purposes. Henry Leitner and Richard Norman Lucas, 37, Chancery-lane, London.

5512. Improvements in electric cables. George Gatton Melhuish Hardingham, Clun House, Surrey-street, Strand, London. (Felten und Guilleaume Carlswerk Actiengesellschaft, Germany.)

5530. Improvements in apparatus for measuring and indicating an electricity supply. Charles Hesterman Merz, 46, Lincoln's-inn-fields, London. (Complete specification.)

MARCH 6.

5536. Improvements in electricity meters. Knowles Anderson, 65, Albion-street, Leeds.

5560. Improvements in and connected with electric tramcars. Benjamin North, Sunbridge-road, Bradford.

5592. An electric self-registering target. William Griffith Williams and Herbert Henry Edwards, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Aug. 20, 1901, being date of application in Queensland.) (Complete specification.)

5603. Improvements in or connected with electric cables or conductors and casings therefor. George Edward Heyl-Dia, 6, Lord-street, Liverpool.

5610. An improved form of high-frequency apparatus commonly called a d'Arsonval coil. Alfred Charles Cossor and William Underhill Hilliar, 54, Farringdon-road, London.

5618. Improvements in or connected with wireless telegraphy. Julio Cervera (Baveria), Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

MARCH 7.

5647. Improvements to safety clutches used on hoists, davits, arc lamps, or any haulage gear. Albert Ernest Carter, 64, Church-street, Brighton.

5651. Improvements in guard wires used in connection with electric traction trolley wires. Frederic Smith, 17, St. Ann's-square, Manchester.

5654. Electric trolley wire finder. Thomas Corser, 9, Blackfriars-street, Manchester.

5656. An improved safety guard or obstruction remover to be used in connection with electric tramcars and the like vehicles. Henry Stephenson Hunt, 6, Finkle-street, Stockton-on-Tees.

5663. Improvements in electrical fuse boxes. Lawrence Maxwell Waterhouse and the Simplex Steel Conduit Company, Limited, 34, Castle-street, Liverpool. (Complete specification.)

5668. Improvements in or applicable to pendants for incandescent electric lamps. William Royston Laidlaw and George Hamer Scholes, 70, Deansgate, Manchester.

5670. Improvements in automatic apparatus for controlling and operating the points of electric railways and tramways. Thomas Bell Stewart, William Herbert Turner, and Rowland Edward Dixon, 8, Quality-court, Chancery-lane, London.

5702. Improved brake and speed controller for electrically-operated cars. John Adam Thümling, 322, High Holborn, London.

5711. Improvements in driving devices for electrical purposes. Jacques François Jacob, 40, Chancery-lane, London. (Complete specification.)

5713. An improved electromagnetic igniter for explosion motors. Theodor Bergmann, 40, Chancery-lane, London. (Complete specification.)

5715. Improvements relating to electrolytic cells. Phillippe Auguste Guye, 45, Southampton-buildings, Chancery-lane, London.

MARCH 8.

5735. Improvements in or relating to electrolytic interruptors for X-ray work. Harry William Charles Cox, 10, Cursitor-street, Chancery-lane, London.

5743. An improvement in or in connection with the trolleys of electric tramways. William Edward Layland and Charles William Dawson, 30, Park-row, Leeds.

5759. Improvements in apparatus for electric tramcars and other cars for cleaning the rail metals, removing obstructions, preventing oscillation with concussion guard, and auxiliary brake to modify accidents. Robert James Plunkett, Victoria Lodge, Wells-road, Bristol.

5779. Improved construction of controller for electric lifts, tramcars, and other moving bodies. Robert Falkland Carey and J. Richmond and Co., Limited, 173, Fleet-street, London.

5786. Improvements in reverse electric current relays. British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

5797. Improvements in apparatus for wireless telegraphy. Marconi's Wireless Telegraph Company, Limited, and Andrew Gray, 24, Southampton-buildings, Chancery-lane, London.

5802. An improved electrical safety fuse appliance. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktiengesellschaft, Germany.) (Complete specification.)

5804. Improvements in wireless electric selecting systems. Louis Heathcote Walter, 83, Holland Park-avenue, London.

5812. Improvements in liquid resistances or switches for electrical purposes. John Harold Woolliscroft, 55, Chancery-lane, London.

5818. An improved arrangement for the prevention of pulsations and sudden alterations in periodicity in alternating-current generating plants. William Edward Evans, 27, Chancery-lane, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

5819. Improvements in electric and other power hoists and cranes. Joseph Holt, Charles Holt, and John William Powell, 128, Colmore-row, Birmingham.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published March 27.

1901.

2238. Toll apparatus for telephones. Baird. (Date applied for under International Convention, July 2, 1900.)

4819. Device for connecting the trolley with the trolley wire in electrically-driven vehicles. Weintz.

5038. Incandescent electric lamps. Mance and Nernst Electric Light, Limited.

5040. Nernst incandescent electric lamps. Garrard and Nernst Electric Light, Limited.

5265. Recovery of precious metals by electrolysis. Webb, Lilley, and Chapman.

5421. Means for converting alternating electric currents into direct currents. Nodon. (Date applied for under International Convention, Aug. 17, 1900.)

5460. Prepayment meters for the supply of electricity. Finlayson and Scott.

6161. Method of and apparatus for controlling single-phase alternate-current motors. Siemens Bros. and Co., Limited, and Lydall.

6358. Electric ignition devices for internal-combustion engines. Aldridge and Linley.

9011. Electro-deposition of metals for the manufacture of compound wire bars and the like and apparatus therefor. Sanders.

9187. Electrical accumulators. Elieson and de Bobinsky.

9279. Trolley poles of electric cars and the like. McCullough, Blaney, and Baron.

9611. Trolley heads for use in connection with the overhead system of electric traction. Metcalfe.

11120. Galleries or holders for gas, electric light, oil lamp, and like globes or shades. Wyler.

19136. Cover for electric cells. Vogt.

21602. Polarised electromagnetic devices. Cerebotani and Moradelli.

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24449. Dynamo-electric generators and motors. Everett.

26702. Controlling devices for connecting storage batteries with a charging circuit. Stover and Suren.

1902.

609. Electrical switches and cut-outs. Hall.

1496. Electric switches. Berry, Simon, and Skinner.

2159. Electric fuses. Shawfield and Wetmore.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	Mar. 1	553	562	− 8	28,579	26,454
Birmingham Tramways	—	—	—	—	—	—
Blackburn Corporation	,, 7	699	546	+ 153	5,737	5,036
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 8	199	166	+ 33	1,521	1,394
Bolton Corporation	,, 9	1,410	1,331	+ 79	11,959	11,228
Bradford Corporation	,, 9	2,611	841	+ 1,770	16,948	7,541
Bristol Tramways Company	,, 7	4,882	3,753	+ 1,129	—	—
Carlisle Tramways Company	,, 8	126	120	+ 6	1,160	1,068
Central London Railway	,, 8	6,757	5,855	+ 902	66,113	60,662
City and South London Railway	,, 9	3,071	2,067	+ 1,004	30,472	20,198
Cork E. T. and L. Company	,, 6	372	343	+ 29	3,146	3,190
Darwen Corporation	,, 7	197	164	+ 33	1,655	1,493
Darwen-Hoddlesden	,, 7	30	—	—	—	—
Dover Corporation	,, 8	166	159	+ 7	1,609	1,533
Dublin & Lucan Electric Railway	,, 9	81	68	+ 13	814	711
Dublin U. T., electric cars	,, 7	3,373	3,154	+ 219	—	—
Dublin S. District, Electric	,, 7	741	647	+ 106	—	—
Dundee Tramways Company	,, 5	647	470	+ 177	—	—
Glasgow Corporation	,, 8	10,765	8,239	+ 2,526	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 8	1,606	1,555	+ 51	82,414	68,244
Liverpool Corporation	,, 1	8,866	7,790	+ 1,076	77,517	69,859
Liverpool Overhead Railway	,, 9	1,401	1,507	− 106	13,609	14,695
Newcastle-on-Tyne Corporation	,, 8	1,889	—	—	—	—
Portsmouth Corporation	,, 8	1,108	531	+ 577	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 9	3,805	—	—	—	—
Southampton Corporation	,, 6	782	625	+ 157	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £387 decrease.
Barcelona Ensanche y Gracia, £3 increase. Barcelona, £378 increase.
Brisbane, £583 decrease (month of Feb., £1,341 increase).
Buenos Ayres and Belgrano Electric, £136 decrease.
Calcutta, £20 decrease.
Cape Town (month of Feb.), receipts, £15,896; expenditure, £6,780.
La Capital Traction and Electric, Buenos Ayres (month of Dec.), £1,394 increase.
Mexico Electric (month of Feb.), receipts, £16,500; expenditure, £9,800.
Perth Electric, £166 increase.
Port Elizabeth (month of Feb.), receipts, £3,559; expenditure, £1,784.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Tramways.—	£	£
Anglo-Argentine, 1-260,007	5 ..	4-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	124-127
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2⅞-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6⅞-7¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9⅝
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-103 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13-14
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12½-12⅝
—— 5 per cent. Perpetual Debenture Stock	100 ..	126-129
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅜-1⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11-12
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¾-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	102-104
New General Traction, Ordinary	5 ..	2½-3¼
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10⅝
—— 5 per cent. Cum. Pref.	10 ..	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	98-101
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	10¼-11¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	10s. ..	¼
—— £250,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	50 p.c. ..	50 p.c.

Name.	Amount paid.	Last price
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅝-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¼-⅜
—— Ordinary, 1-125,000	1 ..	⅜-½
British Insulated Wire, Ord., 1-70,000	5 ..	9½-10½
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¾-6¼
—— 5 per cent. Mortgage Debentures	100 ..	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5¼-6
Brush Electrical Engineering, Ordinary	2 ..	1⅜-1⅝
—— Nos. 90,001-105,731	2 ..	1⅜-1⅝
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-2⅛
—— 4½ per cent. Debenture Stock	100 ..	101-104
—— 4½ per cent. 2nd Debenture Stock	100 ..	97-100
Callender's Cable, Debentures	100 ..	111-115
—— Ordinary	5 ..	17¼-18¼
—— 5 per cent. Pref.	5 ..	5¼-6
Crompton and Co.	3 ..	3-3¼
—— 5 per cent. Debentures	— ..	99-104 p.c.
Edison and Swan United, Ordinary	3 ..	1⅝-1¾
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	78-83
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	83-88
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1⅜-1⅞
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9⅜-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	99-102
W. T. Henley's Telegraph Works, Ordinary	5 ..	17½-18½
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15½-16½
Telegraph Construction and Maintenance	12 ..	37-40
—— 5 per cent. Bonds	100 ..	102-105
Telegraph Manufacturing, Ordinary	5 ..	10½-11½
—— 5 per cent. Cum. Pref.	5 ..	5½-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	9½-10½
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	100-105
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9½-10⅛
—— Debenture Stock, Red.	100 ..	103-106
Brompton and Kensington, Ordinary	5 ..	9-9½
—— 7 per cent. Preference	5 ..	9-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	8-9
—— Nos. 20,001-30,000	5 ..	7½-8¼
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14¼ xd
—— ,, ,, £10 Ord.	6 ..	10¾ xd
Charing Cross and Strand	5 ..	8½-9½
—— 4½ per cent. Cum. Pref.	5 ..	5½-5⅞
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	104-106
Chelsea Electricity Supply	5 ..	5-5½
—— 40,501-50,936	5 ..	4⅜-5¼
—— 4½ per cent. Debentures	100 ..	110-113
City of London, Ordinary	10 ..	9-10
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	8½-9¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6-6½
—— 6 per cent. Cum. Pref.	5 ..	6-6½
—— 4½ per cent. First Mort. Deb.	100 ..	106-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-4⅜
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10¼-11¼
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-2
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	95-100
Metropolitan, Ordinary	10 ..	15-16
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9½
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	14½-15½
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7¼-8
—— £4½ Shares, New	4½ ..	6¾-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	98-101
River Plate Electric Light and Traction, Deb.	100 ..	65-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1⅜-2⅛
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-2½
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	98-101
Westminster, Ordinary	5 ..	11½-12½
Electric Railways.—		
Central London, Ordinary	100 ..	102-105
—— 4 per cent. Pref.	100 ..	103-106
—— ,, ,, deferred	100 ..	99-102
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-118
City and South London, Consolidated Ordinary.	100 ..	65-68
—— Ordinary	10 ..	—
—— Nos. 60,001-70,000	10 ..	—
—— 4 per cent. Debenture Stock	100 ..	112-116
—— 5 per cent. Pref. Stock '91	100 ..	128-133
—— ,, ,, '96	100 ..	122-126
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	92-95
Telephones.—		
National Telephone, Ordinary	5 ..	—
—— 6 per cent. Cum. First Pref.	10 ..	13-15
—— Preferred, 590,001-790,000	2 ..	1⅜-1⅝ xd
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-5¼
—— 4 per cent. Deb. Stock, Red.	100 ..	93-96
—— 3½ per cent. Deb. Stock, Red.	100 ..	101-105
Oriental Telephone and Electric Company	1 ..	¾-1

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Supplement to "The Electrical Engineer,"

MARCH 14, 1902.

THE BERLIN ELEVATED AND UNDERGROUND ELECTRIC RAILWAY.

(*Concluded from page 334.*)

Both the motorcars and the other car are of the bogie-truck type, with spring couplings. Only in regard to the interior arrangement and equipment of the car body does the centre car differ from the motorcars. The motorcars are intended for third-class passengers, and the centre car for second-class. The extreme length of the car body is 39·36ft. The weight of the empty motorcar amounts to about 17·73 tons, and its weight when full to about 21·67 tons. The body of the car is carried by two longitudinal iron girders of ⊏ section, which are connected by transverse girders of similar section, the whole forming a stiff frame. The skeleton of the car body is of wood, the underframe, which is secured to the longitudinal iron girders, carrying the corner and intervening uprights. and two at the rear end of the train. The lamps of each car are arranged on two circuits, so that the failure of one need not entail a total failure of the lighting. Candles are also provided for lighting the interiors of the cars in an emergency. Both motorcars are equipped with contact shoes, through which current is conveyed to the motors and lighting circuits. In order to maintain an uninterrupted supply when passing over crossings, contact shoes are provided on either side of the cars, the centre car being similarly equipped in this respect.

The driving cab is quite shut off from the rest of the motorcar, so that the driver may concentrate his whole attention to the track ahead and the controlling gear. In the driving cab is also placed the brake valve for the air-brakes, together with a manometer. A bell serves the purpose of a warning signal for ordinary use, but a whistle is added for emergencies. The bogie wheels are of the wrought-iron open-spoke type, the diameter of the runner being 2·78ft. The frames of the bogie trucks overhang

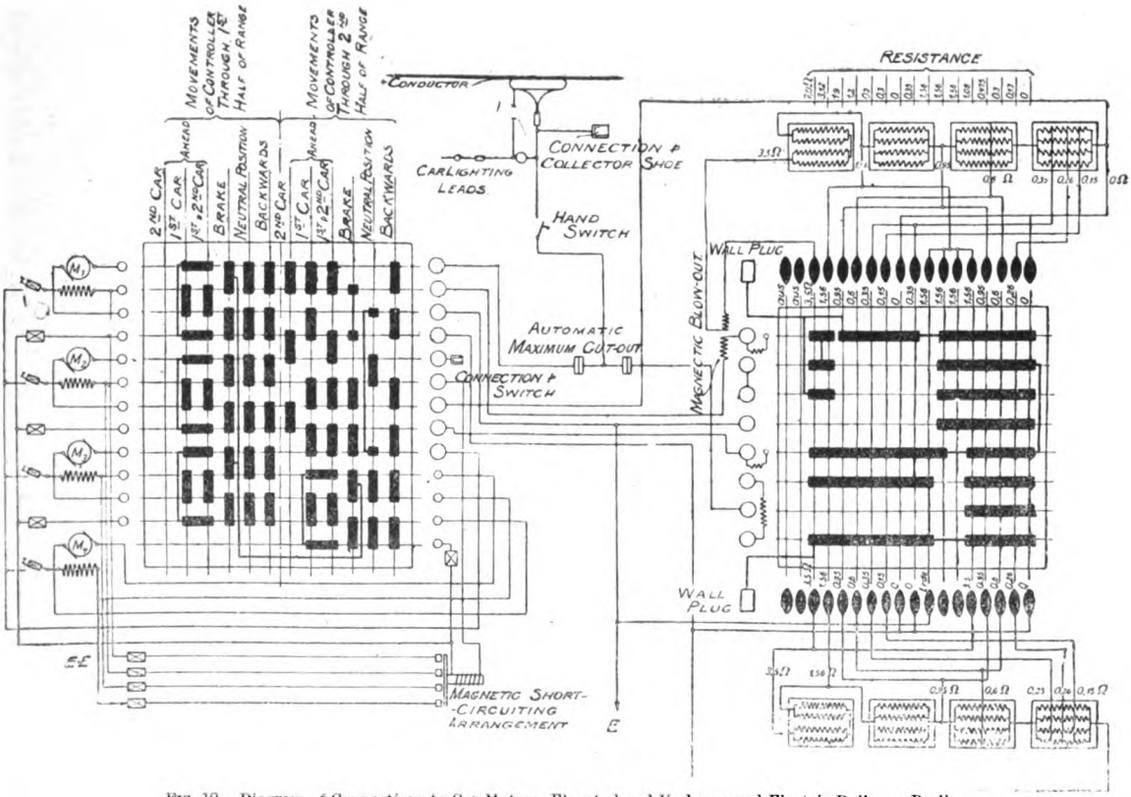

FIG. 12.—Diagram of Connections to Car Motors, Elevated and Underground Electric Railway, Berlin.

Two doors are provided at each side of the car, which give access to the end vestibules, as clearly shown in Fig. 9. In order to facilitate ingress to and egress from the car, one vestibule will be used by the passengers boarding the car, while the other vestibule will serve for those leaving the car. Each centre car provides seating accommodation for 44 second-class passengers, and each motorcar for 39 third-class passengers, there being also standing room in the centre gangway and vestibules of each car for 57 passengers. The combined drawbar and spring coupling arrangement is shown in Fig. 9. The coupling is of the screw type. The ventilation of the car is provided for by means of roof windows, of which there are 12 on each side. These windows are movable round a vertical axis, and may be so arranged as to obtain a constant current of fresh air through the front windows, while the vitiated air escapes at the back. The cars are electrically heated, the radiators being placed under the seats. The interior of each car is illuminated by means of 12 incandescent lamps, which receive their supply of current from the conductor rail. Two signal lamps are carried in front the wheels, and are strengthened by means of ⊏ and ⊔ iron girders, which serve at the same time for the suspension of the springs, to which the weight on the axles is transferred. The oscillations of the train are taken up by

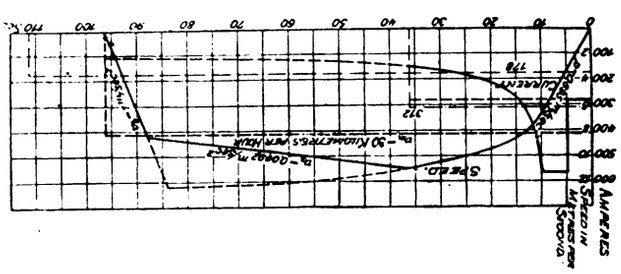

FIG. 13.—Acceleration Curve of Train on Level Track.

spiral springs provided with rollers, which allow the car body a certain amount of play relative to the bogies. Each bogie is equipped with a four-block brake, which may be actuated by means of compressed air, and also by hand

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from the motorcars. Provision is also made whereby each train may be brought to a standstill by short-circuiting the motors of the leading car. The hand-brake is intended for use only when individual cars are being shunted. This brake is of the spindle type, similar to those employed on street cars. For regular use the air-brake is provided. The brake cylinder and the air reservoir, together with the air-pipes and compressor pump, are arranged beneath the underframe of the car. The air-compressor is driven by an electric motor, which is arranged together with the compressor under one cover. Current for driving this motor is conveyed through a hand switch and fuse from the main supply to the train. The brake rods are attached partly to the underframe and partly to the bogie trucks. To prevent an accident in the case of the fracture of a rod, the bogie trucks are provided with means to catch the broken ends. The brakes are designed for a maximum pressure equal to 70 per cent. of the rolling weight, which amounts to 12·6 tons in the case of the motorcar and 9·1 tons in the case of the centre car.

Each motorcar is to be equipped with four continuous-current motors—that is to say, one to each axle—the drive from each motor being transmitted to the corresponding axle through toothed wheel gearing. The motors are of the four-pole type, their size and capacity being proportioned to give the train a maximum speed of 31 miles per hour. The cover of each motor is provided on one side, parallel to its axis, with two bearings, which embrace the axle, while the opposite side is firmly screwed to an iron plate, attached by means of springs to the bogie truck. The screws are subjected only to a pulling strain, as the catches attached to the motor cover, and resting on the iron plate, prevent any shearing stress; thus the motor is supported on two sides, while its weight is for the most part taken by the iron plate, so that the axle is practically free.

So long as only one centre car is attached to each train each motorcar will be equipped with only three motors. The fourth motor will not be required until two centre cars are attached to each train, as is intended later on. A diagram of the connections to the car motors and auxiliary apparatus is shown in Fig. 12. The controlling gear of each motorcar is arranged for four motors, but for the present is used for three only. The motors of each car are always in parallel, and at full speed the whole of the eight motors comprising the equipment of the train are connected in parallel. In starting, however, the four motors of the leading car are grouped in parallel with each other, but in series with the four motors attached to the rear car and with the starting resistances. The switch gear of each motorcar comprises two controllers, one a motor controller, and the other, which is shown on the right in the accompanying diagram (Fig. 12), a resistance controller, or rheostat. These two controllers are connected to work in unison. The motor controller is constructed in two halves, and is provided correspondingly with two rows of contact studs. The resistance controller has two wall plugs, above and below respectively, and a number of contact studs. The wall plugs serve to form the connection between the resistances and contact studs of each half

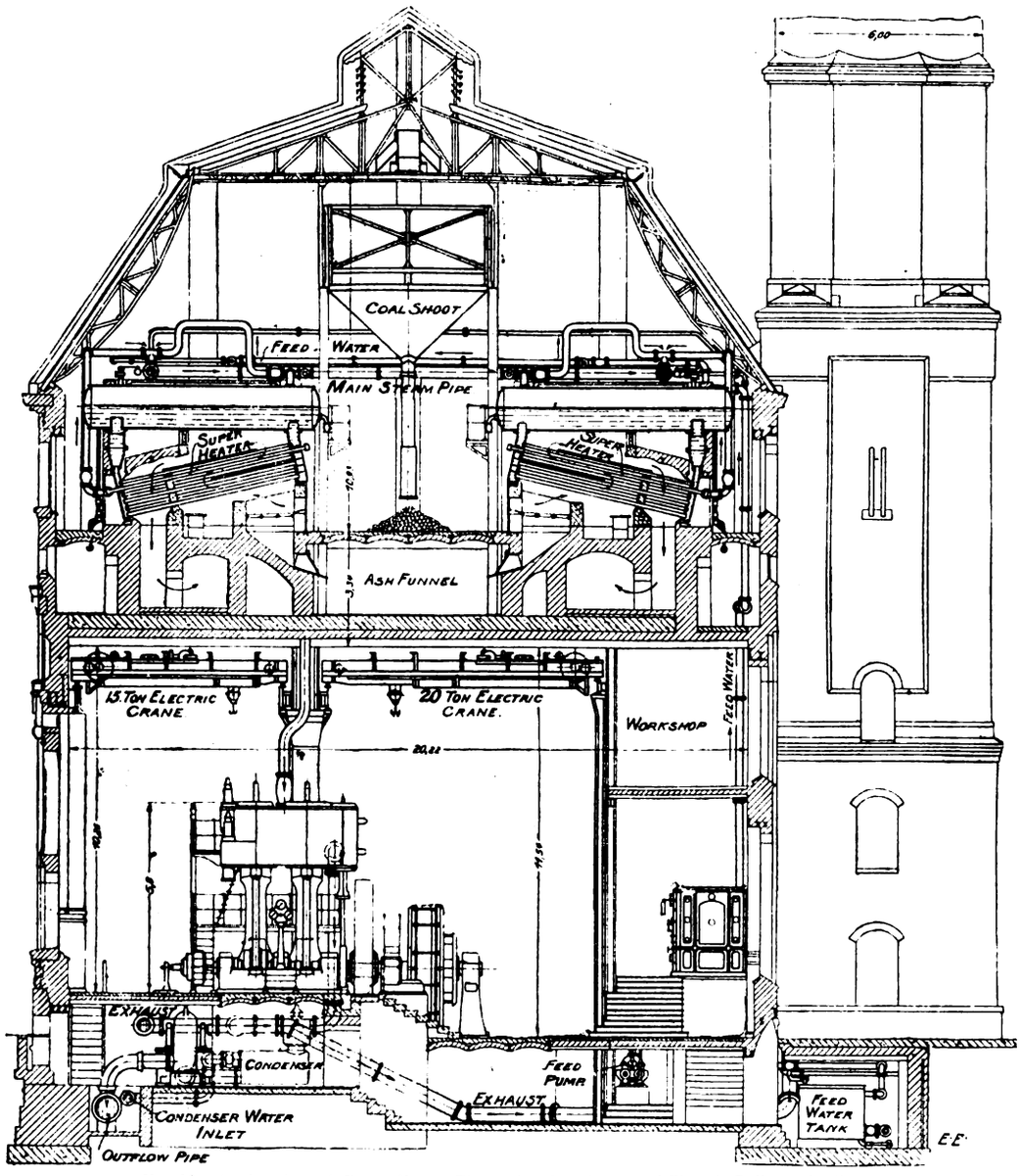

Fig. 14. Section through Power House, Elevated and Underground Electric Railway, Berlin.

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and the motor controller. The controller wheel can be taken off only when the motor controller is in the neutral position, in which position the motors are switched in, but can obtain current only if the cable connected with the controller coupling is carrying current, and not when the current comes direct from the conductor. Hence the motors are cut off from a direct supply of current from the conductor in the neutral position of the controller. If the motor controller of the rear car be left in the neutral position, where it must be before the hand-wheel can be removed, the motors attached to this car will then be in a position to take current when it is conveyed to them from the leading car through the connecting cable attached to the controller coupling. Should, however, the motor controller of the leading car be also in the neutral position, the contact stud, marked *c*, will receive no current. In order to start, the controller in the front car must first be brought to the position marked "Cars 1 and 2" in the diagram, and the resistance controller to the first contact. Thereupon the current will flow from the conductor into the contact stud *e*, through the corresponding contact piece of the motor controller into the contact stud *f*, and hence through the magnetic blow-out into the first contact stud of the resistance controller, through this and the wall plug into the series-connected resistances, then through the motors of the first car, through contact stud *c* into the controller coupling and through the connecting cable into the contact stud *c* of the rear car, from this through the contact stud corresponding to the neutral position into the contact stud *g*, and then through all the motors of the rear car, and finally to earth. In working the resistance controller through its entire range, the resistance is gradually cut out when all the motors are paralleled in the usual way, at first with resistance in series and finally without this. By means of this arrangement it is possible to control all the motors attached to the train from the leading cab, and indeed, by the employment of but two connecting cables, which are taken to the points in the diagram (Fig. 12) marked respectively "Connection to collector shoe," and "Connection to switch." In Fig. 13 is shown the acceleration curve of the train on the level for the mean distance between stations of 860 yards. The rolling weight is taken at 64 tons, the acceleration being 2·5ft. per second and the maximum speed attained 36·3ft. per second, which corresponds to a mean speed of 18·64 miles per hour. The retardation effected by the brakes is 3ft. 3in. per second. As indicated by the dotted portion of the curve, the maximum speed can be increased to over 39·5ft. per second, whereby it is possible to make up time for delays. The pressure in the conductor rail averages 700 volts. The ratio of the gearing is 1 : 4·14, and the consumption of energy per ton-mile = 62·1 watts.

The details of the power-house are shown in Figs. 14 and 15, the connections to the main switchboard being shown in diagrammatic form in Fig. 16. On the ground floor the steam-driven generators and the switchboard are placed, while the boilers are installed on the first floor, as shown in Fig. 14. Coal is conveyed from below by a conveyor. Water for the boilers and condensers is taken from an adjoining canal. A repairing shop is provided above the switchboard gallery as shown. The engine-room is served by two electric cranes of 15 tons and 20 tons lifting capacity respectively. The chimney shaft has an extreme height of 260ft., but of this height only 211ft. is utilised owing to the position of the boilers. At present there are installed six water-tube boilers, designed for a working pressure of 150lb. per square inch and having a heating surface of 2,474 square feet each. Superheaters enable the temperature of the steam to be increased to 225deg. C. By means of valves these superheaters may be filled with water and employed for generating steam in conjunction with the other parts of the boilers. The feed water is provided by two steam-pumps,

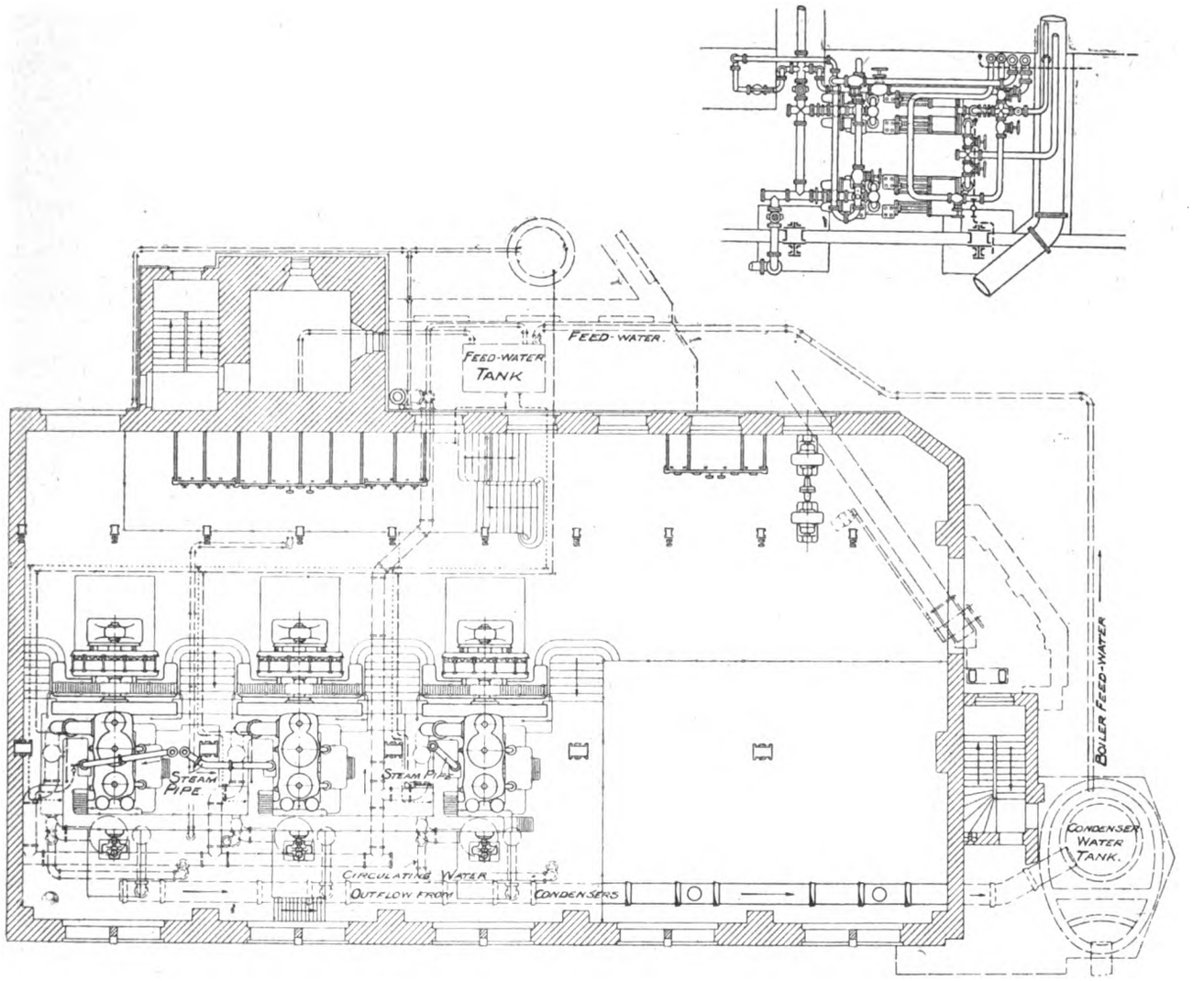

FIG. 15.—Ground Plan of Power House, Elevated and Underground Electric Railway, Berlin.

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each having a capacity of about 11,700 gallons per hour. The steam-pipes are arranged on the ring system, and consist of Mannesmann tubes and cast-iron bends with wrought-iron flanges.

Three dynamos are installed of the multipolar continuous-current shunt-wound type by Messrs. Siemens and Halske. Each has an output of 800 kw. at 750 volts terminal pressure. The disposition of the machines is shown in Fig. 15. The current generated is conveyed from the dynamos through iron-armoured, lead-covered cables to the main switchboard, and from there to the feeders. The latter are provided with the usual automatic maximum current cut-outs. Further, all the conductors have fuses in circuit with them. The switch gear for the booster machines and the lighting and buffer batteries is mounted on a separate board, which is connected with the main board by cables (see Fig. 16). The boosters provide the excess pressure necessary for the charging of the buffer battery, and are also used for charging the lighting battery, etc. The buffer battery is capable of fully taking the place of one of the main generating sets for the period of an hour, and of temporarily supplying a much larger output. It is housed under three arches of the viaduct carrying the elevated railway. The engines are direct-coupled to the dynamos. They are of the vertical compound condensing type, with cylinders of 2·62ft. and 4·16ft. diameter respectively. Running at 115 revolutions per minute, with a steam pressure at the stop valve of 135lb. per square inch, each engine is capable of developing a normal output of 900 h.p. and a maximum output of 1,200 h.p The weight of the flywheels amounts to 32 5 tons each. Adjoining each flywheel there is a starter, which is driven by means of transmission gear from a 20-h.p. electric motor which serves the three starters. These starters stop automatically directly the incoming machine attains to a speed which is quicker than that of the motor. The feed-pumps and condensers are placed as shown in Fig. 14 The air-pumps and condensers are driven direct by the machines to which they belong. The drawings reproduced herewith make further explanation of the engine-house arrangements unnecessary.

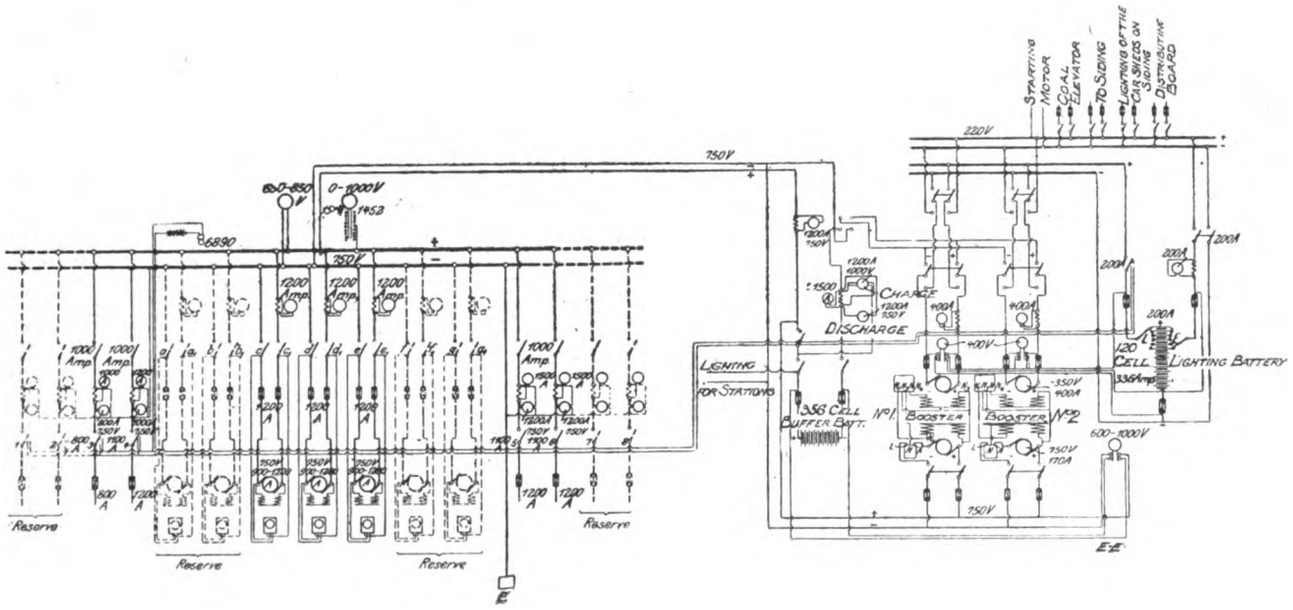

FIG. 16.—Diagram of Connections to Power House Switchboards, Elevated and Underground Electric Railway, Berlin.

REMINISCENCES OF WORKSHOP LIFE.

BY A CENTRAL-STATION ENGINEER.

It seems only yesterday that, big with hope, I entered the door of an engineering works and started life as an apprentice to machine work and fitting, and to the erection of locomotives. I say big with hope, because I thought, as so many do, that when I was out of my time I should find a post as a manager at once—how and where I did not trouble to consider. The glory of paying a premium carried a halo of its own, and seemed of itself to be a sufficient guarantee that a prosperous career awaited me.

Fresh from a technical college with my brains full of mechanics, physics, and electrical science generally, I had, previous to my apprenticeship at the works in question, looked about with a somewhat perplexed countenance, and wondered what I should do next. While tossed on the seas of doubt, I met a friend one day who asked me how I was getting on. On hearing of my uncertainty, he said with cheerful and confident readiness, "My boy, take my advice! Get your dad to apprentice you at the loco. works. You want to go through the shops, you do. You want some of your college polish taken off!" I took his advice. I worried my father, and at last we interviewed together the manager of the works aforesaid. The manager received us kindly; he said he would be glad to have me, but that, as I was over the age limit for apprentices, he would have to write to his headquarters about it. The delay seemed interminable, and the check added fuel to my desire to enter those realms of bliss—the railway repair shops of the town. To see the locomotives in their undress robes, so to speak, to fathom the depths of that enchanting place the erecting shop, with its row of large doors, through which, as viewed from the station platform, at times could be seen monstrous forms in all stages of repair, to work amongst the cheerful apprentices, whose blithe whistling could oft be heard, seemed to me to be the ideal of enjoyment, and my impatience to receive the letter from headquarters knew no bounds.

At the risk of making a long digression, I should like to say that from a small boy I had always felt a great attraction for locomotives, and many an hour had I spent at the railway station or its vicinity. Scarce one of the iron steeds that passed through was unknown to me, their class, style of painting, and distinctive numbers were alike familiar. I knew the stately single-driver, I knew the fussy six coupled saddle-tank. I had watched with deep regret the older class of locomotives, with their peculiar bell-mouthed funnels, their low squat boilers, their large domes with Salter's balance valves, gradually disappear from the scene. They passed away and gave place to a sturdier rising generation, for whom at first I had no small dislike. I cared not for the high boilers of the newer locomotives, their short bull-dog funnels, their single frames, their side rods spoke-coupled—to coin rather a doubtful expression. I mourned the air of gravity that pervaded the older class, their hesitation in starting, their steady gathering up of speed; and when running, their rods would whisk round like giant arms on outside cranks, chocolate or red, clanking fitfully when the bushes were worn. I used to watch with interest the evening express arrive at the station with a stylish single-driver at its

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head: a pause of a few moments, then the green light is shown, and the driver opens the throttle. The white feather is flying at the pops, the steam betrays too much enthusiasm; the pistons, impelled as if by fear, force round the tall drivers, which skid unreservedly, and the sparks fly at an angle of 15deg. to 20deg. either side of the rails. The steam is checked at the regulator, the stoker rattles the sand gear, and the adhesion between wheel and rail is restored. Friction, that troublesome factor in laboratory experiments on mechanics, the rock on which the lazy student splits when, having wasted all the afternoon, he attempts to fake the figures to give a realistic touch to the results of his experiments—friction here comes out strong. Steam being obdurate, adhesion tenacious, something has to give, so the train meekly starts moving, not without sundry strainings as if in anguish. By the way, a train must be very conservative, or lazy in disposition, or else the brake blocks cling too kindly to the wheels, and will not shake loose, for there is always a great disinclination shown to moving, a desire to stay where it is, a wish to let things be. Some drivers seem to apply a steady haul, a strong and firm constrainment; others rely on a little jerk, a sudden call to activity, which often causes a lot of wrath amongst old ladies who are trying to fix or have just fixed 2ft. hatboxes upon 9in. racks.

Seeing that I had a decided enthusiasm for locomotives, it may easily be imagined what my feelings were on receiving word that I could start at once on my month's trial—on my month's probation to the order of engineering. In a new and very stiff vesture of canvas, vulgarly called slops, and in an exalted frame of mind, I—the youthful neophyte—followed the foreman into the works a few days after the letter had been received. I was put under the care of an old gentleman—a white-haired machinist of venerable aspect, who had the thankless task of instructing raw apprentices how to work a planing machine, how to manipulate deftly a little shaper, and how to guide the side nose tool of a slotter so that the belt would not come off "sudding," or the tool rasp out a rugged channel in a brass axle-box with a noise like a housewife tearing calico, only more grating and more prolonged. I soon picked up my duties, not before I had, however, brought a slide valve or two off the bed of the planer, narrowly missing getting my foot lamed for life. Beyond the slight difficulty experienced at first in grinding my tools properly or holding them steadily against a grindstone that had a trick of wearing most unevenly and of developing an eccentricity of at least 5 per cent. of its diameter (at least, so it appeared when holding the tool against it), I found that the work was easy enough.

My month's trial being up, I was called into the office of the manager. My father was present, and the ceremony assumed a kind of solemnity. When the clerk cleared his throat preparatory to reading the indentures, I began to feel as if I was on the eve of some great event! It is said that it is but a short step from the sublime to the ridiculous, and it certainly seemed so here, for as the clerk proceeded with his monotonous recital, and as the expressions "said" and "aforesaid" chased each other with a stubborn regularity, I could not but smile at the obvious discomfort of my paternal relative. He was striving to conceal the irritation he felt at the somewhat hesitating way the clerk delivered the text of the legal instrument. I remember to have had a vague idea of deciding to rebel against the usual porridge for breakfast when I heard the indentures solemnly declare that I was to be provided with due and proper food for my sustenance. The restrictions against marriage I recked not of; the possibility of my wanting to take such a step as to marry before I was 21 appeared quite remote, and I believed my wishes would not clash with the bond in this particular.

At last I was duly bound, and as duly importuned by my fellow-workmen for my footing. After satisfying the craving of the machinists for money—doubtless to give to charity—and for tobacco, so that they could smoke my health, I was confronted with an unexpected extortioner, a spectre that could not easily be laid. From the blacksmiths' shop adjacent came a striker—lean, whiskered, and threatening. "Was I so mean," he demanded, "as to defraud a poor but honest man of his due? Why had I not given him the price of a pint, an ounce of twist, or half a cake of Sweet William?" For the moment I was confounded; answer at first had I none! I was at the end of my cash, and my credit was shaky. I temporised, and sent him away with promises and with a heaven-felt benediction none the worse that it was outwardly suppressed and only distinguishable in my inner consciousness. Strangely enough, that man never demanded the fulfilment of my promises; he never renewed his importunities. Either for once he showed mercy, or else the matter slipped his mind; if the latter, it is the most curious instance of forgetfulness that I have ever come across in such cases. Soon after that a new apprentice appeared on the scene, and all we apprentices moved up one—that is to say, each youth left the machine he was in charge of and took the next in order of dignity, or moved to the fitters' bench or the erectors' trestle.

The new apprentice hailed from a village not far off, and by the name of the village he was usually known. The first day he arrived I was instructing him how to manage the planer I had vacated, how to set the work on the bedplate and test the truth of it with an antiquated and not over-true square, when I noticed him searching under the machine with a puzzled air, and asked him what he wanted to know. Pointing to the connecting rod of the machine, which, coupled to a sort of horizontal disc with a radial slot in it to vary the length, pulled and pushed the moving plate on which the work was fixed, he said, "I can see the engine, but I can't tell where the boiler is!" The idea of looking under a planing machine to find a boiler, and mistaking the machine itself for an engine, struck me as being rather rich.

(To be continued.)

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Question No. 456.—I have a boiler which is constantly priming. Can any reader tell me the best means of determining the quantity of water in the steam?

Best Answer to No. 456 (*awarded* 10*s.*).—*Priming* is the carrying over of particles of water from the boiler which have never been turned into steam. This is very troublesome, as the small particles form a nucleus, around which further condensation takes place on the smallest provocation. The following are the principal causes of priming: (*a*) Activity of ebullition, small particles of water being dragged up with the bubbles of steam. This may be due to bad design of boiler, the area of the water surface or the volume of the steam space being too small for the work the boiler has to do. This might be cured to some extent by fitting dash-plates in the steam space. (*b*) Position of steam valve. This should be at the very top of the boiler (not the side), and as far away from the furnace as possible. (*c*) Dirty water—*i.e.*, presence of solid matter and salts. (*d*) Irregular demand for steam. Rapid fluctuations of load tend to cause priming even in well-designed boilers.

The bad effects of priming may be cured to some extent by a separator close to the engine. Suppose in a pound of "wet" steam we have x pounds of steam and $1 - x$ pounds of water, then x is known as the *dryness fraction of the steam*, and this can be measured by a *steam calorimeter*. Now, the total heat of evaporation in British thermal units of a pound of this steam will be

$$H = S + x L,$$

where S = sensible heat $(t_1 - t_2)$, and L = latent heat at t_1, which = $966 - \cdot 7\ (t_1 - 212\text{deg.})$,

$= 1{,}114 - \cdot 7\ t_1$.

The first form of steam calorimeter used was the "barrel" calorimeter. This was simply a closed wooden barrel containing a known weight of water and carefully lagged. The whole thing was placed on a weighing machine, and a sample of the steam to be tested was passed in through P for some little time, and the increase of weight noted. This increase will be the weight of the sample. We estimate as follows:

Heat given up by sample = heat gained by water,

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Let W_1 = weight of *water* before mixing.
W_2 = „ „ after „
x = dryness fraction.
L = latent heat of dry saturated steam at initial temperature of sample. If t degrees F. be this temperature = 966 - ·7 (t degrees – 212).
S = sensible heat of steam in sample (t degrees – 32).
S_1 = sensible heat of water in barrel before the experiment. This = (t_1 degrees – 32).
S_2 = sensible heat of water in barrel after mixing—*i.e.* (t_2 degrees – 32).

Now, heat given up by sample of wet steam

$$= (W_2 - W_1) \times ((S - S_2) + x\,L).$$

Heat absorbed by the water = $W_1 (S_2 - S_1)$.

Equalising these two and simplifying out, we have

$$x = \frac{\frac{W_1 (S_2 - S_1)}{W_2 - W_1} - (S - S_1)}{L}$$

The results obtained from this apparatus are, however, rather unreliable, owing to loss by radiation, and also

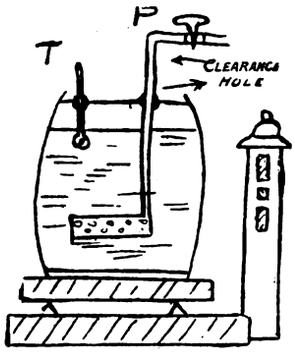

FIG. 1.

owing to the fact that the British thermal units used to raise the barrel from t_1 to t_2 degrees are not taken account of. A far more reliable apparatus is *Peabody's throttling calorimeter*. This depends for its action on the fact that if we "throttle" our steam we get a reduced pressure, and the heat given up by this reduction in pressure may be utilised to evaporate the moisture in the steam. This is the most reliable calorimeter if the moisture does not exceed about 3 per cent. of the total "stuff" by weight. If it does, the amount of heat given up by wire-drawing may not be sufficient to evaporate all the moisture. Suppose, in Fig. 2, we throttle our steam at A B, and that C

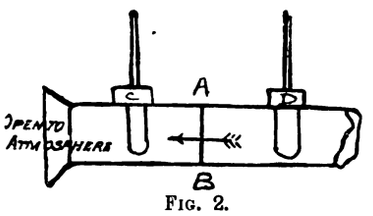

FIG. 2.

and D are two mercury-cups, let in the steam-pipe and containing thermometers, by which we can read the temperatures at both sides of the diaphragm, A B.

Let t_1 = temperature of steam before throttling;
t_2 = temperature of steam after throttling;
t_3 = temperature corresponding to pressure after throttling (if open to atmosphere, $t_3 = 212°$ F.).

Let L_1, L_2, and L_3 be the latent heats corresponding to t_1, t_2, and t_3; x = dryness fraction.

Now, total heat in 1lb. of steam before throttling

$$= S_1 + x\,L_1$$
$$= (t_1 - 32) + x\,L_1 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and total heat in 1lb. of steam after throttling = total heat of 1lb. of dry saturated steam at $t_3 + \{\cdot 48\ (t_2 - t_3)\}$. (2)

Since ·48 is the specific heat in British thermal units of superheated steam, equalising (1) and (2) we have, since the total energy must remain the same,

$$(t_1 - 32) + x\,L_1 = \text{total heat at } t_3 + \{\cdot 48\ (t_2 - t_3)\},$$

whence $x = \frac{\text{total heat at } t_3 + \cdot 48\ (t_2 - t_3) - t_1 + 32}{L_1}$

$$= \frac{L_3 + (t_3 - 32) + \cdot 48\ (t_2 - t_3) - t_1 + 32}{L_1};$$

or, if low-pressure end is open to the atmosphere,

$$x = \frac{966 + 212 + \cdot 48\ t_2 - (\cdot 48 \times 212) - t_1}{1{,}114 - \cdot 7\ t_1} = \frac{1{,}076 + \cdot 48\ t_2 - t_1}{1{,}114 - \cdot 7\ t_1} \quad (3)$$

The most recent type is known as *Barrus's separating and wire-drawing calorimeter*, made by McInnes and Co., Glasgow. This, as its name implies, consists of a separating and a wire-drawing calorimeter "in series"; although we can use each separately, if we choose, by disconnecting the nut, A. The separating calorimeter takes care of most of the moisture in the steam; but the wire-drawing calorimeter deals with the remainder, and ensures an accurate reading. Steam of almost any dryness fraction can be dealt with by this instrument. It is shown in Fig. 3.

The method of working is as follows: C is shut and B is opened admitting the sample of steam. This is shot against the diaphragm, D, and the heavy particles of moisture collect and trickle down into E. The remainder of the "stuff," which is more or less dry steam, passes through the throttle, F, and then to a condenser, G, where it is condensed and collected.

After it has been running some little time, we find the weight of condenser water (W_1) and the weight of water in E (W_2). Then we have, assuming that all the moisture

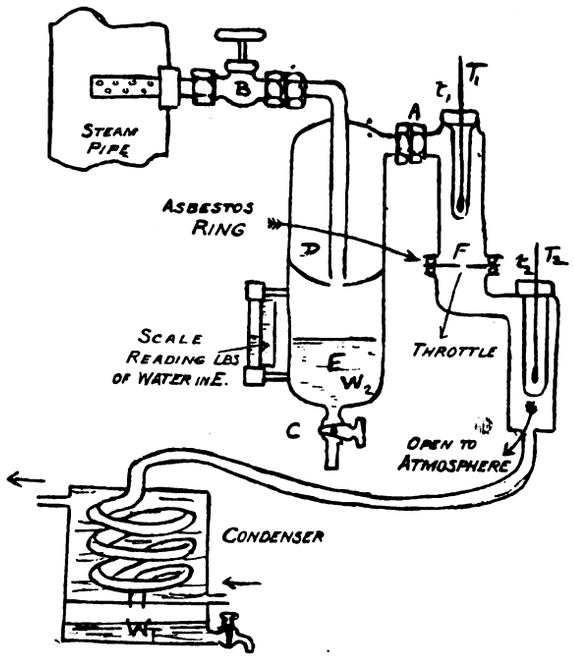

FIG. 3.

was abstracted by the separating calorimeter, and that only dry steam passes A.

$$x = \frac{W_1}{W_1 + W_2}.$$

But W_1 is *not* quite free from moisture. But by applying equation (3) we have

$$x_{w1} = \frac{1{,}076 + \cdot 48\ t_2 - t_1}{1{,}114 - \cdot 7\ t_1},$$

which gives x_{w1}; and finally, our true or corrected dryness fraction is

$$x = \frac{W_1 \times x_{w1}}{W_1 + W_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The great trouble is to get a true average sample of steam. The percentage of moisture varies considerably for the same steam according to weather. We take our sample from a horizontal or vertical bend. T. Hudson Beare recommends a vertical bend, as shown in Fig. 3.—A. W. M.

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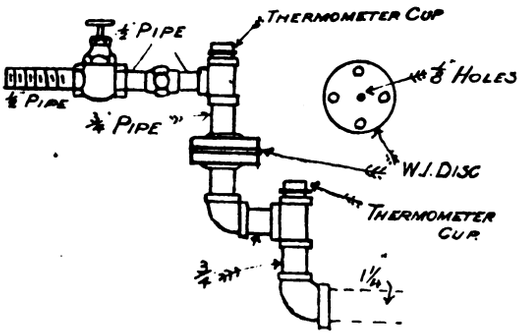
Answer to No. 456 (*awarded* 5*s.*).—The design shown is a throttling calorimeter designed by G. H. Barrus, of Boston, which, if properly handled, gives very accurate results. The apparatus is screwed into the main steam-pipe just after it leaves the top of the boiler; steam is taken from a ½in. pipe provided with a valve, and passes through two ¾in. tees situated on opposite sides of a ¾in. flange union. A thermometer cup filled with mercury is screwed into each of the tees, and a piece of sheet iron with an ⅛in. hole in the centre is inserted between the flanges and made light with asbestos gaskets. The steam may be led away through the 1¼in. pipe shown dotted. The whole arrangement from the main steam to the 1¼in. pipe must be carefully lagged with hair felt, else the results will be futile. Take care that the ⅛in. hole in the wrought-iron disc is not choked with dirt, and that no leaks occur. Then place a thermometer in each cup and open the ½in. valve wide open; let this continue for 10 to 15 minutes, then take frequent readings, say every minute.



The throttling calorimeter depends on the action that when any steam is expanded from a higher to lower pressure without doing external work it becomes superheated; the amount of superheat depends on the difference of the two pressures. Assuming there was no back pressure, no loss of heat, the total heat of the steam before throttling and the total heat after throttling would be the same. The percentage of moisture is expressed by the following equation:

$$x = \frac{H - 1{,}146{\cdot}6 - {\cdot}48\,(t - 212)}{L} \times 100.$$

x = percentage of moisture;
H = total heat above 32deg. of steam at boiler pressure;
L = latent heat in steam at boiler pressure;
1,146·6 = total heat in steam at atmospheric pressure;
t = temperature shown by lower thermometer.

The above formula is purely theoretical, because in practice some heat is lost; still, if the instrument is well covered and every care taken, one will be fairly near. Mr. Barrus recommends a calibration for dry steam; some engineers make an allowance for error. To make the calibration close the boiler stop valve (which is beyond the calorimeter), keep the steam at the same pressure as in the previous test; let the steam flow through for 15 minutes, and take readings during the last five minutes. The upper thermometer should read the same as in the last test, the lower thermometer should read higher; the reading of the lower thermometer is the calibration reading for any steam. Call the lower reading T, then by the following formula you get the percentage of moisture

$$x = \frac{{\cdot}48\,(T - t)}{L} \times 100.$$

x = percentage of moisture;
T = calibration reading of lower thermometer;
t = test reading of lower thermometer;
L = latent heat of steam at boiler pressure.

This arrangement is really to determine the moisture in steam, but fixed as it is so close to the boiler it can indicate the amount of priming that goes on.

The following is a chemical test, given, I believe, by Prof. Kennedy, and shows exactly the amount of priming that goes on. Its action is based upon the fact that silver nitrate in the presence of potassium chromate forms a precipitate with the slightest trace of chlorine. Condensed steam is nearly absolutely pure, and certainly does not contain chlorine. In this test proceed as follows: Put two or three handfuls of ordinary salt in the boiler by way of the feed. (Salt is made of soda and chlorine.) Take a burette, fill it with silver nitrate mixed with a little potassium chromate, draw from the boiler some of its water, and test for chlorine by putting one cubic centimetre of the silver solution in at the time; allow a little time for the precipitate to settle, and then continue to add the solution till no further precipitation occurs. Take exactly the same amount of water from your condenser or separator and test in the same manner for chlorine. If it took 50 cubic centimetres of the silver solution to precipitate the whole of the chlorine in the water from the boiler, and two cubic centimetres to precipitate the chlorine brought over into the condenser by priming, then the amount of priming going on is 4 per cent.—C. A. B.

Answer to No. 456 (*awarded* 5*s.*).—There are several methods in use for testing the dryness quality of steam. Two of these methods I shall describe here as being most suitable in the general case, and being the methods which I most commonly adopt in practice. The first method is known as the salt test. Add to the boiler feed water any quantity of ordinary salt until a sample of water taken from the gauge cock is turned milky on addition of a few drops of silver nitrate solution, showing the presence of salt in the boiler. Now take simultaneously a sample of condensed steam from the main steam pipe and a sample of water from the gauge cock on the boiler. It is well to note here that if the water is drawn quickly from the gauge cock a certain fraction is evaporated owing to the sudden reduction in pressure, leaving the sample stronger in salt than the water within the boiler, so that a small calculation is necessary to eliminate this error, most easily illustrated by a small practical example. If water is drawn from a boiler when the internal pressure is 250lb. per square inch, what fraction of the water will be converted into steam due to its being reduced to atmospheric pressure? Temperature of water at 250lb. pressure = 405deg. F.

W = weight of steam generated;
S_1 = sensible heat of water in boiler;
S_2 = " " " sample.

Then
$$S_1 - S_2 = W \times L;$$
$$(405 - 32) - (212 - 32) = W \times 966;$$
$$405 - 212 = W \times 966;$$
$$W = \frac{405 - 212}{966} = {\cdot}2\text{lb.}$$

After having made due connection for evaporation as above, in gauge-cock sample dilute, say, two grains with 100 parts of fresh water, then we have a solution of one one-hundredth of the saltness of the boiler water. To 500 cubic centimetres of this diluted sample add a small quantity of yellow potassium chromate (K_2CrO_4), about two drops, then carefully add one-tenth per cent. solution of silver nitrate till the colour becomes red-brown. Preserve this sample for comparison with the same mass of the condensed steam sample similarly treated. When the depth of colour in the two solutions have been made the same, we determine the dryness fraction thus:

w_1 = weight of silver nitrate solution required for boiler sample;
w_2 = weight of silver nitrate solution required for condensed steam.

Then
$$\text{Percentage of priming} = \frac{w_1}{w_2}.$$

The second method is known as the "barrel calorimeter." Put into a barrel or other similar utensil a weighed quantity of water, lead a flexible hose pipe from the main steam-pipe into the barrel, and take the temperature of the water; then, whilst stirring the water well, allow steam to pass through the flexible hose into the water, and take the final temperature when enough steam has been condensed, this quantity being at the discretion of the operator. Then the following formula gives the dryness fraction.

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W = initial weight of water in the barrel in pounds;
w_s = weight of steam condensed (got by subtracting initial weight from final weight of barrel);
w_1 = water value of calorimeter—*i.e.*, the weight of water which has the same thermal capacity as the barrel;
t_1 = initial temperature of water;
t_f = final temperature of water;
t_s = temperature of steam in boiler;
q = dryness fraction.

Then heat lost by steam = heat lost by water and barrel.

$$w_s (q L + t_s - t_f) = (W + w_1)(t_f - t_i).$$

From this equation we can find the value of q.

These are two very simple methods, and of the two I should recommend the use of the first, being less likely to accumulate errors in readings, and being the one which I use most frequently with least percentage error when the usual precautions in dealing with chemical substances have been observed. However, the second method is quite reliable, and exceedingly simple.—D. M.

COMPANIES' REPORTS.

OLDHAM, ASHTON, AND HYDE ELECTRIC TRAMWAY.

The report of the directors for the year ended Dec. 31, 1901, states that the total revenue for the year amounts to £26,401. 16s. 11d., and the expenditure (including £1,600 for debenture interest) to £19,319. 14s., leaving a net profit of £7,082. 2s. 11d., which added to the amount of £177. 11s. 8d. brought forwaad from the previous account, makes an available balance of £7,259. 14s. 7d., which the directors propose should be applied as follows: amount to be placed to depreciation and reserve fund, £1.500; dividend at the rate of 5 per cent. per annum on the cumulative preference shares for the year, £2,122. 18s. 4d.; dividend on the ordinary shares at the rate of 11 per cent. per annum for the six months ended Dec. 31, 1901, making, with the interim dividend paid on Aug. 15 last, 8 per cent. for the year, £3,370. 6s. 3d.; balance to be carried forward to next account, £266. 10s. The total capital expenditure amounts to £132,751. 17s. 6d. In order to cope with the traffic during certain days of the week and on holidays, the directors have purchased eight additional motorcars. In accordance with the resolution passed at the last general meeting, the directors issued in May, 1901, 500 ordinary shares and 500 preference shares at the price of £12. 10s. per ordinary share and £10 per preference share. The premium in respect of the issue of these shares, amounting to £1,183. 15s. 5d. (after deducting expenses), has been added to depreciation and reserve fund, which, with the sum now recommended to be credited, will stand at £4,505. 15s. 5d. The subscribed share and debenture capital is now £45,000 in ordinary shares of £10 each, £45,000 in 5 per cent. cumulative preference shares of £10 each, £40,000 4 per cent. debentures—total, £130,000. A satisfactory agreement has been entered into with the Hyde Corporation in regard to the breaking-up of the footpaths for the repair of the feeder cables. The directors regret that their opposition to the promotion of new lines by the local authorities was unsuccessful, but negotiations are in progress with the Hyde Corporation with regard to a lease to the Company of the tramway from the terminus of the Company's line to the Stockport boundary, and with the Stockport Corporation for mutual running powers between Hyde and Bredbury. The directors who retire by rotation are Mr. E. Garcke and Alderman Thomas Heginbottom, J.P., and they offer themselves for re-election. Messrs. Edwin Guthrie and Co., the auditors, retire, and they offer themselves for re-election.

HOVE ELECTRIC LIGHTING.

Directors: Colonel A. J. Filgate, R.E. chairman); Colonel H. Wood, C.B. (vice-chairman); Harold A. Hoare, Esq.; Carleton F. Tufnell, Esq. Engineers: Messrs. Crompton and Co., Limited, London and Chelmsford. Secretary: Francis R. Reeves, Esq., M.I.E.E.

Report of the directors (with abstract of accounts) to be presented at the annual general meeting of the shareholders at Salisbury House, London-wall, on March 12 at 1 p.m.:

The result of the year's working has again been satisfactory, the net profit having increased from £7,715 in 1900 to £8,282 in 1901. This profit would have been considerably larger but for two items in the working expenses, which are unusually high this year. One is the increased cost of coal, the price of which, however, is now considerably reduced, and the other is the large increase in rates and taxes. The progress of the Company is best shown by the following statistical table:

Year.	Houses.	8-c.p. lamps.	Units sold.	Gross revenue.	Net revenue.
1898.....	513	36,967	350,254	£9,480	£5,089
1899.....	671	44,824	444,499	12,070	7,097
1900.....	802	52,919	539,208	13,828	7,715
1901.....	921	61,366	629,427	15,519	8,282

To the net profit of £8,282. 0s. 9d. there has to be added £272. 8s. 3d. balance from the previous year, making a total of £8,554. 9s. After deducting debenture interest paid and accrued, and the interim dividend at the rate of 7 per cent. per annum paid in October last, there remains a net balance of £5,437. 1s. 3d. to the credit of net revenue account. The directors propose to place £2,250 to the credit of the reserve fund, to declare a dividend, payable on April 15 next, at the rate of 9 per cent. per annum for the half-year on the share capital paid up, making with the interim dividend 8 per cent. for the year, and to carry the balance £453. 19s. 11d. forward. During the past year the directors offered to the shareholders 1,000 additional shares at the price of £7. 10s. per share. Seven hundred and forty-five of these were subscribed for, the premium realised being added to the reserve fund. With the addition now proposed to be made, the sum at credit of the reserve fund will amount to £21,150. 7s. The amount of £600 annually set aside for repairs and maintenance, in accordance with the contract with the Hove Commissioners, has again proved insufficient to meet the necessary outlay on this account during the year. As a result, the excess of £188. 18s. 6d. has been taken from the maintenance reserve account, leaving a balance of £758. 16s. 5d. The expenditure on capital account during the year has amounted to £9,215. 7s. 6d., the total expenditure up to Dec. 31 being £109,738. 11s. 3d. The directors intended to have had the erection of the new generating station well on towards completion by this time, but in consequence of delays and opposition on the part of the Corporation of Hove, the works could not be proceeded with. This opposition, however, is now at an end, and instructions have been given for commencing the construction at once. At the last general meeting a shareholder put forward a proposal that the directors' fees should be increased, which was duly carried. The chairman, however, considered that as no notice had been given of the motion, the matter should remain in abeyance until the next meeting, when the suggestion would be brought forward. The following resolution will accordingly be moved at the general meeting: "That the fees payable to the directors be increased to £150 each per annum, with £100 additional to the chairman, to take effect from Jan. 1, 1901." In accordance with the articles of association, Colonel Henry Wood, C.B., retires from the Board by rotation, but offers himself for re-election. Messrs. J. H. Duncan and Co., the auditors, also offer themselves for re-election.

REVENUE ACCOUNT.

Dr.	Generation of Electricity.	£ s. d.
Coal or other fuel	£3,005 9 2	
Oil, waste, water, and stores	137 7 4	
Proportion of salaries	379 12 0	
Wages and gratuities	781 10 9	
		4,303 19 3
Repairs and maintenance		600 0 0
	Rents, Rates, and Taxes.	
Rents payable	298 6 11	
Rates and taxes	498 8 0	
		796 14 11
	Management Expenses.	
Directors' remuneration	450 0 0	
Salaries	654 3 0	
Stationery and printing	108 8 5	
General establishment charges	157 11 4	
Auditor of Company	15 15 0	
		1,385 17 9
	Special Charges.	
Insurances	145 0 0	
Legal expenses	5 6 6	
		150 6 6
Total expenditure		7,236 18 5
Balance carried to net revenue		8,282 0 9
		£15,518 19 2

Cr.	£ s. d.
Sale of current (629,427 units)	14,846 7 11
Rental of meters and other apparatus	631 1 0
Transfer fees	3 15 0
Miscellaneous receipts	37 15 3
	£15,518 19 2

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£ s. d.
Share capital account—amount received	61,984 0 0
4½ per cent. debentures	7,300 0 0
4 per cent. debenture stock	17,700 0 0
Sundry creditors	3,737 3 3
Consumers' deposits	38 0 0
Creditors for interest	173 14 5
Unclaimed dividends	25 11 5
Reserve fund	18,900 7 0
Maintenance and repairs account reserve fund	758 16 5
Net revenue account, balance at credit	5,437 1 3
	£116,054 13 9

Cr. Assets.	£ s. d.
Capital account—amount expended for works	109,738 11 3
Stores on hand	100 15 0
Sundry debtors	5,846 13 1
Cash at bankers and in hand	368 14 5
	£116,054 13 9

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NOTES.

New Books.—We have to acknowledge the receipt of a new work, entitled "Tramway Companies and Local Authorities," by Mr. F. N. Keen, barrister-at-law. The book is published at 10s. From Messrs. Macmillan and Co. we have received a new text-book on "Elementary Electricity and Magnetism," by Messrs. Dugald C. and John Price Jackson, professors of electrical engineering at the University of Wisconsin and the Pennsylvania State College respectively. The price of this work is 7s. 6d.

Wireless Telegraphy in Russia.—A message to hand from Odessa indicates in what light the Russian Government regard the possibilities of wireless telegraphy. The news is to effect that the director of the chief post and telegraph office at Odessa has authorised the installation of wireless telegraphy apparatus for experimental purposes between Kherson and Golaya Pristan, a distance of under 10 miles, in order that the officials may become acquainted with all the details of the new system. It is not stated which system of wireless telegraphy it is proposed to use for these experiments.

Electrical Progress in Burma.—Electric light enterprise in Burma is rapidly extending. We hear that the Municipal Council of Rangoon are about to apply for the necessary powers for the supply of electric energy within their area. It does not appear, however, that the Council will reserve the working of the undertaking to themselves, but on obtaining a license, will most probably hand it over to a company to carry the powers into effect. It is proposed that the maximum price for lighting per Board of Trade unit shall be fixed at 1s., and for power purposes 6d. per Board of Trade unit.

Magnetism.—At the Royal Institution on Friday Prof. Silvanus Thompson lectured on "Magnetism in Transitu." Starting *ab ovo* by demonstrating Gilbert's experiments with an oval capped loadstone which was presented to the Royal Society by King Charles II., Prof. Thompson, in his customary lucid manner, went through a number of experiments tending to illustrate the circulation of magnetic force around the molecules of iron rings and bars. The experiments all came off exceedingly well. A number of experiments with alternating current followed. The lecture closed with an animatograph exhibition of photographs of electric wave diagrams. These gave a most vivid impression both of the ordinary waves and of the lateral movement of the Hertzian waves.

Telegraphic Rates between Germany and the East.—It is announced that the German Post Office authorities have concluded an agreement with the German Marine Telegraph Company, the Indo-European Telegraph Company, and the other cable companies concerned in regard to a reduction in the rates charged for the transmission of Press messages between Germany and China. The new charge, which came into force on the 15th inst., amounts to 1s. 11d. per word, as compared with 5s. 9d. hitherto, and telegrams can only be forwarded *viâ* Emden, Vigo, Madras, or *viâ* Bushire and Madras. It is provided by the agreement that messages may be dispatched according to the new tariff to all places in China, they must be written either in German or in English, and they will not be allowed to delay the transmission of fully-paid telegrams.

Municipal Electrical Association.—The proceedings at the meeting of the Incorporated Municipal Electrical Association on Feb. 21 last, when the subject of the repayment of loans was discussed, have now been published in the form of a pamphlet. The meeting was held in private, but at the time we were enabled to announce the results of its deliberations, and we also gave in full the resolutions which were adopted in favour of the suspension of the operation of sinking fund for three years from the date of loan. From the official report of the proceedings before us we now see that the meeting was unanimous in its decision. The speeches of those who attended the conference followed one another much in the same strain, and do not call for special mention. We understand that it is intended to send a deputation to the Local Government Board on the subject.

Alloys of Aluminium and Magnesium.—By treating fused mixtures of aluminium and magnesium in various proportions with ammonium chloride solution or dilute hydrochloric acid, Mr. Octave Boudouard has, according to a recent issue of *Comptes Rendus*, isolated three definite crystalline compounds of the two metals: $AlMg_2$, sp. gr. 2·03, from a mixture of 30 parts of aluminium and 70 parts of magnesium; AlMg, sp. gr. 2·15, from mixtures of 40 to 50 parts of aluminium with 60 to 50 parts of magnesium, and Al_4Mg, sp. gr. 2·58, from mixtures of 70 parts of aluminium and 30 parts of magnesium. All the fused mixtures of the two metals, except that containing equal parts of each, show dendritic crystals in considerable quantity. The existence of the compounds $AlMg_2$ and AlMg was predicted from determinations of the melting points of the two metals.

Potential Differences in Vapours.—In a recent paper Mr. Rudolf von Hasslinger gives an account of a research he has made into the potential differences in vapours and in some solid electrolytes. He has measured the potential differences assumed by metals when placed in a Bunsen burner into which solutions of various salts are sprayed. The potential difference is influenced by the basic as well as the acid constituent of the salt, but the greater part of the potential difference measured seems to be due to the latter. The most remarkable result observed was that, in the vapour of certain salts, iron and nickel assumed a positive potential towards platinum. In fused lithium chloride, iron is negative towards platinum. The difference of potential varies with the temperature, the maximum value being reached at about 800deg On further raising of the temperature, the E.M.F. decreases, and in lithium chloride vapour passes through zero to the change of sign. The same phenomenon is well shown with the solid electrolytes, calcium and magnesium oxides.

Electrical Propulsion of Barges.—Probably the first Bill of the kind to receive the assent of any British Parliament is that which authorises the use of electrical propulsion of barges on a canal proposed to be constructed in Kent. The new canal, when built, will run from Chatham and find an opening out into the Thames somewhere in the neighbourhood of Gravesend, and the proposal is to propel the barges by electricity from the banks on the overhead trolley system. We believe that this will be the first instance of the electrical propulsion of canal barges on commercial lines in England, although the system is employed on some of the waterways in the United States. The promoters claim that the proposed new canal is necessary, owing to the high railway rates and bad service which the Chatham and South-Eastern Railways provide for the conveyance of agricultural products, and it is thought that with the introduction of electrical traction on the canal the present high freight charges may be substantially reduced.

Automatic Control of Tramway Points.—The Leeds Tramway Committee have recently been experimenting with a new device, which aims at the simultaneous automatic adjustment of the points on the rails and the frogs

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on the overhead wires of the electric tramway. From the description of the same which we have seen we gather that the arrangement is controlled by a small switch conveniently placed in front of the driver of the car. To this switch the trolley head is connected by an ordinary electric conductor, and the arrangement is such that when passing a convenient position in front of the points to be moved, by means of the switch the points on both the rails and the trolley wire overhead are opened, while a second contact, after passing the points, closes them. It seems that the necessary current for the circuit is obtained from batteries, which are enclosed in boxes and placed on the side of the pavement at each junction. At present the points are adjusted by a man stationed at these places, and for this service the Leeds Corporation pay nearly £1,000 a year in wages. According to the inventors, who are the principals of a local firm of electrical engineers, Messrs. S. Dixon and Son, the cost of the equipment will be about £100 for each set of points.

Royal Institution.—The following are the lecture arrangements at the Royal Institution after Easter: Dr. Allan Macfadyen, three lectures on "Recent Methods and Results in Biological Enquiry"; Prof. F. York Powell, three lectures on "English Kings and Kingship"; Prof. Karl Pearson, three lectures on "The Laws of Heredity, with Special Reference to Man (the Tyndall Lectures)"; Prof Dewar, three lectures on "The Oxygen Group of Elements"; Dr. A. Smith Woodward, three lectures on "Recent Geological Discoveries"; Mr. M. H. Spielmann, three lectures on "Contemporary British Sculpture"; Mr. W. H. Cummings, three lectures on "British National Song" (with musical illustrations); Prof. Walter Raleigh, three lectures on "Poets and Poetry"; and Prof. Brander Matthews, three lectures on "The Development of the English Drama." The Friday evening meetings will recommence on April 11, when Prof. Dewar will deliver a discourse on "Problems of the Atmosphere." Succeeding Friday evening discourses will be delivered by Sir John H. A. Macdonald, Dr. J. Mackenzie Davidson, Sir Robert Ball, Sir Benjamin Baker, Prof A. E. Tutton, and other gentlemen.

A Pneumatic Fire-Ladder.—A very interesting piece of apparatus, to wit, a pneumatic fire escape and tower, is illustrated in the *Scientific American* for March 8. Although the device has been used for the last few years in some of the leading Continental cities, being the invention of a German engineer, its adoption by the Fire Department of the city of Pittsburg marks its first appearance in America for practical purposes. The apparatus is worked by compressed air, a tank of 300lb. pressure supplying the necessary energy to telescope a heavy ladder into the air. Standing on this ladder, one, two, or three firemen, each with a section of hose, can be lifted to any particular window desired, say, in a five-storey building. One of the obvious advantages of the use of compressed air for this purpose is a saving of much valuable time in cases of fire, and it is expected that the introduction of this pneumatic fire-escape into Pittsburg will shortly be followed by other cities in the States. In the past the fire service in American cities as a whole has admittedly not been all that it might have been, and our contemporary acknowledges that, owing to the lax methods for fire prevention employed in that country, the annual loss by fire is far greater than that of the Old World.

Telegraph Rates.—Following close upon the recent substantial lowering of tariff for telegrams between Europe and British India, the Eastern Extension Telegraph Company announce a reduction of rates to come into force from April 1 for telegraphic messages exchanged between Europe and the Straits Settlements and Netherlands East Indies. The tariff has been reduced as follows: for Straits Settlements, from 4s. 6d. to 3s. 6d. per word; for Java, from 5s. to 4s.; and for Sumatra and other islands, from 5s. 5d. to 4s. 5d. With reference to the new rate to India, Mr. Henniker Heaton asked the Secretary for India in the House of Commons on the 13th inst. whether he had made any fresh agreement with the Eastern Telegraph Company, or with the Indo-European Telegraph Company, and whether he would give an assurance that no agreement or rearrangement of agreements with these companies should be made until after the House had had an opportunity of examining and discussing the full and final report of the Departmental Committee. Lord George Hamilton replied that no fresh agreement had been entered into with the Eastern and Indo-European Telegraph Companies in connection with the recent reduction of rates to India. It was not proposed, however, to interrupt or delay the negotiations now in progress with regard to a date for the determination of the joint purse agreement and of the Australian message fund.

Electrolytic Alkali.—We have to call the attention of our readers to a misprint in our descriptive article last week on the works of the Electrolytic Alkali Company at Middlewich. In the last part of the article, on p. 375, it is stated that the production of soda is from 82 to 85 tons per week. Lower down in the same paragraph this is repeated as 62 to 65 tons. The first figures are correct, the production being considerably over 80 tons a week. There is one point in connection with this interesting equipment which was not referred to in the article. Each of the lines of cells which are supplied in series at 60 volts are, of course, insulated the one from the other. The incoming brine and the outgoing soda solution, however, form connections of considerable resistance between these cells and the pipes which convey the liquids in question. The stream of brine going into each cell is about the thickness of a lead pencil, and forms in this way a continuous connection. The current which flows through this liquid is small, and it is sufficient to cause a certain amount of electrolytic corrosion of the delivery pipes. At first it was thought it would be advisable to break up these streams of liquid so as to avoid such currents, but it is found that the eating away of the pipes only occurs just where the liquid leaves, and these ends can be renewed at small cost. Otherwise these leakage currents do no harm, and are an exceedingly small proportion of the main current. Hence it has not yet been found advisable to introduce any mechanical means to give intermittent flow into and out of the cell.

Dangers of the "Tube."—Mr. S. J. Shaw wrote to the *Daily Chronicle* at the end of last week as follows: "Good-bye to safety on the Tube if the suggestion of Lord Rayleigh's Committee is adopted. The cumbrous engine now used may cause the unpleasant vibrations complained of, but at any rate it is safe. The motor-carriages proposed mean fire and havoc if a short-circuit happens. At present the danger is confined to the engines; there let it stay! To spread it over the whole trains means catastrophe at any moment." We presume from the tone of the letter that Mr. S. J. Shaw is an expert with considerably more experience than Lord Rayleigh, Sir John Wolfe Barry, and Prof. Ewing, and that he foresees actual dangers of which these experts know nothing. The utter fallacy of the idea that motors under the carriages are a source of danger, is exposed by the fact that there has not been a single case of an electric tramcar being burnt up by electric current in this country. With the motor equipments for the multiple-unit system on the Central London Railway the motors,

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and the whole of the conductors connecting up to them, will be iron-clad, and being enclosed in iron will be absolutely fireproof. Short-circuits, of course, may occur, but owing to the proximity of the earthed envelope they will immediately operate the automatic cut-outs and disconnect the circuit from the main. Mr. S. J. Shaw should also remember that the Board of Trade are quite capable of protecting the travelling public against danger, and that they would not permit the introduction at this stage of electrical progress of plant such as caused the burn out at Liverpool, which evidently he has in his mind.

Telephone Tunnels in Chicago.—The underground tunnel system now being constructed under Chicago's principal business streets by the Illinois Telephone and Telegraph Company, affords an excellent illustration of what can be done in the matter of placing telephone and telegraph wires underground. The tunnels, which are to serve the purpose of conduits for the wires, will also provide for the operation of small cars or trucks for carrying mails and handling freight. About six miles of tunnel have already been completed, and very shortly the independent telephone service proposed by the Illinois Company in opposition to the telephone company, which at present holds sway in Chicago, will be introduced. The tunnels are 40ft. below the surface and of concrete arch construction. The main or trunk tunnels are 14ft. high and 12ft. wide. The branch tunnels are 8ft. high and 6ft. wide. This gives sufficient room to not only hold all the telephone wires of the company and the underground wires of other companies, but, as before stated, to provide for the operation of cars in the tunnels. A notable fact is that the whole of the excavation work has been carried out without interfering with the surface of the streets. At the present time the tunnels have advanced far enough, so that instead of bringing dirt to the surface through shaft-houses, it is hauled in dump cars by mules through the tunnels to an opening on the river at Congress-street, from which place it is taken down the river. The amount expended on the work to date is stated to be over £600,000, and it is likely that £1,400,000 more will be spent before all the tunnels and other work are completed.

The Metric System.—The advantages and disadvantages of the metric system have been much discussed in the States lately, and, on the whole, general opinion seems to be in favour of its adoption. The report of the special committee, consisting of well-known engineers and scientists, appointed by the Franklin Institute of Philadelphia to consider the feasibility and advisability of the general introduction of the system in the United States, has just been published. In it the committee recommend that the Franklin Institute should approve of any movement which would promote the universal introduction of the metric system with the least confusion and expense. The committee also favour the enactment by the United States Government of such laws as would ensure the adoption of the system as the sole standard in its various departments as rapidly as may be consistent with the public service. The views of several prominent electricians and scientists have also been taken on the subject before the House Committee on Coinage, Weights, and Measures at Washington, and these, too, were generally in favour of the adoption of the system. Prof. Elihu Thomson was among those who gave evidence, and he recommended that manufacturers should be given about two years to get their new gauges, and to make plans for new work on the metric system. On the other hand, Mr. W. H. MacFarland, representing the Westinghouse Company, opposed the change on the grounds of cost and the confusion that might arise. It is believed, however, that the committee will report favourably on the Bill now before Congress to authorise the introduction of the system in the United States.

Researches on Contact Electricity.—The current number of the *Journal* of the Chemical Society abstracts a paper by Mr. Oscar Knoblauch under this title. In the course of his experiments the author determined the sign of the charge left on plates of platinum, paraffin, glass, and sulphur, on the removal of various powders which had been placed on the plates. Seventy-five different compounds were employed, including acids, bases, neutral salts, and various organic products. Platinum and paraffin become positively charged if the powder is of an acid nature, negatively if it is alkaline, whilst for neutral compounds the charge left is sometimes positive, sometimes negative. Sulphur becomes positively charged by contact with acid powders, but negatively in almost all other cases; glass, however, becomes negatively charged, except when the powder is of an alkaline nature. These results are satisfactorily explained on the assumption that plates and powders are coated with a film of the saturated aqueous solution; when an acid powder is placed on the platinum or paraffin plate and the films are hence in contact, the hydrogen ions, on account of their greater velocity, pass in excess into the platinum surface film, so that when the powder is removed, the plate is positively charged. Similar reasoning explains the negative charge with alkaline powders, whilst in the case of neutral salts the charge is dependent on the relative velocities of the two ions. The differences between the results obtained with glass and sulphur plates are due to the fact that the films on the plates themselves are respectively alkaline and acid solutions. The author further discusses the law enunciated by Coehn that, of two dielectrics in contact, the one with the higher dielectric constant becomes positively charged.

A Shallow Conduit.—We have received from Mr. J. E. Parker, of Balham, S.W., an illustrated description of an electric conduit for tramways and railways which he is patenting, and which he has submitted to the London County Council as suitable for the conversion of their lines to an electric system. We regret to say that there is no evidence in the design as illustrated that the inventor has any idea of the conditions which a successful underground conduit system has to fulfil, and hence he has in several instances failed to meet these requirements. He proposes to use an almost continuous cast-steel conduit with three longitudinal divisions. In the outer two of these the insulators which are to bear the conductor rail are placed. A cross-section of the conduit practically consists of three rectangular recesses in the casting, the outer two of which are closed in with steel covers. These covers do not quite meet over the inner rectangular space, and thus form the slot through which the collector has to go. The objections to the construction are, firstly, that the exposed surface of the steel covers would be exceedingly dangerous to traffic; secondly, the space in the inner compartment where the feeder is to be carried seems to be insufficient for the usual types of collector; and, thirdly, from the author's description, he provides for a single conductor only. The last and, perhaps, most fatal objection is that the conduit has hardly any strength against a side thrust such as is given by the expansion of the pavements, and the slot would soon be closed up in practice. We regret to have to damp the ardour of Mr. Parker, but he would do well to look into the subject rather more fully before he pays the usual patent fees for protecting his invention.

An Improved Marconi Arrangement.—It is stated that Mr. Marconi has successfully devised a new wireless

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telegraphy apparatus with a view to obtaining a light arrangement more adapted to ships at sea in high winds. The first vessel to be equipped with the new apparatus is the American liner "Philadelphia," which arrived at Southampton at the latter end of last week with Mr. Marconi's representative on board. The new arrangement is fitted close to the mainmast. Instead of the customary long spar, there is a short length lashed to the stay, from each end of which are suspended the connecting wires to the instrument room on deck, the object being to obtain quite the lightest kind of apparatus for use at sea. During the passage of the "Philadelphia" across the Atlantic no attempt was made with the new arrangement to keep up communication with New York, and the Lizard was not spoken until the ship was within 50 miles of the station. Mr. Marconi is now in Ottawa, and has completed the agreement with the Dominion Government, under which the latter will grant him a subsidy of £16,000 for the erection of a wireless telegraphy station on the Nova Scotia Coast. It is hoped that the installation will be ready for work in two or three months, and it is reported that Mr. Marconi believes he will be able to communicate with Cape Town from his new station. With reference to the probable use of wireless telegraphy in South Africa, Mr. Austen Chamberlain in the House of Commons on Friday, in reply to Sir Edward Sassoon, denied that any agreement had been made between the Cape Government and the Eastern Telegraph group which would have the effect of excluding Marconi's wireless system of telegraphy from being tried and worked in Cape Colony.

Lord Rayleigh's Lectures. — Lord Rayleigh delivered the fifth of his course of lectures on "Electrical Developments" at the Royal Institution on Saturday afternoon. As on the previous occasions when Lord Rayleigh has spoken on this subject, much interest was manifested in the experiments. The first of these dealt with the galvanometer needle and its relation to the integral value of the electric current. By means of two of Dr. Lodge's syntonic jars the noble lecturer showed that when these were in tune, a spark produced in the one induced a spark in the other. By altering the length of the circuit in the second jar, it was put out of tune with the first and at once the sparking ceased. Lord Rayleigh, remarking on these effects, said they could hardly be due to the propagation of electric waves, as the circuits were too close to one another. He next went on to discuss electrical waves, and showed experimentally that on bringing an electrophone near a battery of three cells the detecting bell rang, because, he explained, the filings in the tube were rendered conductive when electric waves fell on them. The latter part of the lecture was occupied with some remarks on wireless telegraphy, in the course of which Lord Rayleigh paid a special tribute to Mr. Marconi, whose extraordinary skill and remarkable perseverance, he said, had made wireless telegraphy a wonder of wonders. He had known Mr. Marconi for some time, and never remembered him to say he could produce results unless he was certain he was able to do so. Lord Rayleigh further remarked that there was a mountain of water 100 miles high to be got over between England and America, and he would have thought that the curvature of the earth would have been a drawback in signalling across the Atlantic, because electric waves tended to go straight. The fact that the waves were bent round this mountain of water was an illustration of the phenomenon of diffraction.

The Osmium Lamp.—Mr. Gabriel read a paper before the Electrotechnical Society in Vienna recently, in which he gave the results of some experiments concerning the life, etc., of the osmium lamp. We find the paper well abstracted in a late number of the *Electrical World* as follows: "The illuminating power and the watt consumption of the osmium lamp remain constant at a long life. The economy even increases for some time with an increasing number of hours of burning. The average life of a normal osmium lamp of '1·8 watt specific consumption' is 1,400 to 1,500 hours. By experimenting with a lamp built for 25 volts normal, he demonstrated that the osmium lamp stands a large overload very well. When 20 volts were applied to it, it gave 22 Hefner candles and consumed 1·5 watts per candle. When the voltage was increased the following results were obtained: 25 volts, 26 candles, 0·995 watt per candle; 30 volts, 99 candles, 0·654 watt per candle; 35 volts, 171 candles, 0·478 watt per candle; 40 volts, 275 candles, 0·380 watt per candle; 46 volts, 460 candles, 0·322 watt per candle; at 50 volts the lamp burned through. The company which own Welsbach's patents has so far succeeded in making practical osmium lamps up to 50 or 60 volts. Lamps have also been built for 100 volts, but they are not yet in a practical form. In order to introduce the lamps in the existing installations, the company will put on the market lamps of about 25, 33, and 50 volts, in order to be able to use these in series of four, three, or two in ordinary installations. The lowest illuminating power for which 50-volt lamps are made, is 16 to 17 Hefner candles, but the company intends to introduce the lamps not so much in order to save energy but to increase the illumination. They intend to supply as a standard lamps of 40 candles. The introduction on a large scale is expected to be made during this year, but the lamps will not be sold outright at first—they will be rented. This method was found to be a success when the gas incandescent light was first introduced. The company owns enough osmium to make millions of lamps. Besides, the osmium of destroyed filaments can be again utilised with no great loss.

Expensive Cures.—There are instances in which the cure is worse than the disease, and this can practically be said to be the case with the following ingenious suggestions of Mr. J. T. Pearson for the prevention of breakdowns in overhead telegraph conductors. These suggestions were given in a letter to a Glasgow paper, in which attention had been drawn to the long period likely to elapse before there was underground telegraphic connection between London and Glasgow To quote the suggestions as given, the writer states that "in the meanwhile the interruptions will not be discontinued unless certain simple and indisputably infallible remedies which have been submitted to the Telegraph Department in detail are adopted, the only reason for not doing so hitherto being the proverbial apathy, indifference, and neglect of the Department. By adopting one of these, the cause of the breakdown of the wires, which, according to the Postmaster-General's own statement, is the accumulation of snow and ice on them, will be entirely prevented. This may be accomplished by the well-known principle extensively adopted for other, although not analogous, purposes, of heating them to a few degrees above freezing point by a slight electrical current, generated in small batteries placed underground near the bottom of some of the telegraph poles, connected to the wires by a thin conducting wire, and switched on and off by hand or automatically during snowstorms, the result being that the snow and ice which falls on wires is melted and drops to the ground. Lord Kelvin and other acknowledged experts and authorities on the subject may be referred to as to the efficacy, simplicity, and feasibility of this method, the cost of applying which to the exposed parts of the system is

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absolutely insignificant, and the consequence would be that the breakdowns would be entirely prevented, and the cost of reinstating the damage done, together with the reduction of revenue, which last year, according to the Postmaster-General, amounted to £37,500, would be saved. The cost of adopting this simple and infallible remedy is estimated, after making liberal allowances, at £50 per mile." We might almost leave the criticism of these suggestions to our readers, who will bear in mind that the batteries would not be small, and that their output would only be required at infrequent intervals. Also that while the heating process was on the wires would be practically useless for telegraphy. Otherwise any accident in the heating circuits would be apt to do damage inside the telegraph offices *en route*.

Institution of Junior Engineers.—At the meeting of this institution held on 14th inst. at the Westminster Palace Hotel, Mr. Kenneth Gray, vice-chairman, presiding, the paper read was on "The Uses of Engineering Models," by Mr. Percival Marshall, A.I.Mech.E. There was an exceptionally large attendance. The author commenced by pointing out that the high-class condensing steam-engine of to-day can trace its origin back to a working model of one of Newcomen's engines constructed in the eighteenth century, for James Watt made his famous invention of a separate condenser and air-pump as the result of some experiments with a working model engine of this type which had been placed in his hands for repair. After pointing out the historical value of models as a record of engineering progress, the author suggested that present-day firms would confer a valuable benefit on engineering posterity if they would make a point of presenting to the national collection at South Kensington a scale working model of all important novelties in engineering construction which they might introduce. Dealing with the scientific uses of models, he described the testing of model ships as carried out at the experimental tanks belonging to the Admiralty, and quoted the Hon. C. A. Parsons's experiments with model propellers, which were conducted in connection with the design of the "Turbinia" and the other high-speed turbine-driven vessels. Further instances of the uses of models for experimental investigation described were Prof. Dalby's models for investigating the balancing of engines and Mr. F. W. Webb's model for experimenting with locomotive valve gears. The commercial advantages of inventors' models, and of small scale models for use by firms handling specialities which were too large to keep permanently on view, or which might require to be sent for inspection to a client at a distance, were next discussed, and reference was also made to the uses of models in law courts and arbitration cases where such matters as infringement of patents, light and air cases, party wall disputes, etc., were being tried. The author then passed on to the important uses of engineering models in connection with educational work, and described the many ways in which sectional and other models are of value to the engineering teacher in facilitating the instruction of his students. He advocated the construction of simple well-designed model engines in technical school workshops in preference to work of a heavier character, expressing the opinion that the average student would learn more about the construction and working of an engine by making a complete model himself than by making one or two parts only of a large engine; and, moreover, would take a far greater interest in doing something which would be entirely his own work when finished. Such a model would call for more delicate and accurate workmanship than a larger engine, which was an advantage in the right direction. The author concluded by referring to the value of model-making as a hobby, and quoted several instances of excellent work accomplished by engineering students and amateur mechanics in their spare time. The paper was illustrated by a complete series of lantern slides, and by a large number of exhibits of the various classes of models referred to by the author.

Patent Law.—A question was put to the President of the Board of Trade in the House of Commons last week with regard to the effect on British industries resulting from the conditions in this country under which foreign manufacturers can introduce patented articles without working. Mr. J. Lawrence wanted to know whether the President of the Board of Trade is now prepared to take steps, by legislation or otherwise, to compel foreign patentees to work their patents in this country just as British manufacturers of patented articles are compelled to work their patents in Continental countries. Mr. Gerald Balfour explained that the proposals of the Government with reference to this subject are contained in the Patent Law Amendment Bill now before the House, but he stated that he is ready to consider any representations that may be made with respect to the details of the measure. He further mentioned that a deputation from the Manchester Chamber of Commerce would lay its views on the matter before him this week. On the subject of this same Amendment Bill Prof. S. P. Thompson has written a letter to the *Times*, in which he advocates that prior publication of an invention before a scientific society should not debar the inventor from obtaining a patent in this country. As an illustration of what he terms the inequitable operation of the present law, he states that "when the late Prof. Hughes in 1878 read before the Royal Society a description of that marvellous invention the microphone, he was by that act of publication debarred from securing any patent; while, by the irony of fate, others stepped in and took out patents for special arrangements of two, three, or more microphones, and sold their patents for thousands of pounds. The United States patent law is much more reasonable in this regard: it permits a scientific man to appeal to the proceedings of the learned societies as evidence of his title to have made the invention. Thus, when my friend Principal Oliver Lodge seeks an American patent for the wireless telegraph, he is able to appeal to the proceedings of the Royal Institution or of the British Association to show how in 1894 he used a coherer to relay the electric waves in the ether to a telegraph instrument. That he then supposed the limit of wireless telegraphy to be a few hundred yards is not to the point. He actually showed wireless telegraphy in operation, and is granted subsequently an American patent for this invention. But the very records which thus establish beyond all cavil his prior rights are, under British law, held to preclude him from having a valid patent: and so a foreigner steps in to reap where the Briton has sown." Prof. Thompson urges that, in order to remedy this unjust state of things, an inventor should be allowed to patent within two years any invention which he has described before one of the learned or scientific societies of the United Kingdom. We quite see the professor's point, but it must be remembered that this publication of an invention before a learned society would also prevent anyone else from patenting the same, and, given a period of two years for the patenting, the inventor would be able to draw up his specification with a full knowledge of the progress made during that interval. In fact, it would then be found more advantageous to read a communication before a learned society than to take out a provisional specification.

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THE NATIONAL PHYSICAL LABORATORY.

This laboratory, situated in Bushy House amongst picturesque and historical surroundings, was opened on Wednesday last by the Prince of Wales. Through the courtesy of the director of the laboratory (Dr. Glazebrook) we were enabled to inspect the equipment of the laboratory previous to the opening, and to obtain numerous photographs, from some of which the accompanying illustrations have been prepared. At the end of this article will be found the report of the Executive Committee covering the period up to Dec. 31 last, and also a statement of the work which is to be carried out during the present year. We would refer our readers to these for a complete statement of the equipment and objects of the laboratory, and propose now to give a somewhat disjointed account of items which struck us as being of special interest at the time of our visit.

Practically the whole of the ground floor and the basements of Bushy House have been equipped as laboratories, while the numerous rooms enable the various classes of work to be kept distinct. For the power-house and engineering laboratories new buildings have been erected round the old laundry, which is situated about 100 yards from the main buildings. In these all the tests on strength of materials will be carried out, the testing of pressure gauges, and probably the commercial testing of the magnetic properties of iron. The pressure gauges will be tested in this department against secondary standards, as the mercury column for more accurate determinations is situated in Bushy House. The power and light supply for all departments is obtained from a Parsons 60-kw. steam-turbine (seen in Fig. 1). As a rule, however, the current required in any department will be obtained from accumulators, which will have the advantage that slight and periodic fluctuations in voltage will be avoided. A Crossley gas-engine, coupled to a Parker dynamo, acts as a stand-by to the steam-turbine. There are three batteries of Chloride accumulators provided, the first being in the power-house, and from this all the lighting is done, and the motors which drive the plant in the engineering laboratories get their current from the same source. The next battery of accumulators, which consists of 55 cells, is situated in Bushy House itself. It has a normal discharge rate of 50 amperes, and supplies the various testing circuits by means of the main distributing board (Fig. 2). A smaller battery has also been erected in the laboratory devoted to thermometric investigation, where it is used for heating up the electric furnace in which the high temperatures for standardising up to 1,400deg. C. are obtained. Reverting to the main battery in Bushy House and to the switchboard shown in Fig. 2, the arrangements are such that a very large number of combinations of cells in series or parallel circuits can be obtained. The plug-board by which this is done was manufactured to Dr. Glazebrook's designs by Mr. H. Hodgson Wright for Mr. G. A. Steinthal, who had the contract for the wiring of the building. The various cells of the battery are not connected in series in the cell room in the usual way. The main body of the battery is connected up in groups of five cells in series, the positive and negative terminals being brought out to the plug-board. The horizontal plug bars can then by means of switches, which are seen at the farther end of the board, be connected on to these leads, so that there are practically 10 volts between each successive horizontal plug bar in the normal way. The vertical bars, which are connected by means of fuses on to the distributing circuits, can then be plugged through to the horizontal bars according to the voltage required. Thus, if the positive circuit bar is connected to one horizontal bar, and the negative circuit bar plugged on to the horizontal bar immediately below the first, there will be 10 volts put on to the distributing circuit. If the negative plug is then moved one hole, 20 volts will be obtained, and so on. At the one end of the battery more frequent connections are brought out, so that lower voltages can be obtained. If now larger currents are required, the switches at the end of the horizontal bars are opened, and the groups of five cells can be connected in parallel on to two special plug bars, which also run vertically. In this way at normal discharge rates 550 amperes at 10 volts can be drawn from the battery. Also, if 20 volts is required with a large current, every alternate switch connecting the groups in series would be closed, and the groups of 10 cells so made up would be plugged into parallel. In order to keep all the battery in good order, although the various sections of it will be unequally discharged, a motor-generator has been installed in the main engine-room, from which low voltages can be obtained for charging any section of the main battery. The resistances seen on the right hand of Fig. 2 are used for regulating the charge to small sections of the battery. This switchboard is most simple to work, and it avoids the use of mercury, which, although convenient in many ways, is always unsatisfactory in the long run.

Bushy House, the Home of the National Physical Laboratory.

In Bushy House there are two totally distinct systems of wiring. Thus, the lighting wires are run in the usual way, except that in the electrical laboratories a concentric system is employed to avoid any interference by the lighting currents on the testing instruments. The other system of wiring is that for providing the current to various laboratories for testing purposes. These wires are all of bare copper, supported overhead on porcelain insulators, as can be seen in Fig. 3, which gives a good view of one of

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the sub-circuit distribution boards. We believe that Mr. G. A. Steinthal, of Bradford, has made a speciality of this kind of work, as he equipped Owens College with testing wires in the same way. Where the bare copper conductors pass through the walls they are carried in tubes, the ends of which are plugged with indiarubber plugs, which keep the wires central. In this way the conductors are practically air insulated throughout their length. These subsidiary distributing boards are similar in construction to the main board. Over each is placed a voltmeter, and there are voltmeter plugholes at the ends of each horizontal bar, and also in the plugs which are used for making the connections from the horizontal bars to the vertical ones. In this way, when an observer has asked the operator at the main board to give him a certain voltage, he can test to see that he has it correctly on his local circuit before he leaves the subsidiary board to start his experiment. This simple precaution will often save considerable trouble and risk of burnouts.

The most interesting electrical apparatus at Bushy House at the present time are the historical standards of the British Association. The various standards of resistance which have been made by the committee of this association at different times are now to be kept in the National Physical Laboratory under the care of Dr. Glazebrook. The British Association air condensers (Fig. 4) have also been erected, and they are being used for the calibration of subsidiary standards both of capacity and of induction. In the same laboratory is placed the Kelvin electrostatic voltmeter (Fig. 5), for which an exceedingly long scale has been provided. This is practically four yards long, and corresponds to an angular deflection of the beam of light of over 90deg. A considerable proportion, however, of the electrical appa-

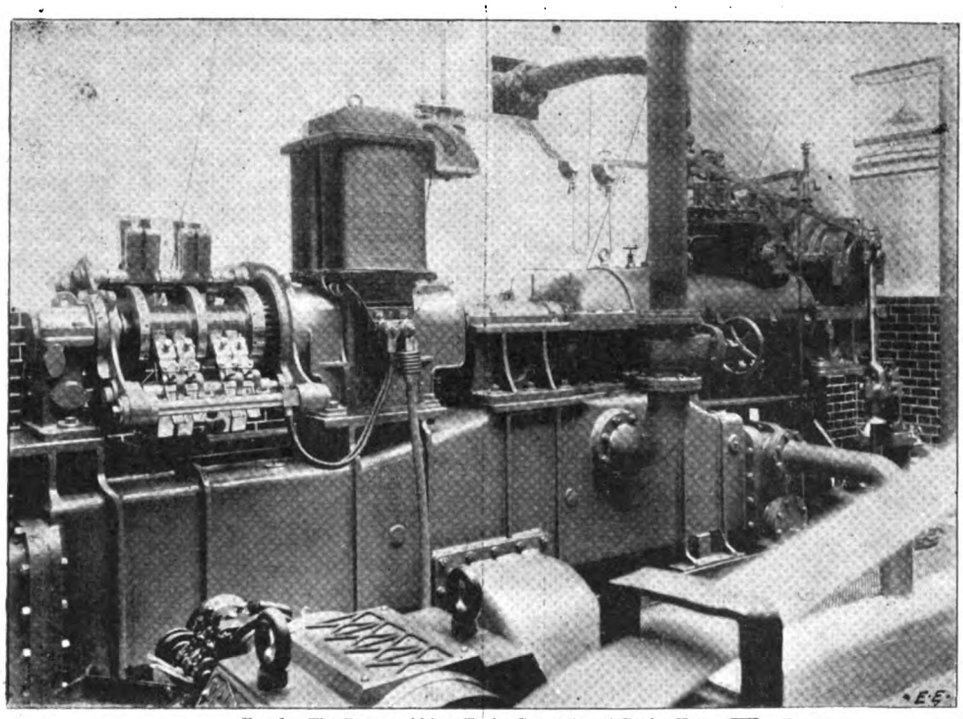

FIG. 1.—The Parsons 60-kw. Turbo-Generator at Bushy House.

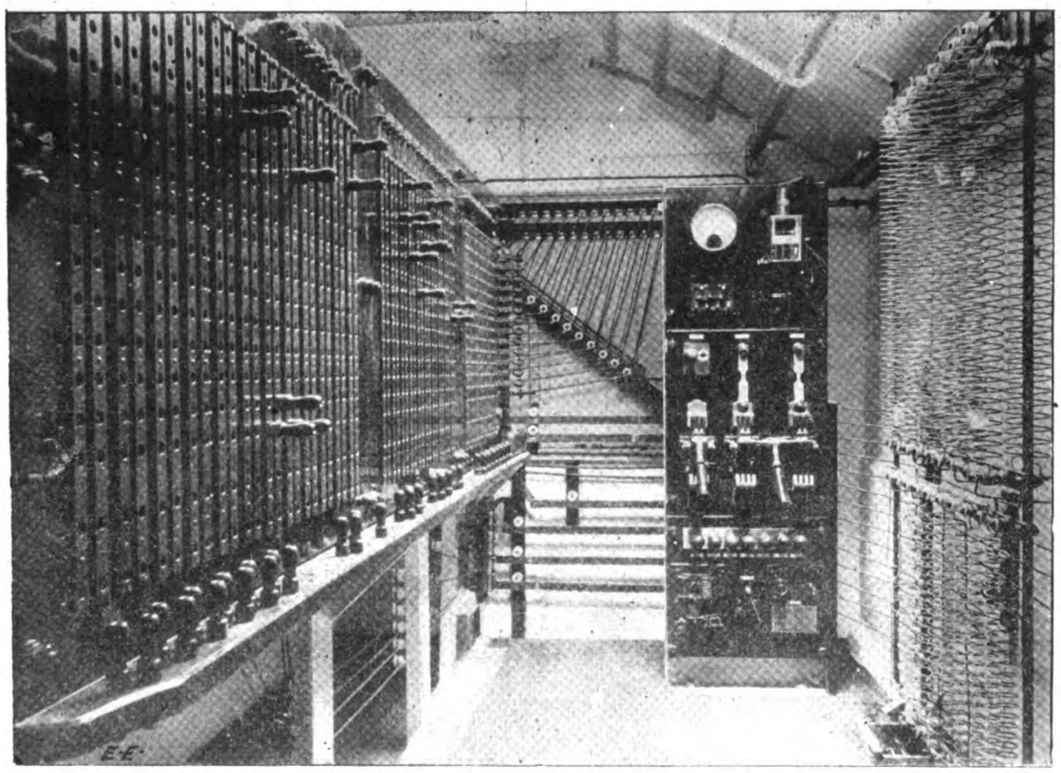

FIG. 2. The Main Distribution Plug Board and Main Switch.

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ratus has yet to arrive, and amongst the absentees on Wednesday was the Lorenz apparatus for the absolute measurement of resistance, which is being given by the Drapers' Company in memory of the late Principal Viriamu

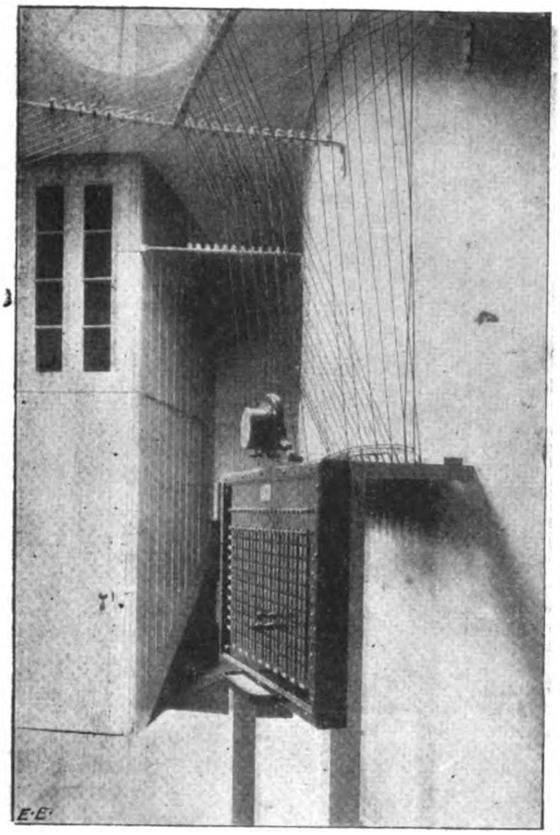

FIG. 7.—Sub-Distribution Board, showing the method of Wiring with Bare Wires on Insulators.

Jones, whose name has been associated with so much original work with this type of apparatus.

Amongst the most complete departments must be classed that devoted to thermometry. This department owes much of its equipment to the gift of Sir Andrew Noble. The standard in this department is a gas thermometer with a porcelain bulb, which is now in course of calibration over wide ranges of temperature. The subsidiary standards will be of the Callender platinum resistance type. In Fig. 6 we give a view of that portion of the laboratory in which the temperatures for calibrating are obtained. An oil bath heated by gas is used up to 300deg. C., the oil being circulated by an electrically-driven propeller. For temperatures up to 700deg., a similar bath, containing a mixture of fused sodium and potassium nitrates, is employed. The design of these baths provides both for the thorough circulation of the heated liquid and for the thermometers being immersed practically up to the reading point. The design is such that there is practically no dead liquid—*i.e.*, liquid not in circulation—round the top of the thermometer column. Electric furnaces, or ovens, are employed for the higher temperatures up to 1,400deg. C. The apparatus consists of a fireclay tube, round the outside of which a resistance wire of nickel is coiled. This is packed in with asbestos and enclosed in another tube, and the whole is then contained in an asbestos-lined receptacle which keeps down radiation. The apparatus gives an equal temperature inside the greater part of the length of the inner tube, and this temperature is well under control. As the resistance of the nickel wire is one ohm when cold and seven ohms when hot, the need of the plug-board and resistances, seen in the foreground of Fig. 6, will be appreciated. From this laboratory, besides valuable research work, there will be issued to the commercial world standard platinum thermometers and thermo junctions, which are of preat importance to the metallurgists.

The laboratory which is to deal with photometric measurements is yet to be equipped, but we know of no branch of the scope of the undertaking which is more urgently needed by the commercial world. Our present standards of light are both inconvenient and unreliable, with the result that there is much inconvenience in making any accurate determination of candle-power. We trust, therefore, that this subject will be energetically taken up as soon as the laboratory equipment arrives. We have not in this article touched on more than a tenth part of the equipment at Bushy House, but would conclude generally by saying that while this equipment provides in every case for obtaining that extreme accuracy which is to be desired, there is quite as much care devoted to the provision of appliances for testing of commercial instruments in which such extreme accuracy is neither sought nor required. In other words, the laboratory will form the link between pure science and practice which is so urgently needed in this country

FIG. 4.—One of the Electrical Laboratories at Bushy. The B.A. Standard Air Condensers are on the left.

Opening Ceremony.

Under most favourable conditions the National Physical Laboratory was declared open by his Royal Highness the

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Prince of Wales on Wednesday afternoon last. The Prince, accompanied by the Princess of Wales and attendants, arrived at Bushy House at 4 p.m., when they were received by Sir William Huggins, president of the Royal Society; Lord Rayleigh, the president of the societies

The PRINCE OF WALES said: "I am glad that my first duty as a Fellow of the Royal Society should be to join with my distinguished brethren in opening this institution, the direction and administration of which has been entrusted to the society by the Government. It is also a great

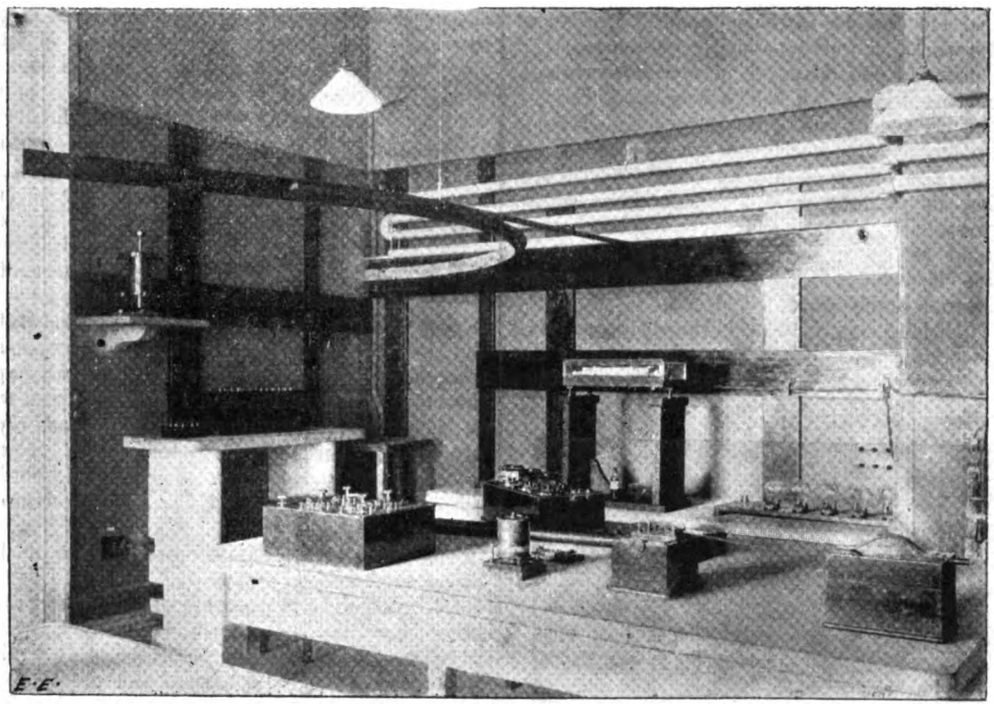

FIG. 5.—The Standard Kelvin Electrostatic Voltmeter and Scale.

represented on the Board; and the members of the Executive Committee. Without delay the Prince and Princess were then conducted through some of the main rooms of the physical laboratory to the engineering building, wherein the opening ceremony was performed. Sir William Huggins, in the chair, was supported by a large gathering

pleasure to assist in the inauguration of what may fairly be called a new departure, for I believe that in the National Physical Laboratory we have almost the first instance of the State taking part in scientific research. The object of the scheme is, I understand, to bring scientific knowledge to bear practically upon our everyday industrial and com-

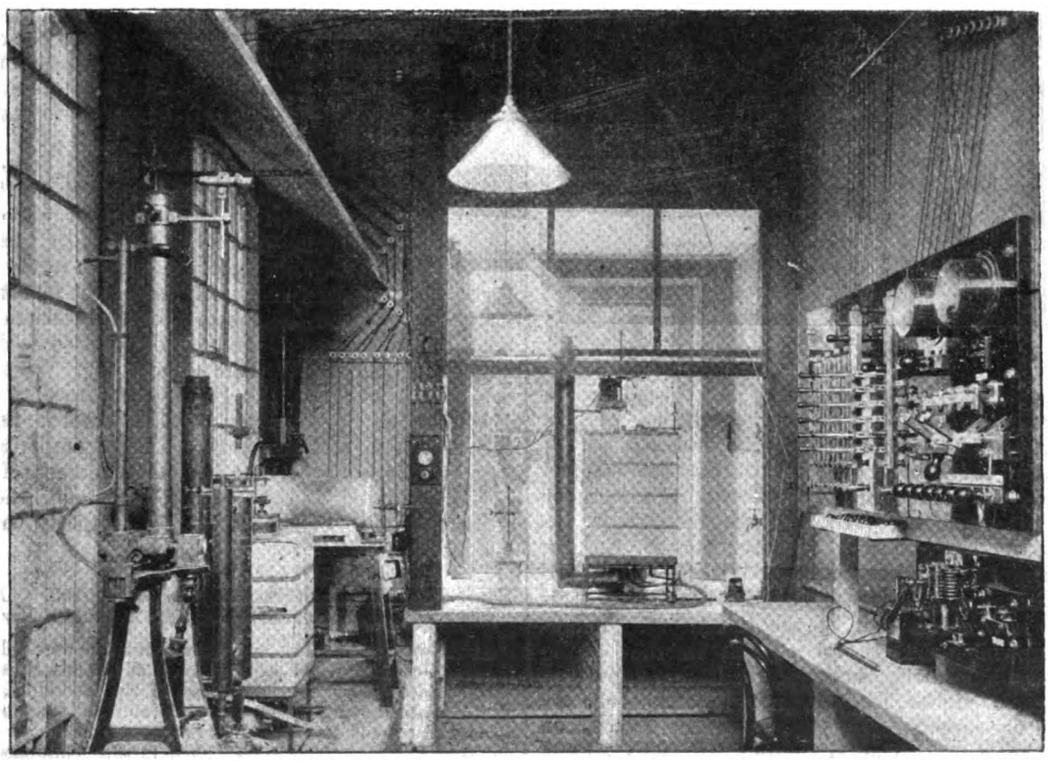

FIG. 6.—The Heating Chamber adjoining the Thermometric Laboratory with Electric Heating Furnace.

of prominent scientists and others. At the invitation of the chairman, Lord Rayleigh made a statement as to the aims of the laboratory. Mr. Gerald Balfour, M.P., President of the Board of Trade, supported the statement. The chairman then invited his Royal Highness to declare the laboratory open.

mercial life, to break down the barrier between theory and practice, to effect a union between science and commerce. This afternoon's ceremony is not merely a meeting of the representatives of an ancient and world-renowned scientific society for the purpose of taking over a new theatre of investigation and research. Is it not more

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than this? Does it not show in a very practical way that the nation is beginning to recognise that if her commercial supremacy is to be maintained, greater facilities must be given for furthering the application of science to commerce and manufacture? In the profession to which I am proud to belong there are, perhaps, special opportunities of gaining a certain insight into the general trade and commerce of the world, and of comparing the commercial vitality of the different countries. And certainly, abroad, one finds an existing impression, which was confirmed by the experience of my recent and interesting Colonial tour, that the superior technical and scientific knowledge of our foreign competitors is one reason why our hitherto pre-eminent position in manufactures and commerce is so considerably threatened. As a simple example, I may quote the opinion of an expert authority in Australia that the aniline dyes of Germany had given to a certain class of German-made goods a decided superiority over those of British manufacture. In Germany and America much valuable work has been carried out by the State. In this country the Government have provided

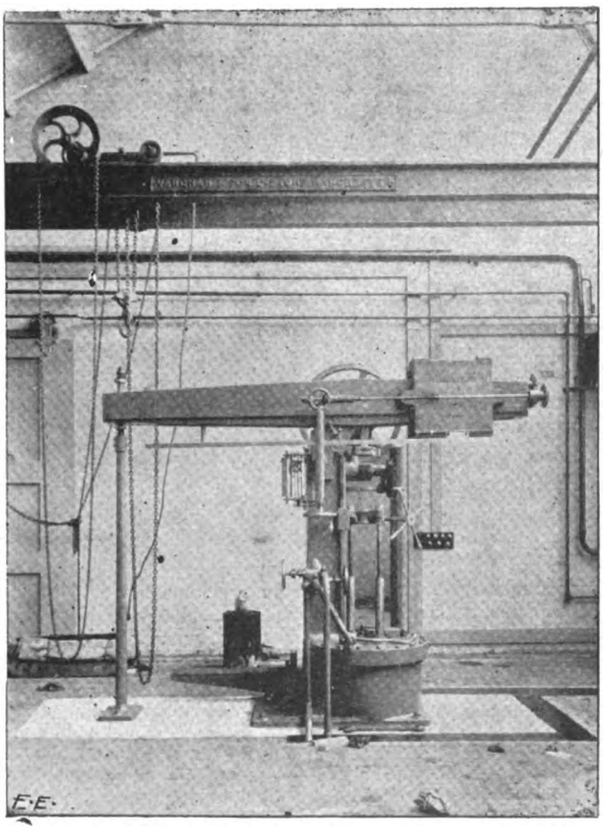

FIG. 7.—The Buckland 5-ton Testing Machine.

these buildings, and found machinery for the supply of light, heat, and power. They are at present not inclined to spend more money upon equipping the laboratories. It is, therefore, to the liberality of the public that we must look, not only for money, but for presents in machinery and necessary appliances. Already the institution has benefited in the latter respect by gifts from Sir Andrew Noble, the Drapers' Company, Messrs. Willans and Robinson, Lady Galton, and others. The old-established Kew Observatory now forms part of the laboratory. Important and growing work is carried out in the testing of telescopes, binoculars, sextants, and, more particularly, telescopic sights for the navy. Most of the scientific outfit supplied for the Antarctic Expedition was tested at Kew. The laboratory will also supply a want which is much felt for standardising and testing the many other forms of apparatus in daily use, while investigations will be carried out on points of importance to the manufacturer or the merchant, from the solution of which valuable results may be expected to accrue. I am particularly pleased to know that it is possible that, within the precincts of this laboratory, there will be established a work of the utmost importance—viz., a tank after the design of the late Mr. Froude, in which the performance of a ship can be predicted from experiments on a model. At present there is such a tank at Haslar, which is fully occupied in Government work. The Institute of Naval Architects, impressed with the demand for this work, have proposed to raise the sum required to erect the tank and for the necessary appliances. But the funds at present at the disposal of the laboratory will require to be considerably supplemented if they are to undertake this much-needed work. No doubt the working expenses of the tank will ultimately be met by fees. But a difficulty may arise in tiding over the interval which must elapse before such fees are available. I am confident that, through the generosity of the public, the necessary means will be forthcoming to meet these difficulties and to secure that which is almost an essential to the shipbuilding industry of a country possessing the largest mercantile marine in the world. Before such an audience, I have not presumed to speak of the value to science of this institution. Though the navy has given many notable names to scientific theory, it is the practical results which naturally appeal more to the mind of the sailor, and I am sure you will accept this as my excuse for having ventured to base my few remarks upon the future of this institution from merely an utilitarian point of view. Ladies and gentlemen, I now have much pleasure in declaring the National Physical Laboratory open."

The LORD CHANCELLOR moved a vote of thanks to their Royal Highnesses.

Lord KELVIN, in seconding the motion, said the results to be anticipated from the laboratory, both in a material aspect and from a purely scientific point of view, were very great indeed. A large part of the practice of the institution would have to do with exceedingly minute measurements, sometimes to the millionth part of an inch and the hundred-thousandth part of a degree. This work was very important to science, and it taxed the resources of science more, perhaps, than any other. They must remember that some of the most brilliant discoveries had been due to very minute measurements. Newton's discovery of the law of gravitation was due to such very minute observation. His great generalisation was 10 years at least under his hand and in his mind. He would not declare the result until he had an extremely minute measurement of the earth's dimensions, much more accurate than had ever been made before, and that proved the keystone to the grand arch, and established for ever the law of universal gravitation.

The LORD MAYOR and Mr. W. L. JACKSON, M.P., supported the vote, which was enthusiastically accorded.

In his reply the PRINCE OF WALES said: "I am sure both the Princess and I thank you most warmly for this kind vote of thanks which has just been passed. I am sure, also, that it is not necessary for me to say that it has given the Princess and myself very great pleasure to have been able to come here to-day to take part in these interesting proceedings. I should like before I sit down to announce that Sir William Armstrong, Whitworth, and Co., impressed with the great importance of this work, are prepared to subscribe £1,000 towards its funds. I earnestly hope that such an excellent example as this may be promptly followed by other manufacturing firms."

This concluded the proceedings, and the company adjourned to Bushy House to inspect the physical laboratory.

Report of the Executive Committee from Oct. 1, 1900, to Dec. 31, 1901, submitted to the General Board at their Meeting on March 19, 1902.

At the date of their last report the committee were able to announce that the Government, with the approval of her late Majesty, proposed to allot Bushy House for the purposes of the laboratory. The details of the scheme under which the sites and buildings are held were shortly afterwards settled, and arrangements made to carry out the necessary alterations and to erect some further buildings. This work is now practically complete: its cost has been largely in excess of that originally estimated. Twice during the year it has been necessary for the Executive Committee to ask H.M. Treasury to sanction additional grants amounting in all to £5,000, and the committee are glad to recognise the liberality with which their approaches were met. The accounts are not yet complete, but the total sum expended will reach about £19,000. In addition to this, the committee have authorised the expenditure of over £3,000 on apparatus and fittings. This has been provided out of the sum saved during the past two years the house is only partial. Still, enough experience has been gained

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from the grant for annual expenditure. The committee are indebted to the officials of the Office of Works, and particularly to Mr. E. G. Rivers, surveyor-in-charge, for their care and attention in giving effect to the plans.

The basement and ground floor of Bushy House have been transformed into a physical laboratory, while the upper floors form offices and a residence for the director, in whose salary a corresponding reduction has been made. The basement is covered with a brick groining on which the main building rests, but the more important laboratories are in four large wings, one at each corner, and these have no basement below, thus steady supports are everywhere possible. One wing, containing the original dining-room and library, has been fitted as an electrical and magnetic laboratory. All iron has been, as far as possible, removed from the structure, and, with a view of preventing a stray magnetic field from any currents which may be used, concentric wiring has been employed for all large currents, while the wires for smaller currents have been twisted. In this room will be placed the Lorenz apparatus which the Drapers' Company have recently with great generosity given to the laboratory in memory of the distinguished services to science and to education of the late Principal J. V. Jones, F.R.S., of Cardiff. Along with this there will be other apparatus for the absolute measurement of current and of E.M.F. Another wing has been fitted for thermometric work. A special study will be made of high-temperature thermometers, and the laboratory owes to the generosity of Sir A. Noble the means for installing a number of electric ovens for testing thermopiles and other instruments for the measurement of temperature up to 1,000deg. or 1,200deg. C. In a third wing a metallurgical laboratory has been fitted in which to continue the work begun at the Mint by Sir William Roberts-Austen and the Alloys Research Committee. For this purpose apparatus for cutting and polishing sections, and further photo-micrographical examination, has been obtained. The committee have to thank Mr. Stead for his assistance in arranging this. The fourth wing is fitted as a chemical laboratory. In the basement are a number of constant temperature rooms.

Sir Andrew Noble's fund, referred to in the last report, has provided a measuring machine, a dividing engine, and a comparator, which will be placed in some of the basement rooms. In an adjoining room the resistance measurements of the British Association Committee will be continued, while in another apparatus for the production of liquid air is being set up. The testing of pressure gauges will form an important branch of the work, and for this a mercury column some 50ft. in height has been erected in one corner of the house. Gas and water have been laid on freely throughout the building; also electricity. A 100-volt circuit is connected to the main dynamo and battery in the power-house, and supplies light. Numerous plug points enable a supply to be taken off for lights for experimental purposes or for small motors. For experimental work a special battery of 55 cells has been installed. This is divided into groups of five. Wires run from the switchboard to the various rooms in such a way that one or more of these groups can be switched on to any circuit. Thus voltages between 10 and 110 volts can be obtained as required. The house is heated on the Webster low-pressure system by steam from a Lancashire boiler in the boiler-house at a distance of about 100 yards. The boiler also supplies steam to one of Parsons's 60-kw. turbo-generators, which is the main source of power. The power-house also contains an 18-h.p. Crossley gas-engine, driving a 12-kw. dynamo by T. Parker and Co. This serves as a stand-by, and for charging the main battery of 58 Chloride cells. The engineering laboratory, a building 80ft. by 50ft., adjoins the power-house. This is divided into two bays; a shaft, driven by a motor supplied by Mather and Platt, runs along one, and in it will be placed the lathes, drilling machines, planing machine, and other tools. The other bay is for experimental work. It is traversed by a two-ton crane, and will contain a testing machine and machinery for testing steam-pressure gauges, indicators, and such instruments. For this purpose a valuable instrument has been given by Messrs. Willans and Robinson.

During the year work has been continued at the Kew Observatory, now the observatory department of the laboratory, and further details of this are given in the director's report. The number of instruments tested was 29,184, about 1,100 in excess of those tested last year, and very greatly in excess of any previous year. The increase has been chiefly in ordinary thermometers, telescopes, and sextants. Vessels used in the Babcock milk tests have been examined for the first time. The number of these has been 527. There has been a fall in the number of lenses, watches, and chronometers examined. A considerable amount of time was occupied during the year in testing apparatus for the Antarctic Expedition, and in giving instructions to some of the observers, and arrangements have been made during the coming year to co-operate with the expedition in special magnetic observations.

The committee have to thank various donors for gifts. The Drapers' Company have undertaken to provide the sum of £700 to meet the cost of a Lorenz apparatus. This will be placed in the laboratory in memory of the late Principal Viriamu Jones, and will bear a tablet stating that it has been given by the company for this purpose. Messrs. Willans and Robinson are providing apparatus for testing steam-pressure gauges and indicators, while in a number of cases very advantageous terms have been granted to the committee by manufacturers of tools and machinery. The committee have to thank Lord Rayleigh, Lord Kelvin, Mrs. Hopkinson, and the syndics of the Cambridge University Press for gifts of valuable books. The financial position continues to cause the committee considerable anxiety.

The accounts for the year, which accompany this report, show a balance of £1,528. 13s. 3d.,* but no additional members of the staff beyond the director were appointed until September last, and Bushy House has been occupied for only one quarter of the year. Moreover, the number of the staff is not yet complete, and the occupation of to show that the expenditure on internal maintenance, cleaning, heating, and lighting will be very heavy, while the receipts from fees can grow but slowly, hence the committee can only conclude by again expressing their opinion, in the words of their resolution of last year, to the effect that "The committee cannot, however, conceal from themselves that it will be very difficult for them to maintain and administer a national physical laboratory on the Bushy site for the amount annually allowed by the Treasury, and they fear that it may be necessary for them to press in the near future for an addition to that allowance." In accordance with a resolution adopted at the last meeting of the General Board, this report is made up to Dec. 31, 1901.

Statement of Work for the Year 1902, submitted to the General Board at their Meeting on March 19, 1902.

The new staff is now settled at Bushy House, and work in the various departments has begun. The first task appears to be to set up and test the new apparatus. Much of this will require careful examination and calibration before it can be used for standard investigations. With regard to research work, in accordance with the scheme approved last year, the first place will be given to continuing the investigations of the Alloys Research Committee. Dr. Carpenter, who will be in charge of the chemical side of this, has had the great advantage of working, during the past four months, in Sir William Roberts-Austen's laboratory. Unfortunately, the funds at the disposal of the committee have not been sufficient at present to purchase the complete outfit of apparatus required. The automatic recording instrument devised by Sir William Roberts-Austen and his assistants has yet to be bought, as well as some high-temperature furnaces. The apparatus for cutting and polishing sections and for their photo-microscopical examination is reasonably complete. On the mechanical and magnetic side of the investigation Dr. Carpenter will have the assistance of Mr. Keeling, who, after a distinguished course with Prof. Ewing at Cambridge, has, by the kindness of Sir W. G. Armstrong, Whitworth, and Co., spent some months in their works at Openshaw.

Another investigation referred to in the last report was the measurement of wind pressure. Dr. Stanton hopes before long to attack this problem. In thermometry, Dr. Harker will continue his investigations. During the past year, Sir A. Noble's air thermometer has been set up at Kew, and a number of mercury thermometers have been standardised for the range 100deg. C. to 200deg. C. It was not possible with the arrangements at Kew to work above this range, but a bath giving temperatures between 200deg. and 600deg. C. has been constructed. It is proposed now to set up the air thermometer and the baths at Bushy, and to proceed with the construction of electric ovens suitable for the range between 500deg. and 1,200deg. C. When this is done it will be possible to standardise platinum thermometers, thermopiles, and other apparatus for the measurement of high temperatures up to about 1,200deg. C. Some means of measuring temperatures up to, say, 2,000deg. C., remains to be found. The electrical and magnetic work will, for the present, consist chiefly in making and testing the standards to be used in the standardising work. Mr. Campbell and Mr. Molsome have for some time been busy with this, and there is much to be done in setting up standards of induction and capacity, and for the magnetic testing. Apparatus has been provided for the measurement of resistance, current, and E.M.F., and it is hoped before long that the laboratory will be able to undertake the measurement of resistance and insulation tests, as well as the usual magnetic tests, on iron and steel. For some time past Mr. F. E. Smith has been making preparations for the construction of mercury resistance standards. This work will be pushed on, and the new Lorenz apparatus, given by the Drapers' Company, set up and got into order under the personal supervision of the director. In the engineering department again, work is required to fit the gauge-testing apparatus for use. The mercury column enables pressures up to 250lb. to the square inch to be read directly. Messrs. Willans and Robinson's apparatus will carry the pressure to 400lb. For the measurement of pressures above that amount apparatus has to be constructed. Mr. Jakeman will probably attend to this branch of the work.

As to the commercial testing work, the following list will indicate its scope, though until the laboratory standards have been more thoroughly studied it is hardly possible to do much on a large scale: tests of pressure gauges and steam indicators; tests of measuring appliances and gauges for use in engineering shops, etc. test of screw gauges; tests of thermometers for the measurement of high or low temperature, the platinum thermometer, thermopiles, etc.; photo-micrographic tests on metals, steel rails, etc.; measurement of the insulation resistance and dielectric capacity of insulators; measurement of the electrical resistance of conductors; tests of capacity and induction and of various form of electrical measuring apparatus; tests on the magnetic properties of iron, etc.; standardisation of glass vessels, flasks, burettes, etc., used in chemical laboratories and in various industries — *e.g.*, the dairy trade; standardisation of weights and scales for laboratory purposes; testing of photographic and other lenses. The director hopes before long to issue a pamphlet giving some account of these various tests, together with a statement of fees charged.

Work in the Observatory Department.

The testing of meteorological and other apparatus, which is described in the annual report of this department, will be continued. The attention of the committee is called to the test pamphlet, which was issued last year, and gives a full account of the work done. The various magnetic and meteorological observations will also be continued; although in consequence of the electric trams the former have lost much of their value, it is desirable to continue them until the new magnetic observatory, the establishment of which is engaging the attention of the committee, is in working order. Investigations into some matters connected with terrestrial magnetic measurements will be continued. There are also some questions of thermometry under discussion.

* This sum, as already stated, has been devoted to the scientific equipment.

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THE RAW MATERIAL FOR ELECTRIC CAR DRIVING.

BY F. T. STEWART.

Of the many and varied occupations of mankind few, if any, have during the past two or three years undergone such a remarkable change as that of the tramway servant, particularly the car-driver. This, of course, may largely be ascribed to the electrical conversion of the tramways, and now that the horse has been supplanted by its more compact and hardy rival—the electric motor—it is only likely that many servants (as, for instance, stable hands, puller-up boys, etc.) should, like Othello, find their occupation gone, while the veterinary department (which on a large horse-car system is a very important item) finds its duties to be of a rather limited nature. As already stated, the driver's work differs very considerably from what it was in days of yore, and on the cars, although the hand-brake (of a more improved pattern) is still in vogue, the reins and whip have been entirely discarded for the more convenient controller handle. While what with reduced fares and accelerated services the conductor frequently experiences considerable difficulty in collecting the fares, etc., on a large system with many complicated crossings and junctions, his attention is from time to time required for the purpose of looking after the trolley.

In watching the continual stream of cars in the busy portions of our large towns, it is rather remarkable to note the difference in the sizes and general appearance of the various drivers. While some of them may be 6ft. or even slightly more in height, others are little more than 4ft., and while some are apparently just out of their teens, others appear to be at least 50 years of age. Consequently it might readily be expected that anyone would be suitable for "such a simple job as driving an electric tram," but enquiries would elicit the fact that this is by no means the case. Although it may be comparatively easy to drive a car "in a way," it is only by long and careful practice that a thorough knowledge of the subject can be attained.

On visiting the traffic office on a busy day, one is rather surprised to notice amongst the applicants such a motley crew, all of whom are anxious to act as the "wind cutter" of an electric tram. Some of the applicants are clerks, who have spent most of their time in more or less stuffy offices, and would consequently be poorly suited to withstand the gentle breezes; they are generally told they would never weather a winter, and are advised to try "guarding" for a year or two in order to get seasoned. Next we may have an electrician, who has served his time at So-and-so's, and generally knows "all about it." In some cases, particularly on small systems where extensions are likely to be carried out and a handy man would be of value, he is taken on; it does not, however, follow that because a man has had years of experience in electric lighting, wiring, etc., he is capable of driving an electric car in an effective and economical manner, although his knowledge may incidentally be of value to him in many instances. Many of the applicants may be connected with the railway in some way or other, as, for instance, porters, shunters, pointsmen, or even engine drivers, the latter of whom are accustomed to run trains at a more or less high speed, and imagine that they are just the men. They must, however, bear in mind that they have no distant signal to warn them that a small child is about to cross the line a few yards in front of the car, or a drunken person is about to try the same thing, neither will they be allowed to travel at such a speed as even 30 miles per hour. Frequent applications may also be received from men who have acted as electric car drivers, etc., on other systems, and these are undoubtedly eminently suitable, providing, of course, that incompetence or carelessness was not the reason for their departure from their previous employment, but even in the latter case they may, of course, improve themselves.

"But who," you will probably ask, "are really the most suitable men for the work," and you may or may not be surprised to hear that the best men are those who have acted as drivers on the old horse cars, omnibuses, and even cabs. This may more readily be believed when attention is given to the fact that the making of a good driver depends very largely upon his knowledge of the general traffic of the streets through which his car passes, and it is only natural to expect that men who for years have been accustomed to drive a car or omnibus, and have learnt to know the road as intimately as it is possible to know it, should be the most suitable in this respect. Of course, the majority of them may have only the most limited idea (if any) of the working of an electric car, but they are usually quick and ready to learn, and after being coached for a short time by a "tutor" soon get into the way of it. Through long exposure to the wind and rain, they are also well suited to withstand any of the many and varied changes of weather for which our sea-girt isle is noted. On the tramways size is no object, and so long as a man is tall enough to manipulate the brake and controller handles with ease, he is just as likely to get a job as one who finds the canopy rather low for him. As a matter of fact, the smaller men are frequently capable of giving their larger brethren a few points in good and effective driving, and in at least one instance -viz., at Manchester- -the smallest driver is reckoned to be one of the best.

In the full glory of a new uniform, and the idea of becoming general manager with a salary of anything from £300 to £1,000 per annum, it is quite possible that a new man, when on a car, may be liable to indulge in day-dreams, with the result that he forgets where he is, and there is probably a smash, much to the discomfiture of the driver in question. Carelessness should always be avoided, and the new driver should always endeavour to keep his mind centered on his work and not get excited. He would also do well to practice economy both in the amount of current used and sand, and wherever possible should endeavour to stop and start the car without jerking, as passengers would be saved many more or less serious falls if this point was given more attention.

On some systems a tutor is employed for the purpose of instructing the men in the working of the cars, while on others this work falls to the lot of the older drivers and inspectors. So long, however, as a new man is gifted with a fair amount of commonsense, it is generally much easier to teach him than it is to get him to do the right thing at the right moment when on the car by himself. Whether the drivers benefit to any great extent by the municipal control of the tramways is an open question, but there is generally plenty of room for improvement both with regard to hours of labour, rate of pay, etc. The uniforms now generally provided give the men a much neater and more respectable appearance, and the driver's work is certainly much cleaner, and probably healthier, than it was in the old days.

One advantage of the reversed stairway is that the driver is sheltered from the snow and rain, whereas on the older type of cars no protection whatever is provided, although by the aid of a slight amount of ingenuity and expense this might readily be obviated. The single-decker cars are also usually provided with a canopy over each platform. In some instances, as at Dublin, glass screens are provided. These have several disadvantages, and in the ordinary way would necessitate the displacement of the brake and controller handles. A canvas or waterproof wind guard, somewhat similar to that used on a ship's bridge, would no doubt prove an effective shelter, as it could be fixed so as not to interfere with the brake or controller handles, and at a sufficient height to enable the driver to see over it. It would then protect the controller from damp, and also keep the driver's clothes dry and his hands warm.

Since the advent of the electric car, the term "drivers" is, of course, hardly correct, although in this country they are rarely known by any other name; in America they are generally referred to as "motormen," and in Berlin "wattmen," while possibly the most novel and original appellation is "motoneer." In Berlin it is reported that drivers are subject to a kind of ophthalmia due to the wind currents caused by the car in travelling, and also inflammation of the knee owing to sounding the gong, while through long exposure they are frequently troubled with a kind of sunburn.

Literature with regard to electric car driving is of a rather limited nature. There are several more or less expensive works on the subject of electric traction, but

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few of them make any particular reference to car driving, and in some cases they are of so technical a nature and interspersed with formula, that it is difficult for persons of a limited education and knowledge to understand them. A very handy and useful little book, and one that has been written specially for the use of the car driver, is the "Novice's Guide to Electric Car Driving," by Inspector E. W. Elsley. On some of the larger systems books of instructions are provided for the men, and beyond these the new driver must rely on the information given him by his tutor and other officials and, later on, his own experience.

Unfortunately, on some systems there is a considerable amount of petty tyranny on the part of some officials, both indoor and outdoor, with the result that should, say, a driver or conductor get into the bad books of one of these officials, he stands a good chance of instant dismissal at the first opportunity, even for the most trivial offence. Of course, the officials who exercise their authority in this manner may be in the minority, but they are generally able to make their proximity known, and the sooner matters of this kind are put a stop to the better.

ELECTRIC POWER SUPPLY ON THE NORTH-EAST COAST.*

BY C. S. VESEY BROWN, M.I.C.E., MEMBER.

Amongst the many engineering problems which have during the last few years engrossed the attention of members of this Institution and kindred societies, there are none which may be said to have the same magnetic attraction for both the professional and lay minds as "electrical power supply." It is firmly believed, and, as the author thinks, rightly so, that the adoption of electricity as the motive power in all the thousand and one applications for which power is required in the manufactories of this country, will do a great deal towards enabling the owners of these factories to compete successfully against the very strong bid which has been made by the American and Continental manufacturers for the supply of manufactured iron and steel goods in what has hitherto been looked upon as the sole market for British manufacturers. It is probable that the competition has been less severely felt in the district upon which your attention is more particularly directed to-night, but, nevertheless, signs are not wanting that the time must surely come when certain of the industries associated with the districts in the neighbourhood of the Tyne, Wear, and Tees, will require careful attention to prevent any strong attack by the foreign manufacturer.

The author's intention in presenting this paper is to awaken interest in the question of electrical power supply, as much in the direction of the equipment of the necessary power stations as in the possibilities which lie before their successful instalment, from the point of view of their ultimate requirements, and he asks the indulgence of the members for a brief retrospect of the history of electrical power supply in this country. When Parliament passed the Electric Lighting Acts of 1882 and 1888 it was thought by the general public, and indeed by many engineers, that the possibilities of electric power supply were limited to a radius of two or at the most three miles from the generating station. At that time what may be called the alternating-current branch of the profession were working hard at the development of high-pressure alternating currents, with a view to the transmission of single-phase currents over distances varying from five miles to 20 miles radius from the central station. One of the earliest, if not the earliest, experiments in this direction was in 1890 at the Grosvenor Gallery station in London, where by coupling the trunk cables between that station and Deptford in series, a line of between 13 and 14 miles was interposed between one of the alternators used as a generator to drive the second alternator as a motor, the latter being used in its turn to drive through shafting and belts four horizontal single-crank engines. The loss on the line was about 40 per cent., 2,500 volts being the initial pressure, but the motor ran perfectly in synchronism, and it was proved beyond a doubt that power could be transmitted over this length of line. The members of the Institution are sufficiently well aware of the subsequent discoveries of polyphase alternating currents, and the possibilities which were opened up by these improvements on single-phase generators.

Owing to the difficulties which Parliament had placed in the path of the investor who wished to construct works to supply, under statutory regulations, electrical power over considerable areas in this country, it was not until the year 1900 that any power supply undertakings were authorised; and one had to look abroad for examples of high-pressure long-distance transmission of electrical power, with the solitary exception of the Deptford undertaking, the pioneer of all the extra high-pressure power stations. But it is now possible to say that several power stations have been established on a large scale, and this brings the subject of the paper into closer prominence, for one of the works referred to is that established and in operation at Wallsend; and it may, perhaps, be more correctly termed a "power station" than the others at work in London, the Midlands, and Lancashire, in that it is largely used for power supply to the engineering works on the north side of the Tyne.

The author has prepared a plan of the areas on the North-East Coast over which statutory rights have been granted to supply electrical power, and he has also shown the areas for which powers are being sought in this session of Parliament. It will be seen that practically the whole of the coalfields of Northumberland and Durham are contained in this area, and that the extensive iron ore district known as the Cleveland District of Yorkshire is included. The companies which have obtained Electric Power Acts are the Cleveland and Durham County Electric Power Company (1901), the County of Durham Electric Power Company (1900), the Walker and Wallsend Union Gas Company (1900), and the Newcastle-upon-Tyne Electric Supply Company, Limited (1901), and the Bills in Parliament for session 1902 are those promoted by the Newcastle-upon-Tyne Electric Supply Company, Limited (Extension of Powers), and the Northumberland Electric Power Company.

In this area there are, apart from the works established or authorised under Tramway Acts and electric lighting provisional orders, no less than 11 authorised power stations, to be increased to 13 if the powers sought for this session are obtained, and there are approximately 350 collieries, and, excluding small works requiring under 100 h.p., upwards of 1,000 miscellaneous works, including engine and boiler works, shipbuilding yards, chemical works, sawmills, brickyards, quarries, iron and steel rolling mills, foundries, breweries, dry docks, flour mills, and many other manufactories and works using power of one sort or another. There are also about 100 miles of tramways and light railways, and the North-Eastern Railway system with its connecting mineral railways, and, in addition, there are approximately 150,000 inhabited houses within the 33 authorised distribution areas. From an approximate estimate of the power used in several of the typical works the author considers that the power required to supply the above would not fall far short of 400,000 h.p., and allowing a reserve of 25 per cent. in the plant, machinery to the extent of 500,000 h.p. would be required. In taking into account the probable conversion of the railway system for electric traction, the author is of opinion that the time is not far distant when the whole of the railway systems in this and other countries will be operated by electricity. A commencement in this direction is being made on the Metropolitan Railways in London, and powers are being sought in this session of Parliament to adapt electric traction on at least two authorised existing railways, now operated by steam (one in England and the other in Ireland). From whatever point of view the question is looked at, it is not difficult to show that electrically-operated railways will eventually give greater satisfaction to the users of the line, and to the stockholders whose capital is invested therein, than the present arrangements. Smaller trains and a more frequent service will be the result, with an equivalent increase in the train mileage and passengers carried. No better example of this can be given than the successful running of the tube railways in London. It does not, of course, follow that the division of the above 500,000 h.p. by 11 or 13 stations is an indication of the size of each power station, as undoubtedly the bulk of the power will be required along the banks of the three rivers mentioned; and as there are already in the district some 18 stations (13 for lighting and power, three for lighting, power, and traction, and two for traction only) equipped and in operation with a total of about 33,000 h.p., and with room for expansion beyond the amount, it is not unreasonable to suppose that at least 350,000 h.p. would be required in the power stations, which allows an average of, roughly, 30,000 h.p. per station. In the author's opinion this is properly divisible into two small sets of 3,000 h.p. each and four sets of 6,000 h.p. each. There will always be a considerable amount of power required on Sundays, holidays, etc., such as pumping, hauling, and similar work in collieries, repair work in engine works, shipyards, dock pumping, and traction, etc., which should readily require 3,000 h.p. in each district, and it would be advisable in equipping the stations to arrange that intercommunication is made between each on the trunk mains, in order that separate stations may be stopped down when required on Sundays, holidays, etc., and in this manner the economy in generation will be preserved.

The type of equipment required for these power stations is a matter upon which little can be said here, but one ventures to express the opinion that at no distant date the steam-turbine will be a strong competitor for first place in the equipment, especially in view of the very marked economy at full load and overload which was demonstrated in the recent experiments at Elberfeld. It remains for the advocates of this particular form of steam generator to press forward its claims against the reciprocating engine equipped with poppet or Corliss valve gear. The question of steam generation should also receive careful consideration, and one cannot overlook the enormous amount of heating power which can be derived by combining the waste blast furnace and coke oven gases with efficient water-tube boilers. The combination of blast-furnace gas and the boilers in a generating station of 30,000 h.p. should be able to allow an economy of production which is hard to beat with coal-fired boilers. The use of gas-engines of large power is strongly advocated by many, but beyond powers of 1,000 h.p. or 1,500 h.p. the gas-engine maker has not yet shown that it would be possible to equip an electrical power station with units of 4,000 kw. to 5,000 kw. The system of distribution along the trunk mains should undoubtedly be by three-phase alternating currents. It is difficult to agree with the arguments which have been advanced in favour of two-phase supply. For example, the increase in the copper required for the latter system for the trunk mains would be a very considerable item in the capital expenditure for each undertaking. Where a single-phase alternating system is in use, and it is considered necessary to convert the system to polyphase, it may be advantageous for the time being only to duplicate the mains, but as the business expands the result can only be in one direction—viz., to burden the undertaking with additional capital upon which interest has to be earned, and consequently higher prices charged to the consumer—for there can be no economy in the generation charges in a two-phase system over a three-phase generating station. Those responsible for undertakings similar to that established at Wallsend, where single-phase alternating

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, March 10.

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currents are being displaced in favour of three-phase, are to be congratulated on having taken the right step in abandoning any idea of two-phase generation in favour of three-phase.

The relationship of periodicity to the phase question is of considerable importance, and upon this point there appears to be a divergence of opinion and practice. Primarily the power station is equipped to supply power only, and in the course of time "power supply" will be the bulk of the business carried on, but it is not expected that lighting will be entirely disregarded, and though the greater portion of this will be done by continuous currents transformed through rotary converters from the original alternating current, there still remains the possibility of lighting by alternating currents transformed through the ordinary transformers. The author is inclined to the adoption of 40 periods as a standard, unless the supply is entirely for power purposes, when probably 25 periods is better. On this point a suggestion is made at the end of the paper which it is hoped will bear fruit, and will settle the standard periodicity for the district.

The next important point to be considered is the pressure at which the trunk mains shall be charged, and here there is, if one may express it as such, a distinct timidity to resort to low pressures such as 5,000 or 6,000 volts, instead of at least 10,000 or 12,000 volts. The author had some years' experience in the service of the London Electric Supply Corporation's works at the Grosvenor Gallery and at Deptford, and from the latter works 10,000 to 11,000 volts were and are being transmitted daily to the company's London sub-stations. This undertaking was severely handicapped in its early days by the fact that, at each successive stage in the progress of the works and supply, experiments had to be made to determine the limiting range of the insulation required to keep 10,000 volts "in order" in the dynamos, transformers, cables, and switching apparatus, but in spite of the difficulties which were thus presented, and which have been overcome, there can be no hesitation in saying that 10,000 volts is the minimum pressure at which any power station should generate and distribute along its trunk cables. By fixing the standard of 10,000 volts as the pressure at which the current is to be delivered at the distributing end of the trunk cables, there should be no difficulty in transmitting the power over an area with a radius of from 12 to 15 miles from the power station.

The regulations at present issued by the Board of Trade for those works supplying at 10,000 to 11,000 volts contain a clause limiting the power to be transmitted along each trunk main to 1,000 kw. In insisting on this splitting up of the power the Board of Trade must have overlooked the fact that at the present time gas and water companies are allowed to supply their sub-stations and reservoirs through a single pipe which allow of as much as 4,000 h.p. to 5,000 h.p. being available at the sub-station end of the line, and though the analogy is perhaps not quite the same, yet the insistence of such a clause in the regulations affecting the electric power supply all over the country will add materially to the cost of the distributing the power. There should be no objection to a cable carrying 250 amperes at 10,000 volts with a loss of, say, 10 per cent. on the line, and this would allow of, say, 10 or 12 trunk cables from each works.

In planning out a system of trunk cables there should be no difficulty in arranging that intercommunication through suitable cutting-out devices could be made, and failure of supply minimised accordingly. The adoption of any higher pressure than 12,000 volts is surrounded at present by difficulties with the Government authorities, and, to a certain extent, there would be required more experience in the behaviour of insulating materials before a pressure of, say, 20,000 volts was fixed as the distribution pressure. In connection with the actual generation at 10,000 or 12,000 volts pressure, the author studied the practice of American and Continental dynamo makers at the Paris Exhibition of 1900, and in no case did the pressure exceed 6,000 volts. On investigating the nature of the insulating materials generally used in the armature windings, it is difficult to reconcile this fact with the pressure of 6,000 volts; it may be that the alarming results which were supposed to have accompanied the use of 10,000 volts on the machines and apparatus at Deptford had exercised their influence on this point, but the writer has no hesitation in saying that what has been done in the past can be done now and in the future. There is to-day running at Deptford an alternator generating at 10,000 volts which was constructed as long ago as 1889, and others have been installed since to supply at the same pressure.

Returning to the subject of the distribution of the power along the trunk cables, and assuming that 10,000 volts is adopted, there should be no difficulty in deciding that the distribution shall be by means of underground cables in order to provide for a continuous supply. An agitation has lately sprung up for the purpose of obtaining permission to distribute by means of overhead wires, after the manner of the American and Continental practice. It may be that the suggestion for overhead wires is for the purpose of supplying at a higher pressure than 10,000 volts, and possibly this will account in some degree for the reason of the agitation; but in view of the difficulties of properly insulating overhead wires at the point of attachment to their supports in all sorts of weather, such as was experienced in this district in November and December of last year, one cannot help supporting the action of those in authority who are loth to depart from the regulations laid down on this point. With your permission the author would refer again to the experience of the Grosvenor Gallery works, which at one time was supplying its consumers at 2,500 volts by means of rubber-insulated overhead wires slung by leather tags from steel suspending wires through various circuits, the total length of which was between 80 to 90 miles of route, and though the lines were well put up and each joint carefully made, there was always a considerable leakage of current. It is true that none of the lines were broken or blown down, and this fact redounds to the credit of the men employed on the work, and to the method employed in suspending the lines; but the poles and wires were many times struck by lightning, and one has only to have the experience (one occasion usually suffices) of seeing the effect of a lighting discharge across the air-gap between the armature and fields of an alternator, to wish overhead wires elsewhere. It will doubtless be said that arresters could be used, but even then the results of interruption to supply due to momentarily earthing any line charged with 10,000 volts or more may prove a heavier item of expense than the mere loss of revenue due to the interruption of the service. Some mitigation of the difficulties of overhead transmission might be obtained by the use of insulated wires, but it does strike one as resembling the old saying of "taking coal to Newcastle" to put up overhead *insulated* wires. Why not put a little more insulation on and put them underground? In this particular district it is likely that subsidence of the roads due to colliery workings may take place, and for the protection of the "authorised undertaker" it has been suggested that the penalties to which the undertaker is liable, due to interruptions of the supply from this cause, should not be inflicted, and that the words "or by reason of the operation of any colliery" should be added to that section of the Clauses Act which deals with this point.

The question of distribution of the power at the place where it is to be used is one which can be divided into two headings—(*a*) the isolated works, collieries, tramways, etc., and (*b*) the supply to an aggregation of works and for the lighting of separate districts where the population is large enough to warrant a sub-station. In each case probably the first transformation will be by means of the usual form of static transformer to a low-pressure alternating current, and then through a rotary converter to continuous currents as required. In some of the works and collieries referred to as being isolated, it may suffice to supply alternating currents so that three-phase motors may be run direct off the transformers, but where a number of works are supplied from one sub-station, or where house lighting and small power supply is to be considered, it would probably be better to arrange for a continuous-current supply distributed on the three-wire system, and, in addition to the usual transforming apparatus, there should be installed a fair-sized storage battery for use in case of emergency or repair, etc. From the sub-station to the consumer is a matter which is dealt with in so many ways, and is so well known, that it need not be referred to here in any detail.

A few remarks may be made on the general policy of distributing electrical power from large central stations in view of the opinions which have been expressed against it by many well-known members of the Institution. The two points which directly concern the question are cost and expediency. Is it less costly to generate from, say, one large works with 25,000 h.p. to 30,000 h.p. installed, than from, say, five works, each with 5,000 h.p. to 6,000 h.p.? The author says, "Yes, distinctly so," provided the larger stations are equipped with relatively larger units, but not so if small units of 500 kw. or 1,000 kw. are installed, for then the reduction in costs, as the units generated increase, disappears when probably 5,000 h.p. or 6,000 h.p. output is reached. The expediency of moving the central generating stations from the densely populated and valuable centres of business to the banks of a river and in proximity to a colliery or collieries is undoubtedly right, and the example set by the gas industry in this direction is one to be followed. The opinion has also been expressed that it is difficult to reconcile the assertion that the cost of generation is less for large central stations than for, say, works in Newcastle, Sunderland, South Shields, etc., because, say the opponents of central power stations, each of these towns is large enough to support a central generating station in itself, and that if a number of towns are grouped on to one large station the cost of cables from the station to each town would be so great as to be prohibitive, and, further, that as the maximum load in each place occurs almost simultaneously, there would only result an intensified peak, say, for example, on Saturday evenings. To a certain extent this is true, but as each place with its separate station has to provide a certain proportion of spare plant, and as each of the works are equipped with comparatively small units of plant, each requiring considerable attention, etc., the aggregation of these numerous small units into fewer large units of plant must tend to economy in attendance and reduction in the percentage of spare plant required, and consequently in capital costs.

Against this it will be said that attention is still required at the sub-stations, but even in this event the larger central station, with its sub-stations, is decidedly less costly than a number of medium-sized works. To take an example of what might have been done in the Tees district. The five towns of Hartlepool, West Hartlepool, Stockton, Middlesbrough, and Thornaby are within a few miles of each other. Three of these towns have works of their own at present, and of the other two one is proposing to erect works and the other is applying this session for a provisional order. Why these Corporations did not combine to put up one central station to supply the three towns now working their own plant, instead of at present running three separate works, it is difficult to say; but there is no doubt that a very considerable economy would have been the result, in at least the buildings and generating plant and the management expenses, and when the two other towns were connected the result would have been a cheaper supply for the ratepayers and power users in each place. Generally speaking, the supply of power to the manufactories, shipyards, collieries, etc., from municipal central stations in the district is small—smaller than the supply by the companies established—and though in some towns, such as, for example, Bradford, Manchester, Liverpool, and Birmingham, etc., a considerable motor load is connected to the mains, there is a tendency to hold back from the supply of electrical power by municipal authorities. Whether this is due to the probable uncertainty of the composition of each year's electrical committee, or, on the other hand, the unwillingness of the power user to take any guaranteed consumption, it is difficult to say, but it is for the power supply companies authorised throughout the country and this district to supply the deficiency.

The questions of capital costs for the erection and equipment of the power stations, and prices at which electrical power will be sold to the power users, have been presented to your Institution in many papers at considerable length that it is not proposed to enter into any

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TABLE SHOWING THE INCREASE IN GAS AND ELECTRICITY USED AND THE INCREASE IN POPULATION AND INHABITED HOUSES DURING THE DECADE 1891-1901 FOR ALL THE AREAS FOR WHICH PROVISIONAL ORDERS UNDER ELECTRIC LIGHTING ACTS HAVE BEEN GRANTED, AND WHICH ARE WITHIN THE AREAS DEFINED UNDER THE DIFFERENT ELECTRIC POWER ACTS OR BILLS ON THE NORTH-EAST COAST.

	Electricity.					Gas.						Population.			Inhabited Houses.		
Year.	Prov. orders granted.	Prov. orders put into operation.*	Number of consumers.	Number of units consumed.	Equivalent in 8-c.p. lamps connected.	Gas consumed in the 33 areas, in millions of cubic feet.	Gas consumed in areas where prov. orders are granted, in millions of cubic feet.	Gas consumed in the areas where prov. orders are in operation, in millions of cubic feet.	Gas consumers in 33 areas.	Gas consumers in areas where prov. orders granted.	Gas consumers in areas where prov. orders in operation.	In 33 areas.	In areas where prov. orders granted.	In areas where prov. orders are put into operation.	In 33 areas.	In areas where prov. orders granted.	In areas where orders are in operation.
1891	7	2	341	450,481	23,314	3,731	2,427	997	74,525	52,404	20,000	823,239	530,533	186,300	136,360	76,449	25,423
1896	8	3	940	1,172,538	76,532	4,904	3,418	1,981	94,595	62,330	33,878	—	—	—	—	—	—
1898	9	4	1,413	1,941,431	122,393	5,467	4,095	2,528	111,689	77,473	44,641	—	—	—	—	—	—
1901	33	4	3,026	4,261,731	213,120	5,900	5,900	2,890	120,661	120,661	52,000	1,095,984	1,095,984	458,135	162,191	162,191	61,376
Increase over 1891			2,685	3,811,250	189,806	2,169	3,473	1,893	46,136	68,257	32,000	272,745	565,451	261,835	25,831	85,742	36,953

* Eleven more orders were put into operation late in 1900 or during 1901 from which no returns are available at present.

details, but the author considers that there is a field for the employment of at least 10 millions of capital in equipping power stations and their distributing systems in this district, and provided that sufficiently liberal terms are offered to manufacturers and others to use power, sufficient revenue should accrue to return the statutory dividend to the investor.

Throughout this paper nothing has been said, so far, as to the competition of gas supply and its probable effect on large central stations. Where gas is cheap, as it is in some parts of this district, its functions will be properly discharged in heating, cooking, and power supply by gas-engines, and the annexed table gives some data for the last 10 years which are sufficiently accurate to give encouragement to those engaged in the electrical industry on the North-East Coast that there is a large and ever-increasing demand for light and power. A comparative statement is given showing statistics of the population, inhabited houses, gas and electricity supplied in 1891, 1896, 1898, and 1900 (when the latest reliable returns are available). Incidentally the investigation required for the above table showed that the housing problem is becoming a serious question in the district, for in 1891 there were 6·1 persons per inhabited house, and at the end of 1900 there were 7·8 persons per house. This is also a fact which will give encouragement to those engaged in this district in traction enterprise.

In concluding this short paper, dealing with a subject which is so interesting to all members of the Institution, and which teems with possibilities almost beyond the "dreams of avarice," the author would welcome a free and open criticism and discussion as to the experiences and ideas of those whose business brings them into contact with any phase of electrical power supply, be it as the constructional or managing engineer, or the trader in the electrical apparatus which is so necessary to the power supply authority in extending the business for which the works are established. He wishes to bring before your local committee a suggestion that the power supply authorities mentioned should be approached either by this Institution or any other suggested method to confer on the two points of pressure and periodicity, so that in the laying-out of the trunk mains throughout the area there may be interconnection between adjacent stations for the double purpose of securing economy in generation and standardisation of the motors and other electrical apparatus which will be supplied to the users of power throughout the district. The effect of standardising the periodicity and pressure will tend very materially to cheapen the cost of motors and their accessories, which will act beneficially on the power supply authority, with a corresponding reduction in the costs of production and the price per unit to the consumer. The suggestion which he begs leave to make is that each of the power supply companies, and, if necessary, those who own distribution powers, should appoint a director and an engineer to meet and discuss the two points referred to, and that the conference, or commission, as it may be more correctly described, should be empowered to direct all the power companies to adopt a standard pressure of distribution and a standard periodicity for generation.

ELECTRIC SHOCK.

The following is an abstract of the discussion on the three papers on the subject of electric shock read before the Institution of Electrical Engineers respectively by Major-General C. E. Webber, Mr. F. B. Aspinall, and Mr. A. P. Trotter.

The **President,** in opening the discussion, said the authors had adduced some most important facts which would have very great influence in enabling doctors and other scientists in arriving at some solution of the problems of which the papers treated. He thanked Mr. Trotter especially for his demonstration, because he thought it would do much to remove from the minds of many people the supposed danger of coming in contact with tramway trolley wires and live rails. Only in very exceptional cases it was shown could shocks be of any serious import.

Mr. H. H. Cunynghame, C.B., speaking as one who had been connected with the working of the Factory Acts for many years, said that when he was a member of the Royal Commission on Railways he put this question to two or three of the most eminent engineers who appeared before them. He asked them whether in the whole course of their experience they had come across one case in which the factory laws had really been a substantial drawback to the trade, and in every instance it was admitted that no such case could be found. He was perfectly certain, from what he had heard the Secretary of State for the Home Department say on platforms and in reply to deputations, that there was no desire whatever to make these Factory Acts anything than a means of securing protection for the workman. He did not believe that the trade could have any anxiety about them whatever. Referring more particularly to the subject-matter of the papers before the meeting, Mr. Cunynghame mentioned some experiments he made a few years ago to see how far human beings and animals could stand shocks from a small magneto machine. He found, for instance, that horses were much more susceptible to a shock than men. The nervous organisation of a woman was more highly developed than that of a man, and a man could take a considerably greater shock than a woman. Thus, horses and dogs, whose nervous systems were known to be extremely sensitive, were far more susceptible to shocks than were men. It had been a moot point among medical men as to how far an electric shock without giving pain could affect one's system. It would be very interesting to hear the views of any medical men on this point who happened to be present. He had received the greatest instruction from all three papers.

Dr. Hedley, president of the Therapeutic Society, characterised all three papers as very interesting and instructive, bringing forward as they did the possibilities and probabilities of electric accidents. Referring to Major-General Webber's paper, he noticed that the author was rather down on doctors for regarding the heart as a pump. But to doubt that the force which caused the blood to circulate in a human body was derived from the heart, was to doubt almost the first article of the physiologists' creed. Of course, he was prepared to admit that there were contributory agents, but the heart was the chief factor. The knowledge they had on this point at the present time was that by virtue of their elasticity the arteries exercised a constant pressure on the blood, so that the two chief factors in the production of blood pressure were the action of the heart and the resistance in the capillaries. In the light of these facts they had to consider what happened from an electric shock. Dr. A. M. Bleile's experiments, referred to by Major-General Webber, went to show that when a person was struck by an electric shock the capillaries contracted, and that they thereby formed such an obstacle to the circulation that the heart was no longer strong enough to overcome it. If these results were to be accepted as correct, it followed that the blood pressure should rise, but it fell. By recent experiments it had been proved quite clearly to his mind that low-pressure currents, which were used by Dr. Bleile, killed by acting directly on the heart. High-pressure currents acted in quite a different way. If they put the heart in the path of such a current, it would not paralyse it, but respiration would cease, and after asphyxia had been produced the heart would stop. In point of fact, a strong current continuously applied to the body through the skin acted as a weaker current would when applied direct to the heart. Thus, if the heart was the organ acted upon in this matter, the position of the electrodes and the path of the current through the body were of vital consequence, and experiments had proved that currents were fatal according to how far the heart lay in the path of the current. He mentioned, for instance, that in some recent experiments a guinea-pig weighing 1lb. was killed with 400 joules, and another weighing 8oz. by 250 joules. He agreed that the condition of health one was in at the time of receiving a shock had some influence on the result. The chief points he wished to bring before the meeting, however, were that low-pressure currents killed by direct action on the heart, high-pressure currents acted by stopping respiration, and enor-

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A NATIONAL LABORATORY.

There is much research work the results of which do not seem to have any direct, or immediately direct, connection with commercial work. Such research work may be carried out in any one of various ways. It may be undertaken by young men who wish to obtain a name in the scientific world as investigators, or by monied men who investigate merely for the love of investigation and for the sake of adding to the mass of knowledge in the world; or, again, there may exist a remotely possible chance of the world's advantageously utilising laws discovered by accumulated facts, and investigators may be willing to give their quota of labour to obtain the necessary facts. Take as an example of work that does not seem to promise immediately useful results, the further investigation of the variations of terrestrial magnetism. No one at present sees a very practical outcome to such investigations, but there certainly is a probability of utility; hence in almost every laboratory and observatory throughout the civilised world records are being made and kept in order to be compared and, if possible, forced to give some useful result. It was the result of seeing numberless investigations which did not appeal directly to commercial men not being carried out so expeditiously as might be under the existing circumstances that induced Prof. Lodge, Sir Douglas Galton, and others to urge upon the Government the necessity of a national laboratory. In addition to original research there existed and exists the necessity of investigators using instruments in their researches which are as identical in all respects as science and manufacture can make them, in order that the results obtained may be directly comparable without divergencies to be allowed for other than the "personal equations." After a considerable amount of hard work by individuals and the committee appointed to report the Government agreed to all, the result being shown in the formal opening of the National Laboratory at Bushy House on Wednesday last by the Prince and Princess of Wales. There is no necessity to refer to the opening proceedings at any length here, or to the present equipment, the necessity for further equipment, and the requirement of additional funds in order that the work of such an institution shall be carried out in the most perfect manner possible, as reference is made to these details elsewhere in our columns. The Prince of Wales in an admirable speech, as did Lord Rayleigh, Lord Kelvin, Mr. Gerald Balfour, M.P., and others, directed attention to phases of investigation in which the laboratory might do useful work. We fully concur in all that was said, but would like to reiterate remarks that have been previously made when writing upon the then proposed laboratory. Its efficacy for good will depend upon an individual—the director. Dr. Glazebrook, its first director, has every qualification for his position, and under him we confidently expect good work. Dr. Glazebrook has to organise, and his organisation must be flexible, the great danger to useful work being a clinging to stereotyped custom. The work of the laboratory must vary with the wants of the times, and not be ruled by red-tape and what has been done before. Its work should not be to relieve manufacturers from the scientific investigations needed in their own works, and so relieve someone from the commercial expenses naturally pertaining to factories, but should deal, as has previously been indicated, with investigations that are outside such researches. It seems necessary to say this, as many writers within the last few days have jumped to the conclusion that the National Laboratory is to be the main-

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spring of inventions for all our future progress. Take as one sample references made to iron and steel work. It was hinted that the order for the Atbara Bridge went to America because there they turned out certain standard bridges, but really the work went to America because the factories in Britain were full of work and could not guarantee completion at an early day. The question of early delivery is not a question for a laboratory or of minute measurement: it is supremely a question of £ s. d., and no one except the emotional writers of the sensational Press expects a factory to so organise its business that it shall be ready at a moment's notice to produce work for any demand that may suddenly arise. However, we congratulate the country that it has at last obtained a laboratory for which there is plenty of really valuable work of a character that neither encroaches upon private nor public laboratories, but is essentially national.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

CENTRAL-STATION SERVICE RECORDS.

SIR,—One of the leading daily papers has recently devoted space to particulars of long service records, and this reminds me of a case that is, I believe, unique in electricity works practice. The Shoreditch Corporation's chief electrical engineer (Mr. C. Newton Russell), with his chief station assistant (Mr. G. Kemp), his chief mains assistant (Mr. H. J. Roscoe), and his chief destructor assistant (Mr. E. Wilshear), were all appointed within a very short time of one another, nearly *five* years ago, and these *four* principals have since then held their positions without change. In these days, when station chiefs and chief assistants flit about Great Britain as if it were a chessboard, this record will take some beating. There may be longer individual records, but surely none collectively so long for the positions held. It is hardly necessary to mention the benefits to be derived from the same men running a central station year in and year out, compared with the disadvantages of having a succession of however capable men who are handicapped for a time by imperfect acquaintance with the peculiarities that every station possesses. Farewell gathering, with gold watch, travelling bag, or tantalus presentations thrown in look pretty in print, but the less need for such gatherings the better as a general thing for the station.—Yours, etc.,

Manchester, March 16, 1902. J. BROOKING.

CITY GUILDS EXAMINATION.

SIR,—Could you inform me through your correspondence column whether a slide rule is allowed in the honours grade electric light and power City and Guilds examination, and, also, is more than one pocket-book allowed, and would Fowler's "Electrical Engineers' Year Book" be eligible?—Yours, etc., G. M.

5, Spencer-street, Carlisle.

[We believe that a slide rule is allowed in these examinations, as we know of several who have used them without objection being raised. As regards the other question, the regulation reads as follows: "In the honours grade the candidate may during the examination use an electrical engineering pocket-book; but if he avail himself of this, he must state the title of the book on his answer paper, and in his answers give references to the pages of the book he has consulted." Obviously the use is restricted to one pocket-book, and we should think the one mentioned would come under that category.—ED. *E. E.*]

ENGLISH MEASUREMENT.

SIR,—It is very difficult to say which is the *best* where there are so many good ones, but I would recommend "Young Engineer" to study Wiener for the design of continuous-current dynamos and motors, and Kapp for alternating-current machines. M. M.

PHYSICAL SOCIETY.

At the ordinary meeting of this society on March 14, Mr. S. Lupton (vice-president) in the chair, the Secretary read a paper by **Mr. W. Williams** on **"The Temperature Variation of the Electrical Resistances of Pure Metals and Allied Matters."** In the first part of the paper an attempt is made to correlate the periodic variations which pure metals exhibit as regards their atomic weights, chemical valencies, melting points, and electric resistances. If m is the chemical valency, V the atomic volume, θ the absolute temperature, T the absolute melting point, and C the constant of Pictet's law, then $\sigma \propto \frac{m V \theta}{C T}$, where σ is the specific resistance at 0deg. C. This relation holds for most of the metals, but fails for gold, iridium, tin, and aluminium, and also for metals of the iron group. The temperature resistance coefficients of pure metal are not equal to $\frac{1}{273}$, and an expression for the change of resistance with temperature has been deduced which hols approximately for many metals. The author also obtains simple expressions for the average increment per degree of the specific heat of metals and for the ratio between the specific resistances of the solid and liquid states of a metal at the temperature of fusion.

A paper entitled **"A Suspected Case of Electrical Resonance of Minute Metal Particles for Light Waves—A New Type of Absorption,"** by **Prof. R. W. Wood**, was read by the Secretary. Experiments on which the author has been engaged have led him to believe that he has found a new type of light absorption, which it may be possible to refer to the electrical resonance of small metallic particles for waves of light. Metallic deposits on glass have been produced which are shown by the microscope to consist of particles less than the wave-length of light, and which by transmitted light exhibit colours as brilliant as those produced by aniline dyes. The author has sought to explain these colours by interference and diffraction, and has been forced to accept the hypothesis suggested in the title of the paper. The metallic deposits can be obtained by heating small fragments of the alkali metals in exhausted glass bulbs, when the vapour condenses on the cold parts of the bulbs and forms the films. It can be shown that the colours are due to the presence of metallic sodium (in the case in which sodium has been used) by allowing air to enter the bulb; oxidation takes place, and the film vanishes. In some experiments the air has been allowed to enter very slowly, and the changes which the film undergoes before it vanishes have been examined. The particles which form the deposits can be classed under three heads: (1) coarse particles which diffract or scatter light, and give the bulb a silky lustre; (2) minute particles very close together, which regularly reflect those wave-lengths absent in the transmitted light, but give no scattered light; and (3) minute particles far apart, which diffuse light of the same wave-lengths as those which are to some extent absent from the transmitted light. By observing the spectrum of the transmitted light the author has examined the changes in colour which accompany changes in temperature of the films. The paper gives an account of the relation between the colour of the film and the size and distribution of the particles, and also of the behaviour of the films with polarised light. Experiments upon the electric resistance of the films have proved that they are non-conducting. The author concludes by stating that at the present stage it is impossible to decide either in favour of or against the theory of resonance. The idea of resonance has proved a useful working hypothesis for explaining some of the phenomena described in the paper.

The Secretary read a letter from **Prof. R. Threlfall** drawing the attention of the author to some experiments upon the same subject published by him in 1894. Particles of gold and platinum were deposited in a liquid, and good scattering of light obtained in all cases. The polarisation angle was exactly the same as with non-conducting particles. Prof. J. J. Thomson has shown that the peculiar scattering effect is only to be expected within very narrow limits as to size of particles. The colours observed by Prof. Wood should only be noticed when the particles have a very restricted size, and evidence in favour or against the author's theory should be afforded by comparing the observed and calculated sizes of the particles. The value of the polarisation angle of the scattered light observed by Prof. Wood is evidence in favour of the theory suggested.

The **Chairman** pointed out that the experiments had probably been rendered difficult by the different colours in which the oxides of sodium and potassium can exist.

The society then adjourned until April 11.

NEW COMPANIES REGISTERED.

Burnand Transformer Company.—Capital, £6,000. Objects: to carry on business as manufacturers of and dealers in electrical transformers, electricians, and electrical engineers, etc.

European Electric Railways and Public Works Construction Company, Limited.—Capital, £21,000. Objects: to adopt an agreement with G. W. Jones and C. J. Biggs, and generally to carry on business as contractors for public or private works as mechanical and civil engineers; to construct and maintain rail and tram roads, gas and electric works, etc.

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COMPANIES' MEETINGS AND REPORTS

NOTTING HILL ELECTRIC LIGHTING.

Sir Wm. Crookes presided over the ordinary general meeting of this Company, which was held at the offices, Notting Hill-gate, on Tuesday.

The full report of the directors appeared in our last issue.

The **Chairman** proceeded to explain the reduction in the rate of dividend—from 7 to 6 per cent.—notwithstanding the large increase in the revenue and profit. In the first place, he said, the delay in obtaining the site for the Holland-mews distributing station prevented a considerable amount of additional capital expended on mains and works from being productive. The Company had to pay interest and dividends on £79,500 more capital than in 1900. It could therefore be easily seen in what direction the extra profit had been distributed, and it ought not to be overlooked that the ordinary and preference shareholders, who were allotted new ordinary shares in the proportion of about 1 in 10, received a bonus of practically 2½ per cent. on their holdings, as the shares were negotiable at £2 or £3 above their issue price. The issue to the founders' shareholders of new ordinary shares in the proportion of two for every founders' share held, represented a bonus of about 50 per cent. The distributing stations in Lancaster-road and Holland-mews were now complete, and would be in use directly the requisite junctions were made, so that the Company had at last got out of the unsatisfactory position of having to refuse to supply further customers. Negotiations were pending with the Kensington Borough Council for arc lighting in several of the principal streets in the Company's area, and, in order to meet the growing demand for current, two additional machines had been ordered to be ready for next winter's load. The directors did not anticipate that it would be necessary to issue more share capital during the present year, but if funds were wanted it was proposed to raise them by the issue of debenture capital. He then referred to the satisfactory way in which the Wood-lane works were being run—this Company being jointly interested in the works with the Kensington and Knightsbridge Electric Lighting Company. They were, he added, now obtaining the principal part of their supply from that source, though full use was made of their old plant. All additional supply would be taken from the Wood-lane station, and he believed that there would be a considerable increase in the Company's prosperity in the near future, and at the next annual meeting he hoped to be able to declare a higher rate of dividend. He concluded by formally moving the adoption of the report and accounts.

Mr. A. E. Franklin seconded the motion, which was carried after a short discussion.

A resolution was then passed authorising the directors to issue further debentures, the total to be limited to one-half the amount of the paid-up share capital for the time being.

The meeting, after some formal business, closed with the usual vote of thanks to the chairman.

METROPOLITAN ELECTRIC SUPPLY.

Directors: W. Harrison Cripps, Esq. (chairman); Admiral of the Fleet Lord John Hay, G.C.B.; Sir James Pender, Bart.; Sir Eyre M. Shaw, K.C.B.; Frank Bailey, Esq., M.I.C.E.; F. Leverton Harris, Esq., M.P.; the Hon. John Birkbeck Lubbock; James Carr Saunders, Esq.; John Verity, Esq. General manager: J. Conacher, Esq. Secretary: E. Cunliffe Owen, Esq., C.M.G. Engineer: Reginald R. Todd, Esq.

Report of directors (with abstract of accounts) for year ended Dec. 31, 1901:

The capital expenditure, which at the end of 1900 amounted to £1,417,805. 8s. 11d., has now reached a total of £1,619,731. 2s. 8d., being an increase during the year of £201,925. 13s. 9d. The principal items of expenditure were for the works at Willesden, and for the extension of the low-tension system, principally in St. Marylebone. The gross revenue for the year amounted to £235,741. 18s. 11d., as compared with £209,420. 6s. 1d. in 1900, being an increase of £26,321. 12s. 10d. The cost of generation, which in 1900 was £106,009. 4s. 9d., amounted in 1901 to £112,610. 10s. 3d., or an increase of £6,601. 5s. 6d. The generating plant at Willesden now consists of five machines of 1,500 kw. capacity each. In order to cope with the continued increase of business, two additional machines, each of 3,000 kw. capacity, have been ordered, one for delivery during the present summer, and the other in 1903. A Bill was introduced in the last session of Parliament to confirm a provisional order which had again been granted by the Board of Trade to the Borough Council of St. Marylebone, under which the Council were authorised to enter into a rate-aided competition with the Company. The directors opposed the Bill, and it was amended by placing the Borough Council under obligation to purchase the St. Marylebone portion of the Company's undertaking and business, the operation of the order being suspended until the purchase has been completed. Provisions were also inserted to the effect that the purchase money and compensation to be paid to the Company should, failing agreement, be determined by arbitration under the Lands Clauses Acts. The Bill, so amended, received the Royal assent on July 26, and notice to treat was served on the Company by the Borough Council on Nov. 1. Steps are now being taken to have the purchase money and compensation determined by arbitration. In view of the probability of a rearrangement of the Company's capital becoming necessary on completion of the sale of the St. Marylebone portion of the undertaking, the directors have considered it better at present to provide for current capital requirements by obtaining temporary loans from the Company's bankers, than by the issue of new capital. The hearing of the arbitration under the terms of the London County Council (Improvements) Act, 1899, in connection with the compulsory acquisition by the Council of the generating works at Sardinia-street has been delayed by litigation, which has, up to the present, resulted in the Company's favour. The County Council have, however, appealed to the House of Lords, whose decision is expected shortly. The balance at the credit of the revenue account, before providing for depreciation, is £91,061. 6s. 9d. The directors have set aside £10,000 as an addition to the depreciation and reserve fund, which now amounts to £88,447. 5s. 10d., carrying to the credit of the net revenue account the sum of £81,061. 6s. 9d., which, with the balance brought forward from last account and other receipts, makes a total of £86,033. 0s. 8d. After deducting interest on debenture stock and loans and other charges, there remains a balance of £36,044. 12s. 8d. An interim dividend of 6s. per share on the ordinary share capital was paid on Aug. 15, 1901, amounting to £28,599. 7s., and the directors recommend that a further dividend of 7s. per share on such shares be now paid, making a total distribution of 13s. per share for the year, being at the rate of 6½ per cent. This will absorb a further sum of £35,000, and leave a balance of £1,044. 12s. 8d. to be carried forward to the next account. The directors consider that this result is satisfactory, having regard to the fact that the average price of coal for the year has been higher than in any previous year of the Company's existence, and that the greater part of the capital expended during the year has not yet become remunerative. The number of 8-c.p. lamps supplied by the Company increased during the year from 570,000 to 641,000. The present number of lamps connected is 654,000, and the applications show no signs of decrease. A report from the Company's engineer is appended, showing that the stations, machinery, and plant have been maintained in a satisfactory condition. In accordance with the articles of association, the following directors—viz., John Verity, Esq., Frank Bailey, Esq., and W. Harrison Cripps, Esq.—retire from the Board, and are eligible, and offer themselves for re-election.

Revenue Account.

Dr.		£ s. d.
Generation of Electricity.		
Coal or other fuel	£72,867 2 3	
Oil, waste, water, and stores	7,340 16 10	
Salaries of engineers, etc.	4,076 14 10	
Wages and allowances	12,873 12 4	
Repairs and maintenance	15,452 4 0	
		112,610 10 3
Distribution of Electricity.		
Repairs, maintenance, etc., of mains	742 7 9	
Repairs, etc., of transformers, etc.	2,296 5 0	
Maintenance of distributing stations	561 3 10	
		3,599 16 7
Rents, Rates, and Taxes.		
Rents payable	1,921 15 4	
Rates and taxes	7,008 16 0	
		8,930 11 4
Management Expenses.		
Directors' and trustees' remuneration	3,650 0 0	
Salaries of management, secretary, etc.	8,993 8 3	
Wages of meter readers and inspectors	837 19 4	
Stationery and printing	1,081 16 11	
General establishment charges	2,469 10 7	
Auditors	242 10 0	
		17,275 5 1
Law and Parliamentary Charges.		
Law expenses	700 1 6	
Parliamentary charges	210 11 1	
		910 12 7
Insurance		1,353 16 4
Depreciation in buildings, plant, machinery, etc.		10,000 0 0
Total expenditure		154,680 12 2
Balance carried to net revenue account		81,061 6 9
		£235,741 18 11

Cr.	£ s. d.
Sale of current (11,122,022 Board of Trade units)	228,173 1 11
Rental of meters	7,249 0 2
	235,422 2 1
Rents receivable, including rents, etc.	267 12 7
Work done and goods supplied	52 4 3
	£235,741 18 11

General Balance-Sheet.

Dr.	£ s. d.
Capital account—amount received	1,493,424 18 11
Sundry tradesmen and others	58,184 8 8
Sundry creditors on open accounts	14,290 7 3
Loans from bankers	135,000 0 0
Depreciation and reserve fund	88,447 5 10
Balance at credit of net revenue account	36,044 12 8
	£1,825,391 13 4

Cr.	£ s. d.
Capital account—amount expended for works	1,619,731 2 8
Stores on hand	20,017 1 5
Sundry debtors for amounts paid on account	1,336 19 5
Sundry debtors for current supplied	89,394 2 1
Other debtors	1,649 3 7
Suspense accounts waiting adjustment	7,836 10 8
Deposits (provisional orders, vestries, etc.	175 0 0
Investments at cost	78,081 17 4
Cash at bankers	7,169 16 2
	£1,825,391 13 4

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The ordinary general meeting of the shareholders in this Company was held on Tuesday, Mr. W. Harrison Cripps presiding.

In moving the adoption of the above report the **Chairman** said that £201,995 had been spent on capital account during the year. The great bulk of this sum was for providing new engines and buildings at Willesden, and for the change over in Marylebone from the alternating to the continuous current. Practically the whole of this sum was unremunerative during the year, and would not become remunerative till the change over actually took place in the present year. Part of the extensions of Willesden would be completed in the course of the present summer, when the first of the two additional engines of 3,000 kw. each would, it was expected, be ready, and it was hoped the continuous-current system in St. Marylebone would then be sufficiently advanced for changing over. Turning to the revenue account he remarked that the cost of earning the total revenue of £235,741 was £144,680, which was an increase of £13,761 as against an increase of £26,462 in revenue. This increase in cost was principally attributable to increased rates and taxes and the rise in the price of coal. As regarded the price of coal, it must be remembered that during the last two years it has been extraordinarily high, and if the price paid had been only the average of the last 12 years, the Company would have saved £14,000, which was equivalent to nearly 1¼ per cent. of dividend. Fortunately the price of coal had rapidly fallen, and they had now before them for acceptance tenders for the supply required during the remainder of the year at prices which if they had been in operation last year would have saved the Company upwards of £10,000, a sum equal to 1 per cent. on the ordinary capital. Notwithstanding the exceptional additions to working expenses, there remained a profit of £91,000 as compared with £78,500 last year. It was gratifying to see the continual and progressive increase of the Company's business. Notwithstanding the residue of houses open to be connected becoming smaller, the number of lights required went on at the same steady ratio, and the directors thought there was no assignable limit to that increase. There was an ever-increasing demand for more light, and existing customers were constantly increasing the number of lights in their houses. In conclusion, he referred to the two large arbitrations which the Company had in hand. With regard to the Sardinia-street station, the London County Council's new street between Holborn and the Strand would necessitate their taking the whole of this station. Parliament sanctioned the County Council scheme on condition that the County Council should vest in the Company a new site, which had been agreed upon, and pay to the Company a sum equal to the cost of erecting and fitting up a new generating station upon the new site with new plant of a capacity to generate and supply electrical energy of an output of not less than 4,000 kw., and also pay all expenses to be incurred by the Company in connection with taking up, replacing, relaying, and altering mains owing to the removal of the generating station from Sardinia-street to the new site, both sums to be settled by arbitration under the Lands Clauses Act. That arbitration had been delayed owing to the desire of the Council to get an interpretation from the judges of the meaning of one clause in the Act. The decision of the Court of First Instance was given in favour of the Council. This decision was reversed in the Court of Appeal, and given unanimously in favour of the Company. The Council then took the case to the House of Lords, who with equal unanimity reversed the decision of the Court of Appeal—an instance of the glorious uncertainty of the law. Now this point had been decided, there was nothing to prevent the arbitration coming on at once. With regard to the second arbitration pending, and one of vital importance to the Company—viz., the sale of a portion of their undertaking to the Borough Council of St. Marylebone—they were now obliged to sell a part of their undertaking at a time when, after years of patient waiting, and the expenditure of a large amount of hitherto unremunerative capital, the shareholders were on the verge of reaping an adequate reward for their enterprise. Being in the position of unwilling sellers, they had every confidence that under the Lands Clauses Act the arbitration would result in the award of a fair compensation for this compulsory sale of the best portion of their property with the damage that its severance would occasion to the remainder. He then formally put the motion for the adoption of the report.

Sir James Pender, Bart., seconded, and it was carried unanimously.

OXFORD ELECTRIC LIGHT.

The ordinary general meeting of the shareholders in this Company was held at Oxford on the 7th inst., Sir Henry Mance presiding.

The **Chairman**, in moving the adoption of the report, referred to some of the principal items. The share capital of the Company had been increased by the issue of 2,074 shares and the remaining £1,800 of debenture stock. The expenditure on capital account during the year had exceeded the amount realised by these issues by £1,140. To meet this and to provide for the anticipated capital expenditure of 1902, it was proposed to issue, say, 2,000 shares, which would, in the first place, be offered to shareholders. The bank loan of £2,300 which existed at the end of 1900 had been paid off. Passing to the revenue account, the units of current generated during the year had been 803,000, as compared with 657,000 in 1900, or an increase of 22 per cent. The units of current delivered had been 570,000, as compared with 484,000 in 1900. They expended 1,727 tons of coal, as against 1,337 tons used in the previous year. The cost of coal per unit had slightly increased. This was accounted for by the higher price paid for coal during the year. The additional charge under the heading "maintenance" was explained by the abnormal expenditure of £500 for the new fire-boxes required for the old boilers. Their expenditure on account of rent was slightly increased in consequence of the new station in George-street. Rates and taxes were considerably higher, their assessment for the local rate having been increased from £850 to £1,700. Their sales by meter (£11,938) were nearly 19 per cent. more than for the previous year. The street-lighting remained practically the same. The contract with the Town Council expires this month, but has been prolonged to the end of the year in order to suit the convenience of the authorities. Passing on to the net revenue account, he mentioned that the loss on hire-purchase installations was a little larger than the previous year, principally because two or three installations had been purchased outright, so that the loss on those particular installations fell upon last year's accounts, instead of being spread over a series of years. The net profit for the year, after providing for debenture interest and all charges, amounted to £3,464, inclusive of the amount brought forward from last year's accounts. This was sufficient to pay a dividend of 5 per cent. on the capital, with a margin of £609. 16s. 6d. In comparing this net result with the previous year, it must be borne in mind that they had had to pay additional dividends to the extent of £355 on their increased capital, and that abnormal charges in respect of new fire-boxes to the boilers, amounting to £500, had been paid. The number of lamps connected to the mains during the year had been largely in excess of any previous year of the Company's operations. Seventy-two new consumers were being supplied, chiefly private house customers in the north of Oxford. It was satisfactory to note that the additions had not materially reduced the revenue per 8-c.p. lamp installed. In conclusion, he mentioned that it had been suggested to the Board that if possible the dividends on the ordinary shares should be paid six-monthly, and the Board had this matter under consideration, and, if possible, the practice would be introduced during the current year.

Mr. Courtenay seconded the motion, which was carried unanimously.

WINDSOR ELECTRICAL INSTALLATION.

The annual general meeting of the shareholders in this Company was held at the offices, Windsor, when Mr. M. Drury Lavin, the chairman of the Board, presided.

The **Chairman**, in moving the adoption of the report (which appeared in our last issue), said it was due to the efficient manner in which the chief engineer and his staff had worked that the number of Board of Trade units sold in the past year had risen to 245,694 from 214,338 in the previous year. The policy adopted by the directors of carrying out installation work in Eton and Windsor at a mere shade above cost price has proved successful, and he was pleased to report an increase in the number of lamps connected from 17,808 to 22,689. With regard to the Company's business generally, he mentioned that the rate per unit for power and for the purpose of charging launches, etc., had been reduced to 3d. There was a growing demand for electricity, and further extensions of the Company's plant were inevitable. The directors had accordingly taken time by the forelock, and had ordered another large generating set, which would be ready for delivery as soon as they were prepared to receive it. He concluded by moving, "That the directors' report and accounts for the year ending Dec. 31, 1901, presented to this meeting, be approved and adopted, and that the dividend therein recommended (8 per cent. for the year) be declared and paid forthwith."

Mr. Prior seconded the motion, which was carried unanimously.

NEWMARKET ELECTRIC LIGHT.

The annual general meeting of the shareholders in this Company was held at Newmarket on Monday, Mr. G. H. Verrall presiding.

The report of the directors stated that satisfactory progress had been made during the past year, 2,611 8-c.p. lamps having been connected to the mains. This was a greater increase than in 1900, and made the total connected at the end of 1901 9,591 lamps. Applications for a further 2,466 lamps were awaiting connection, as against 1,127 at the same time last year. Considerable additions had been made to the machinery and mains during the past year. The profit on the year's working, added to £205. 15s. 2d. brought forward from last year's account, amounted to £1,138. 0s. 11d., which after provididing for debenture interest, £461. 2s. 7d., left a balance of £676. 18s. 4d. The directors recommended the payment of a dividend of £2. 10s. per cent., that £100 be written off the preliminary expenses account, and that the balance, £181. 18s. 4d., be carried forward.

The **Chairman**, in moving the adoption of the report, congratulated the shareholders on the progress they were making. They had now 11,107 8-c.p. lamps connected with their mains, and applications in hand for an additional 1,050. Applications equivalent to 2,086 8-c.p. lights had been received since the beginning of the year. The Company had doubled its plant during the past year, and were contemplating an extension of the engine-house with a view of laying down another large engine.

Mr. B. Chennell seconded the motion, and it was carried.

LONDON ELECTRIC SUPPLY.

Report of directors (with abstract of accounts) for the year ending Dec. 31, 1901:

The profit on the working for the year is £25,220. 8s. 2d., to which has to be added interest on deposit and amount brought forward £53. 19s. 8d., making a total of £25,274. 7s. 10d. Out of this the interest on debentures and temporary loans to Dec. 31—viz., £13,308. 8s. 10d.—has been paid, leaving a balance of £11 965. 19s. The Board propose to deal with this amount as follows: by payment of a dividend of 3 per cent. on the preference shares for the year ending Dec. 31, 1901, £7,476; to reserve account, £3,000; to carry forward, £1,489. 19s. The anticipations expressed in last year's report as to efficiency of supply and decrease in cost of production have been fulfilled. The result of this satisfactory service has been a steady accession of new orders. The plant and machinery have been maintained out of revenue,

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and, as will be seen from the engineer's report, are in an efficient condition. It is with deep regret that the directors have to record the death of Lord Wantage, their chairman, who had been a director of the Corporation since its inception. He not only always took the keenest interest in the affairs of the Corporation, but its existence is practically owing to the generous financial support he gave to it. The directors greatly deplore his loss. The vacancy thus caused has been filled by the election of Mr. Robert H. Benson, in accordance with Article 76 of the articles of association. The retiring director is Mr. Robert H. Benson, who is eligible for re-election.

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£ s. d.	£ s. d.
Coal or other fuel	£18,951 17 8	
Oil, waste, water, and stores	2,705 10 6	
Salaries of engineers, etc.	1,868 6 8	
Wages and allowances	5,945 5 9	
Repairs, etc., of buildings and plant	3,086 2 6	
Purchase of current	41 17 4	
		32,599 0 5
Distribution of Electricity.		
Salaries of superintendents, etc.	1,242 15 5	
Wages, etc., to linesmen, etc.	1,455 6 0	
Repairs, etc., of mains	1,301 4 11	
Repairs, etc., of transformers, etc.	1,167 12 8	
Repairs to buildings	212 14 3	
		5,379 13 3
Rents, Rates, and Taxes.		
Rents payable	302 4 4	
Rates and taxes	2,717 0 11	
		3,019 5 3
Management Expenses.		
Directors' remuneration	500 0 0	
Salaries of manager, secretary, etc.	2,642 2 6	
Salaries of canvassers, etc.	766 9 9	
Stationery and printing	232 7 10	
General establishment charges	655 19 6	
		4,796 19 7
Law and Parliamentary Charges.		
Law expenses	67 1 3	
Board of Trade audit	85 0 0	
		152 1 3
Balance carried to net revenue account		25,220 18 2
		£71,167 7 11

Cr.	£ s. d.
Sale of current per meter	66,754 14 3
Sale of current under contracts	475 4 0
Rental of meters, transformers, etc.	3,229 10 4
Transfer fees	12 5 6
Sundry receipts	695 13 10
	£71,167 7 11

Dr. GENERAL BALANCE-SHEET.	£ s. d.
Capital account—amount received	914,700 0 0
Sundry tradesmen and others	11,867 14 9
Sundry creditors on open accounts	7,247 9 2
Net revenue account	11,965 19 0
	£945,781 2 11

Cr.	£ s. d.
Capital account—amount expended for works	914,920 12 4
Cash at bankers and in hand	1,181 18 4
Sundry debtors for current supplied	22,091 4 0
Other debtors	684 18 9
Stores on hand	6,902 9 6
	£945,781 2 11

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY.

Report of the directors (with abstract of accounts) for the year ended Dec. 31, 1901:

The capital expenditure incurred during the year in respect of the Bournemouth Provisional Order, 1890, and the Poole and Branksome Order, 1897, amounted to £26,246. 14s. 4d. The balance from revenue account, together with the balance brought forward from last year, amounted to £15,665. 3s. 7d., from which must be deducted interest charges, depreciation, etc., leaving the sum of £8,918. 11s. 11d. to the credit of net revenue account, as against £8,052. 10s. 5d. for 1900. Out of this sum the full year's dividend on the preference shares has been paid, and the directors now recommend the payment of a dividend on the ordinary shares of the Company at the rate of 7 per cent., less income tax, for the year ended Dec. 31, 1901. These payments will absorb £8,140. 5s., and leave a balance of £778. 6s. 11d. to be carried forward. The equivalent of 65,962 8-c.p. lamps were connected to the Company's mains at Dec. 31 last, showing an increase equivalent to 12,583 8-c.p. lamps connected for the year. The lamps applied for show an increase of 12,378 8 c.p. for the year, as against 10,498 for the preceding year. The Company has been supplying power to the tramways between Bournemouth and Poole since the spring of last year, and terms have now been agreed for supply to the tramways about to be constructed from Bournemouth to Christchurch. The Company's mains have been extended to Poole and Parkstone and to Winton during the past year. The work is practically completed, and a supply is now available in the principal thoroughfares of these districts. The progress made by the Richmond (Surrey) Electric Light and Power Company, Limited, during the past year is satisfactory. The directors of that company have declared a dividend upon its ordinary shares at the rate of 6 per cent. per annum in respect of the year ended Dec. 31 last, as against 5 per cent. for 1900. The retiring directors are Mr. Frederick W. Reynolds and Mr. F. E. Savory, both of whom, being eligible, offer themselves for re-election.

BALANCE SHEET.

Liabilities.	£ s. d.
Capital authorised	300,000 0 0
Capital issued—7,500 preference shares of £10 each	75,000 0 0
7,500 ordinary shares of £10 each	75,000 0 0
	150,000 0 0
4½ per cent. debenture stock	70,000 0 0
Sundry creditors on open account	12,672 1 3
Bills payable	7,997 3 10
Loans against security	51,700 0 0
Reserve from premiums, less preliminary expenses	1,465 19 1
Leasehold and special redemption accounts	1,242 9 3
Reserve for bad and doubtful debts	72 14 7
Depreciation fund account	5,304 15 1
Balance at credit of net revenue account	7,322 1 11
	307,777 5 0

Assets.	£ s. d.
Capital appropriated to the Bournemouth Provisional Order, 1890	187,601 17 9
Capital appropriated to the Poole and Branksome Order, 1897	8,216 19 2
Investments in the Richmond (Surrey) Electric Light and Power Company	96,536 0 2
Christchurch and District Order, 1899	583 11 9
Pending application for provisional order	137 5 7
Stores on hand	859 1 1
Sundry debtors	11,836 16 1
Office furniture and books	23 19 0
Cash at bankers and in hand	1,981 14 5
	£307,777 5 0

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£ s. d.
Coal and other fuel	4,348 9 0
Oil, waste, water, etc.	794 10 8
Engineers' salaries	429 17 2
Wages	1,315 16 11
Stores and works expenses	135 9 11
Repairs to buildings and plant	404 3 8
Distribution of Electricity.	
Engineers' salaries	152 1 8
Wages	203 13 9
Repairs to mains, transformer stations, etc.	214 15 2
Rents payable, and rates and taxes	1,047 0 10
Salaries, local office	416 2 1
Stationery and printing	55 9 0
Postage, travelling, etc., and general charges	182 5 5
Auditor of County Council	10 10 0
Leaseholds redemption fund	10 8 5
Debenture trust fee	78 15 0
Reserve for bad debts	40 0 0
Balance	12,779 7 2
	£22,618 15 10

Cr.	£ s. d.
Sale of current	21,185 3 8
Rental of meters and indicators	919 14 2
Interest and discounts	182 4 9
Trading account	220 8 3
Rents receivable	100 10 0
Testing fees	10 15 0
	£22,618 15 10

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.O.T. units	1,362,500
Quantity sold to private consumers by meter	1,003,401
Quantity used on works	142,370
Total quantity accounted for	1,145,771
Quantity not accounted for	216,729
Total maximum supply demanded (kilowatts)	1,172

DIRECT SPANISH TELEGRAPH.

The report of the directors for 1901, to be presented at the meeting on the 24th inst., states that the accounts show, after providing for interest on the redemption of debentures, a balance to the credit of revenue of £9,706. After adding the usual sum of £5,000 to the reserve fund the balance will amount to £4,706, and the directors recommend the declaration of dividends for the year of 10 per cent. on the preference shares and 4 per cent. on the ordinary shares, amounting to £5,417. Half of this amount was distributed on Oct. 1, 1901, as an interim dividend for the half-year ended June 30, 1901. The dividends on the preference and ordinary shares will absorb the balance of the contingencies account—namely, £566 and £145—from the reserve fund. The traffic receipts show a decrease of £699 as compared with 1900, which is entirely due to the cessation of traffic on the Barcelona cable during interruptions. The ordinary working expenses show an increase of £527 as compared with 1900. As stated in the last report, the Bilbao cable broke down close to the Spanish coast on Dec. 27, 1900. This cable was restored on Jan. 23, 1901, and has worked well since. The Barcelona-Marseilles cable has unfortunately been twice interrupted during the past year, the first interruption, on

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Jan. 6, which was mentioned in the last report, having continued till April 7, 1901. The delay in repairing this cable was due to unusually bad weather in the Mediterranean. The second interruption of this cable occurred on Dec. 3, and was promptly repaired by the Eastern Telegraph Company's cable ship "John Pender" on Dec. 16, 1901, the interruption having lasted only 14 days. The cost of these repairs, amounting to £15,231, has been taken from the reserve fund, which was established for repairing and renewing the cables.

LEGAL INTELLIGENCE.

SECONDARY GENERATORS' DISTRIBUTION COMPANY.

The Court of Appeal, composed of Lords Justices Vaughan Williams, Stirling, and Cozens-Hardy, on Monday resumed the hearing of the case of the National Company for the Distribution of Electricity by Secondary Generators on the appeal of Mr. Adam Scott, a shareholder, from an order of Mr. Justice Wright dismissing his petition to have the winding-up of the company continued under the supervision of the Court, the company being in voluntary liquidation.

The grounds on which Mr. Scott asked for the supervision order were that there were matters requiring searching investigation which could only be obtained by a compulsory winding-up order, and, secondly, that such an order would tend to the recovery of a large sum of money, which would benefit the whole body of the shareholders. The hearing had been adjourned from March 1 to enable the liquidator to make a report as to the presents of shares and the other matters brought into question by Mr. Scott.

Lord Justice Vaughan Williams said the Court were of opinion that they ought not to allow this appeal. He himself arrived at this conclusion with some reluctance, because he was by no means satisfied that the complaints which had been urged by Mr. Scott were entirely without foundation. More than that, he was by no means sure that the matters he complained of were not matters which, if investigated, might result in increasing the period which would have to be dealt with in the liquidation. He did not, however, think that Mr. Scott had made out a sufficiently substantial case to justify their setting aside the existing voluntary liquidation. The appeal was dismissed.

FINCHLEY ELECTRIC LIGHTING.

Before Mr. Justice Farwell in the Chancery Division of the High Court on Tuesday there came on for hearing the case of the Finchley Electric Light Company, Limited, *v.* the Finchley Urban District Council, which was an action for an injunction to restrain the Council from cutting the wires of the company erected across Regent's Park-road, Finchley.

Mr. C. E. E. Jenkins, K.C., and Mr. Buckmaster appeared for the company and Mr. Upjohn, K.C., and Mr. Lyttelton Chubb represented the Council.

It appeared from the opening statement of counsel that the Finchley Electric Light Company was incorporated in 1899 under the Companies Acts to supply electric light and power in the neighbourhood. It had no provisional order from the Board of Trade, and was not incorporated under the Electric Lighting Act of 1888. The Council in 1898 obtained a provisional order from the Board of Trade enabling it to supply electricity to the inhabitants in its district. Immediately after the company was incorporated, the Council set to work to supply electric light in the district. For this purpose it laid a main down Cavendish and Stanhope avenues, which were private roads not vested in the Council, and over which it had no control. The company laid the mains under the footpaths instead of under the middle of the road, and the Council at once said that it would decline to take over any of these roads if the mains were laid in that way. It insisted that the mains should be laid in the middle of the road. The company found itself in a difficult position. It had to get across the road in order to supply light to a customer, and it obtained a license from the Council to open the road for the purpose of laying a water-pipe. The company laid the pipe, and at the same time laid the electric main. This aggravated the Council, said counsel, because when once the main was laid it could do nothing. The Council then commenced proceedings against the company to restrain it from opening any road in the Council's jurisdiction without giving notice of its intention so to do. That matter was settled upon terms that the company would in future give the required notice, and each party agreed to pay its own costs. The company went on with its business by erecting the wires overhead. In September, 1901, the company desired to supply a customer, and had to place a wire across Regent's Park-road. The Council objected, and gave notice that if any wire were placed above ground across any street without its consent the Council would remove the wire. The company did so erect a wire, and the Council cut it in two, and threatened to cut any other wires similarly placed. Hence the present action. The case came before the Lord Chief Justice, in the vacation, on a motion for an interim injunction. That motion was opposed on the ground that the statute of 1888 gave the Council the right to prevent the crossing of the road by the company's wires. This defence failed, and the Lord Chief Justice granted the injunction till the trial. Pleadings were then delivered, and the Council for the first time asserted the plea that the road across which this wire stretched was a road the fee simple of which was vested in the Council. It was on this point that the whole case turned, and the company contended that the Council was not owner in fee simple of the road.

Mr. Justice Farwell, in giving judgment, held that the fee simple was vested in the Council, and therefore it had the right to prevent the stretching of the wires across the road.

The action was accordingly dismissed, but without costs.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

[Will Mr. C. A. Bowen kindly send us his full address.—ED. *E.E.*]

QUESTIONS.

465. Is there any objection to feeding an overhead wire system of trams by means of a three-wire system, with, say, 1,000 volts between the outers and the inner earthed?—T. P. S.

466. Many high-speed steam-engines which govern well when running on the condenser show a tendency to hunt when exhausting into the atmosphere. What is the cause of this tendency, and to what extent can it be corrected?—E. C.

ANSWERS.

Question No. 459.—I wish to obtain two voltages from the same dynamo. Mr. Sayers stated in 1898 that this can be done for the purpose of exciting the field magnets by means of a third brush, the current, of course, in this case being small. Could I on a 100-kw. dynamo take off 60 kw. (variable load) at a third brush and the remaining 40 kw. at the usual brushes? If not, why not, and what must be done to render it possible? The high voltage (360) is desired for charging accumulators, and the lower voltage (250) for driving motors, etc.

Best Answer to No. 459 (*awarded* 10*s.*).—Mr. Sayers's third brush arrangement is perfectly satisfactory in practice so long as the third brush current is a negligibly small proportion of the output of the machine, but as soon as larger currents are required sparking troubles occur. Even if the machine is a specially well-designed one, with plenty of commutator segments and small reactance voltage per section, so that it works with fixed brushes at all loads and requires practically no reversing field for commutation, yet it is certain that it will not be able to commutate any considerable current when commutation has to take place in a powerful and unalterable field, such as would exist at the third brush. In order to obtain the necessary reduction in voltage, the third brush must be placed well within either the trailing pole or the leading pole, the former giving a field tending to maintain the current, and the latter a field tending to reverse the current in the section under the brush. The leading pole might cause less sparking than the trailing one, but both would be quite unworkable.

The fact that a small shunt current can be successfully dealt with by a third brush is accounted for by the absence of any real commutation in this case. The only change produced under the third brush is a slight increase in the amount of current in the section when on one side of the brush, above its value when on the other side, and the reactance voltage due to this change is negligibly small. The only possible source of trouble is therefore the danger of a heavy current being induced in the section during the time that it is short-circuited under the third brush. This is, however, avoided partly by the high contact resistance of the small brush required to carry the shunt current, and partly by the self-induction of the section (which is at its maximum when right under the pole, as in this case) preventing any sudden increase in current.

Though a machine cannot be transformed into a double-voltage dynamo simply by the employment of a third brush, yet by the introduction of another of Mr. Sayers's suggestions, in addition to the third brush, it is highly probable that a perfectly satisfactory solution of the problem could be obtained. This suggestion consists in cutting a deep slot in the pole-face, the whole length of the magnet parallel to the shaft, at the point where the third

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brush is to work (see Fig 1). In this way a graduated fringe of magnetic lines will be produced, in which the correct strength of field for successful commutation would be easily found by a slight adjustment of the third brush. The depth of the slot should be about three or four times as great as the working air-gap of the machine, from armature core to magnet bore, and its width should be about equal to its depth. The slot should be cut under the leading pole.

In the particular machine mentioned the forward edge of the slot should be placed at a distance, x (Fig. 1), equal to $\frac{360 - 250}{360}$ × whole polar arc from the leading horns of the machine. Fig. 1 shows the approximate distribution of the currents in the different parts of the armature winding at any instant. This has been worked out on the assumption that the currents divide up in such a way that the voltage drop from brush A to brush B due to resistance, is the same on both sides of the winding. This is not quite correct, as the unequal armature reaction will tend to equalise the currents, and the actual differences will not be so marked as those shown. It will be seen that the current in one half of the armature winding is as much as

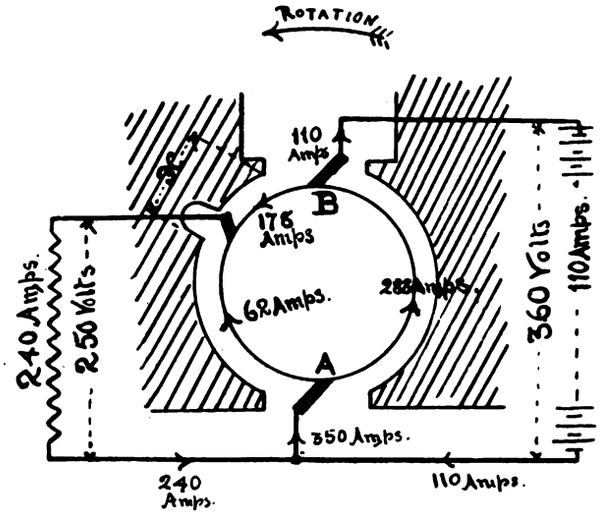

FIG. 1.

288 amperes, whilst the machine is presumably wound for $\frac{100{,}000}{250 \times 2} = 200$ amperes on each side. As, however, this large current is in any one conductor only during half of each revolution, this should not lead to any serious overheating. Since brushes A and B are commutating decidedly different currents, it will probably be necessary to adjust each of these brushes separately as well as the third brush. The diagram, for simplicity, represents a two-pole machine, but the arrangement can be equally well applied to a multipolar machine if a similar slot is cut in every other pole, and provided that the armature is not fitted with equalising circuits, as these latter would give rise to idle internal currents, causing waste.—Q.

Answer to No. 459 (*awarded* 5*s.*).—It is unfortunately impossible to collect from a dynamo currents at two voltages by means of a third set of brushes placed between the other two. It is true that small currents may be so collected, but even they cause a lot of trouble. The reason for this is two-fold: (1) the commutation difficulty; (2) the armature is thrown out of balance electrically.

1. When a coil on the armature is commuted in the ordinary way, the current in it has to be completely reversed. This reversal must be quite finished during the time which the coil is under the action of the brush—which is called the time of short-circuit—otherwise at the last instant the current in the coil has to jump from one value to another in an infinitely short space of time. In order for it to do this we must have a very high voltage between the armature coil and the one next to it, and hence between the commutator bars to which they are connected, so that sparking is bound to result. In Fig. 1 take the horizontal line to represent time, and let a portion of it, O T, be the time of short-circuit of the coil in seconds. Also let O C_0 represent the full working current in the coil at the instant when commutation is just beginning, and T C_t the same current, only in the opposite direction, which has to obtain directly commutation is finished. The value of the current flowing in any armature coil is therefore given by the line A C_0, C_T B, and when the current reaches the value T C_T, it will remain constant at this until the coil comes under the action of the next brush, when identically the same operation will be repeated, only in the opposite direction. Now, the portion of the current curve A C_0 C_T B, which we do not know the actual values for, is C_0 C_T, and on the way in

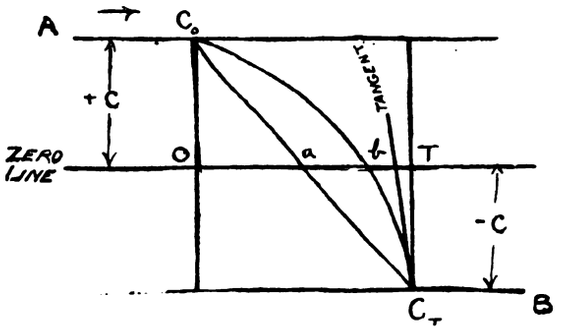

FIG.

which the current passes from C_0 to C_T everything regarding sparking depends. Hawkins has proved in his treatise on "Commutation" that so long as the rate of change of current at the last instant is not too great we obtain sparkless commutation, and a measure of this rate of change is evidently obtained by drawing a tangent to the curve at the point C_T, and the nearer this tangent approaches the vertical the greater is the rate of change of current, and hence the sparking tendency. Thus the curve b is evidently much worse than the curve a. If the resistance of the armature coil is negligible compared with the contact resistance of the brush (which is usually the case, especially with carbon brushes), then it is easy to see from Fig. 2 that if we neglect everything but this resistance the current will come across as a straight line, C_0 a C_T. In

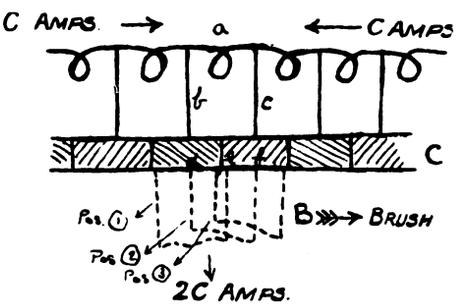

FIG. 2.

Fig. 2 we have a diagrammatic view of the armature winding, commutator (c) and brush (b). For simplicity, the armature is supposed to be fixed and the brushes moving. We have a current of C amperes flowing from each direction, coming down through the commutator, uniting in the brush, and flowing away to the outside circuit. Consider any coil a. When it is not being commuted it has a constant current of C amperes flowing in it, but directly the brush reaches position (1) *commutation starts*, and a small current starts flowing down the lead c, and hence diminishes the current in the coil by that amount. At position (2) the current flowing down the lead b will be rapidly decreasing, till when position (3) is reached it has all but stopped, hence the coil a is just starting to take its full current again, and *commutation is just finished*. Now for any intermediate positions between (1) and (3) the total current, 2 C, must split itself up between the two parallel paths, b and c, inversely as their resistances, and since we may neglect all resistances but that of the surface resistance of the brushes, we have when commutation is half completed—that is, the brush in position (2) —that

$$\frac{\text{Current in } b}{\text{Current in } c} = \frac{d\,e}{e\,f}; \text{ but } d\,e = e\,f.$$

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Therefore C amperes will flow down both *b* and *c*, and hence no current can exist in the coil *a*. Hence we see that in Fig. 1 at half the time of short-circuit the current in the coil is zero. Hence we must have the straight line, $C_0\ a\ C_T$, if we have only brush resistance to consider. Unfortunately, however, we have the induction of the coil coming in, and this, of course, tends to resist the current changing; thus it hangs back and gives a curve similar to that labelled "*b*" in Fig. 1. In order to neutralise this effect and keep the rate of change of current at the last instant low, we give the brushes a lead, the effect of which is to shift the position of the short-circuited coil towards the pole-tip, where the fringing field is such that it will generate a small E.M.F. against the current, thus tending to help it die down and neutralise the induction. We are thus enabled to keep the curve more like the curve *a*. It is evident that the brushes must be shifted into a field which is *opposite in polarity* to that where the current (which it is wished to commute) has been generated. Now, in the case mentioned in the question the third or low-voltage set of brushes would be right under the middle of the pole which is generating the current, so that not only could we *not* move them into a field which would neutralise the self-induction of the coils, but they are actually placed in a *very* strong field which is helping the self-induction—*i.e.*, keeping the current flowing so that it cannot die down. The rate of change of current at the last instance is thus very great, and the sparking which ensues renders it impossible to run even with the best brushes.

2. If we work out the currents for the outputs mentioned in the question we have:

$$60 \text{ kw. at } 250 \text{ volts} = \frac{60 \times 1{,}000}{250} = 240 \text{ amperes};$$

$$40 \text{ kw. at } 360 \text{ volts} = \frac{40 \times 1{,}000}{360} = 110 \text{ amperes.}$$

Now, assuming the machine to be two-polar, as in Fig. 3, let B_1 and B_2 be the brushes collecting the high-voltage current, and B_2, B_3, and B_4 the brushes collecting the low-voltage current. We have in this armature two parallel paths for each of the currents. Hence

Current in bars between

$$(B_1 \text{ and } B_3) \text{ and } (B_1 \text{ and } B_4) = \frac{110}{2} = 55 \text{ amperes.}$$

Current in bars between

$$(B_2 \text{ and } B_3) \text{ and } (B_2 \text{ and } B_4) = \frac{110}{2} + \frac{240}{2} = 175 \text{ amperes.}$$

Hence all the bars on the lower side of the armature are carrying over three times as much current as those on the top half. The armature is thus out of balance electrically.

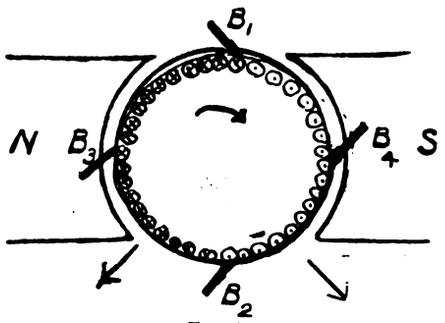

FIG. 3.

One effect of this is that the poles will exert an increased magnetic pull on those parts of the armature which are carrying the greatest current. This will cause undue wear of the bearings, and probably set up a great deal of vibration when running, the accumulation of current at a particular part of the armature being, in fact, a similar state of affairs to that which produces the phenomenon known as "bucking." Probably the most satisfactory way of getting current at two different voltages from the same machine at the same time is to provide two commutators, one at each end of the armature, each of which is connected to its own separate armature winding, which is regularly distributed round the circumference of the armature. The two windings are thus mechanically interleaved, but electrically unconnected with each other.—T. SQUARE.

Question No. 460.—Explain what is meant by the limiting resistance and critical speed of a shunt dynamo.

Answer to No. 460 (*awarded* 7*s.* 6*d.*).—The critical speed of a shunt dynamo is the minimum speed at which it will "build up" its field, the external circuit being open, and a slight initial flux through the armature due to residual magnetism being assumed to exist. Expressed in another way, the critical speed is the speed below which the dynamo, having fully excited itself, cannot be run without losing, if not all, at least a large proportion of its magnetism. Suppose the dynamo be running at its normal speed and voltage with the external circuit open. If the speed be gradually reduced in steps of, say, 5 per cent. at a time with a pause between each reduction, and the next to permit the magnetism to attain its steady state for the particular speed, the readings on a voltmeter connected

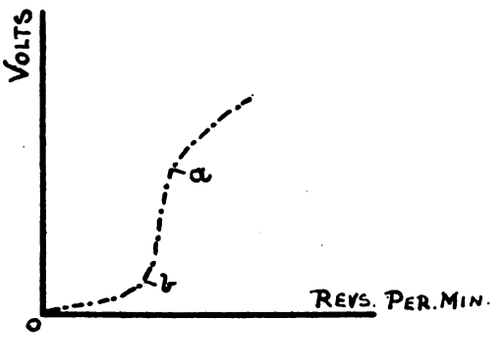

FIG. 1.

across the terminals will at first indicate a gradual drop in volts with speed. When, however, a certain speed, which is usually about two-thirds normal speed, is reached, the voltmeter will indicate a more or less sudden increase of the rate of fall of volts with speed. This high rate will continue until a very low voltage is reached, when the rate of change gradually becomes less again. This lower stable state corresponds to the voltage due to residual magnetism, and, of course, never comes within the working range of the dynamo. The curve connecting speed and volts will be approximately of the shape shown in Fig. 1, the working range being from *a* upwards, the critical speed being at *a*, and the voltage due to residual magnetism being shown by the lower part, *b o*. The definiteness of the point of critical speed—*i.e.* the steepness of the line *a b*—depends partly on the proportions of air-gap and iron excitation at the normal output of the machine,

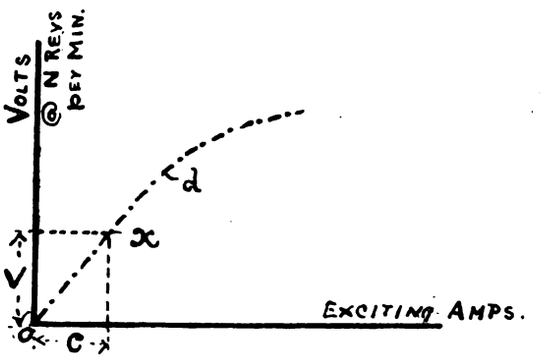

FIG. 2.

and partly on the shape of the permeability curve of the iron employed for the magnets. Thus, an iron having a rounded permeability curve, such as most qualities of cast iron have, would give a less definite critical speed than one having an abrupt bend such as wrought-iron curves generally exhibit, especially if the excitation for the iron form a large proportion of the total excitation. If the no-load magnetisation curve connecting terminal volts and exciting amperes at any speed is known, either by calculation or experiment, the critical speed of the machine can readily be determined. Thus, let Fig. 2 represent such a magnetisation curve at a speed of N revolutions per minute, and let R be the resistance of the shunt winding in ohms. Select any point X on the straight part of the curve O *d*,

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and read off the exciting amperes, C, and the corresponding voltage, V. Then the critical speed of the machine in revolutions per minute is $N \times \frac{C \times R}{V}$, for that is the lowest speed at which the voltage generated by a given flux through the armature is large enough to pass a current through the shunt winding sufficient to produce that flux.

Turning next to the remaining part of the question, the limiting or critical resistance of a shunt dynamo is the lowest amount to which the external resistance across the terminals can be reduced without causing the external current (which at first, of course, increases as the resistance is reduced) to fall. The critical resistance is different for every speed, being lower the higher the speed at which a given dynamo is run. Fig. 3 shows the characteristic

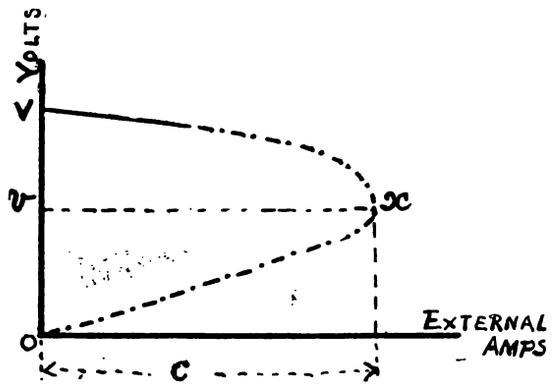

FIG. 3.

curve of a shunt dynamo, the full line covering the usual working range of the machine, and the dotted part showing the effect of gradually reducing the external resistance. Starting with the external circuit open—*i.e.*, an infinite external resistance—the voltage at a given speed is V. As the external circuit is closed and the number of lamps across it increased (external resistance reduced), the voltage, at the same speed, gradually drops at a constantly increasing rate until a sudden bend occurs at a point X with a current, C, which is usually two or three times the normal current of the machine. Then the resistance, $\frac{V}{C}$, obtained by dividing the voltage at the point X by the current, C, is the critical resistance of the machine for that particular speed. If the external resistance is still further reduced, both the volts and the amperes fall off to zero along the dotted line, X O, and since this line is practically straight and the ratio $\frac{\text{volts}}{\text{amperes}}$ is only very little less just before zero than it is at the point X, the whole drop is produced by a very slight reduction in the resistance. The critical resistance depends partly on the armature resistance and partly on the armature reaction, for the external current can only rise to such a value that the shunt ampere-turns at the reduced voltage, V, and opposed by the armature reaction due to the increased current, C, can just produce enough flux through the armature to generate the voltage V + the volts lost in the armature resistance at the current, C. On this account slotted armatures, with their larger armature reaction, can never stand as great an excess load before the point X is reached as smooth-cored armatures.—Q.

Answer to No. 460 (*awarded* 7*s.* 6*d.*).—The limiting resistance of a shunt dynamo is that resistance which, when we reach its limits, results in the magnetisation becoming unstable, and if we go over this limit the machine will fail to excite itself. The E.M.F., E_a, generated in the armature of a dynamo $= \frac{Z \times w \times n}{10^8}$ where Z = flux, w = number of armature conductors, n = speed per second, so that if w and n are constant the E.M.F. will be proportional to the flux, and as the flux depends on product of number of turns in field winding and current in shunt, therefore with a constant number of turns the E.M.F. will be proportional to the current in shunt, C_s. This is shown in Fig. 1, where ordinate represents E.M.F., E_a, and abscissa, C_s. From this it will be seen that an increase in C_s will produce an increase in E_a, and *vice versâ*, as shown by curve P Q, which is the internal characteristic. Now, by Ohm's law $C = \frac{E}{R}$; $\therefore R = \frac{E}{C}$, and as $a\,b$ in Fig. 1 represents volts, and P b represents current, $\therefore$ resistance $R = \frac{a\,b}{P\,b}$. But $\frac{a\,b}{P\,b}$ = tangent of angle $a\,P\,b$, or ϕ; $\therefore$ resistance, R = tan $a\,P\,b$, or tan ϕ. Therefore, the line P a denotes the resistance in this case. Now, the E.M.F., E_s, produced at the terminals of the shunt dynamo on open circuit $= E_a - C_s \times R_a$, where R_a = resistance of armature, and C_s = current in shunt, which on open circuit

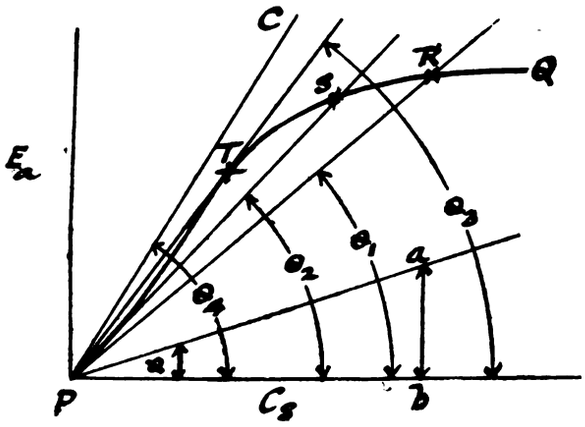

FIG. 1

is equal to the current in the armature. Now, as shown above, tan ϕ = resistance; $\therefore$ tan ϕ may be taken as resistance of armature, or R_a; $\therefore a\,b = C_s \tan \phi = C_s R_a$.

The resistance of armature corresponding to a point R on curve is tan ϕ_1. If we increase the resistance to tan ϕ_2, then S is the point on curve; if to tan ϕ_3, then T is the point, this showing that a gradual increase in the resistance brings down the voltage, and if we were to increase it to tan ϕ_4, then we would have no volts at all, since line P C does not touch the curve P Q. The limiting resistance is tan ϕ_3, because line P T is the last line to touch curve P Q. The limiting resistance is therefore denoted by the line drawn as a tangent to the internal characteristic P Q; anything over this limit (ϕ_3) the machine fails to excite.

The critical speed of a shunt dynamo is that speed which, with a constant resistance in the shunt, limits the point to which the speed can be reduced; any speed under this value, the machine will fail to excite.

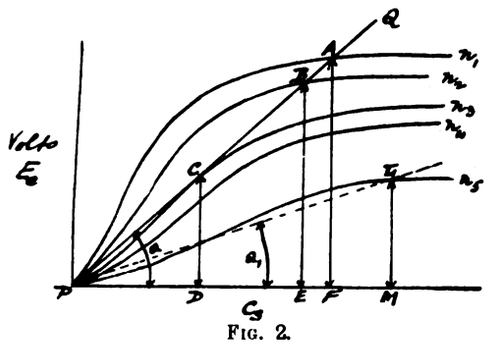

FIG. 2.

Referring to Fig. 2, the curves n_1, n_2, n_3, n_4 are the characteristics produced at the speeds n_1, n_2, n_3, n_4 with a definite resistance, tan ϕ, in the shunt. It will be seen that as we lower the speed we reduce the volts, since at n_1 the voltage is A F, at n_2 it is B E, at n_3 it is C D, and at n_4 we get no volts at all, since with tan ϕ we do not touch curve n_4. The critical speed is n_3, since at any speed below this value the machine fails to excite because we get no volts, curves below n_3 failing to touch line P Q. If we reduced the resistance to tan ϕ_1, however, we would excite the machine even at speed n_5, as shown by volts L M. The critical speed is, therefore, denoted by the curve which just touches the tangent representing the resistance of shunt, as shown by n_3 touching tangent ϕ at point C.—R. S.

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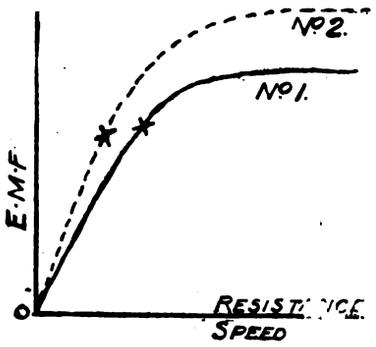
Answer to No. 460 (*awarded* 5*s.*).—In a shunt machine the current from the positive brush to the negative has two paths—viz., through the external circuit and through the shunt coils—the relative magnitudes of which will vary inversely as their resistances. Now, if the dynamo is on open circuit—*i.e.*, the external resistance is infinite—the maximum voltage will be produced, but as this (the resistance) is reduced the voltage will keep constant for a time, as shown by curve No. 1, and will then gradually fall away to a point, X, when the machine will become very unstable, and will fail to excite itself, the voltage falling away very rapidly, therefore from the point X to infinity is the limiting resistance of a shunt-wound dynamo. In the second part of the question to is best to again refer to a characteristic curve showing the relation between E.M.F. and speed. It will be noticed that as the speed increases the E M F. also



increases, as shown by dotted curve No. 2, very rapidly at first; then as the field magnets become saturated, much more current is required to give a certain E.M.F. than when they were not so strongly magnetised, a slower increase is noticed until a maximum is reached. Suppose the dynamo has a load on, and from some cause the speed falls, it will supply a current for some time (although not at the same voltage) until a point X is reached. When the speed falls below this the dynamo becomes very unstable, and fails to excite itself, consequently the voltage falls away very rapidly, therefore this point X is the critical speed of a machine. It is a point in a curve where the straight line portion (starting from 0) finishes.—G. P. D.

Answer to No. 460 (*awarded* 5*s.*).—Imagine a shunt dynamo working at constant speed on a circuit of variable resistance. As the external resistance is decreased, the current in the circuit, and therefore in the armature, is increased. The primary tendency of this is to cause a greater drop of voltage across the armature. This lessens the volts at the terminals of the shunt coil, and therefore the current in the magnet coils. Again, the tendency is to lower the E.M.F. of supply. In Fig. 1 is shown an

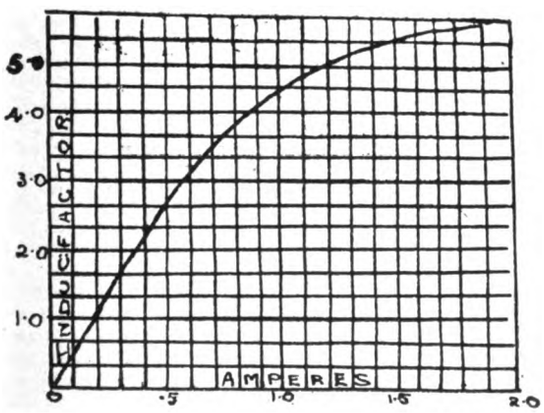


Fig. 1.

actual magnetisation curve of a shunt machine. It will be seen that at the higher values of the magnetising current—*i.e.*, the usual working part—a small difference does not produce much change in the magnetisation, whereas if the same difference took place at the lower current values, a much greater change in magnetisation would result. Therefore the "further" change in armature voltage, due to a decrease in the exciting current, is more marked as the field current approaches its lower values—*i.e.*, as the current in the external circuit increases. It is, therefore, easy to see that if the external resistance is decreased to such an extent, that the voltage of the machine is insufficient to send a current of sufficient dimensions round the field magnets to maintain that voltage, the result will be that both magnetism and voltage will die out. The smallest amount to which the external resistance may be lowered, still keeping in the magnetisation, is called the "limiting resistance." This is the "limiting resistance" for whatever speed the machine happens to be running. For different speeds the machine has different "limiting resistances." We may, therefore, define the "critical speed for any external resistance" as that speed which will just keep in the magnetisation for that resistance. The machine may go faster and still keep in the magnetism, but if it were to go slower, the magnetism would "drop out." Therefore the "critical speed" for any resistance is the lowest speed that will keep in the magnetisation.—T. T.

APPOINTMENTS VACANT.

Borough Electrical Engineer, Middlesbrough, £250 per annum, March 24. Particulars in our advertisement columns.

Tramway Engineer for a large electric tramway system abroad. Particulars in our advertisement columns.

Assistant Engineer and Traveller, A. Koppel, 27, Clement's-lane, London, E.C. Full particulars in our advertisement columns.

Foreman for arc lamp fitting and assembling shop. Full details in our advertisement columns.

Wireman, Gilbert Gilkes and Co., Limited, Kendal. Details in advertisement columns.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bedford.—The Corporation invite tenders for 28 30-kw. alternating transformers. Tenders by April 3.

Edinburgh.—The Corporation invite tenders for annual supplies from May 15 for the electric supply department.

Brisbane (Queensland).—The Postmaster-General invites tenders for a number of telephones. Tenders by April 14.

Madrid.—The date for receiving tenders for the lighting of the model prison has been postponed from March 7 to March 29.

Barcelona.—The Harbour Board invite tenders for an installation to supply electric light, power, and cranes. Tenders by April 7.

Rockhampton (Queensland).—The contract for the municipal tramways, full particulars of which appeared in a former issue, will remain open until March 31.

Maidenhead.—Tenders are required for an electric light installation. Particulars may be obtained from Messrs. Burstall and Monkhouse, Westminster. Tenders by April 4.

Madrid.—The Postal Telegraph Department invite tenders for 12 tons 3mm. and 3 tons $1\frac{1}{2}$mm. bronze wire. Price per ton not to exceed 2,280 pesetas. Tenders by April 5.

Stoke-upon-Trent.—The Guardians invite tenders for one combined engine and dynamo, one electric motor, and spare armature. Tenders by March 26. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the annual supply of indiarubber-covered cables and cast-iron pipes from April 1, 1902, to March 31, 1903. Tenders by March 26. Details in our advertisement columns.

Ilford.—The Urban District Council invite tenders for (Contract No. 6) overhead line equipment, poles, etc.; (No. 7) underground feeder cables, etc. Tenders by 27th inst. Details in our advertisement columns.

Devonport.—The Corporation invite tenders for materials and work for about three miles of double tramway track. Specification, etc., may be obtained from Mr. C. Chadwell, 20, Victoria-street, Westminster. Tenders by April 16.

Ilford.—The Urban District Council invite tenders for motor and trailer cars, trucks, motors, and equipments. Specification, etc., may be obtained from Mr. John W. Benton, clerk, Public Offices, Ilford. Tenders by March 24.

Hackney.—The Electric Lighting Committee invite tenders for the construction and erection of three water-tube boilers and accessories, and water-softening plant. Tenders by April 9. Details in our advertisement columns.

Rathmines.—The District Council invites tenders for supply and erection of engine-house plant, extension of switchboard and electricity supply mains. Tenders by May 1. Full particulars in our advertisement columns.

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Warrington.—The Corporation invite tenders for a complete overhead tramway equipment. Specifications, etc., can be obtained from Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W. Tenders by April 9.

Southend-on-Sea.—The Corporation invite tenders for the installation of electric wiring, lamps, and other fittings on the premises of private consumers in the borough. Tenders by April 2. Details in our advertisement columns.

Madrid.—The Public Works Department invite tenders for extensions to the San Sebastian tramways and working the same for not more than 60 years. Particulars may be obtained from the Department. Tenders by April 5.

Wigan.—The Corporation invite tenders for a 425-kw. steam generator (Willans or Belliss engine), Korting condenser, extension of switchboard, steam piping, and water main. Tenders by March 24. Details in our advertisement columns.

Blackburn.—The Corporation invite tenders for the supply of continuous-current electric motors required for year ending March 25, 1903. Specifications, etc., may be obtained at the office of the Borough Electrical Engineer, Jubilee-street. Tenders by 12 noon on 24th inst.

Ilford.—The Urban District Council invite tenders for overhead line equipment, poles, etc., and underground feeder cables, etc. Specifications, etc., may be obtained at the offices of Mr. J. W. Benton, clerk to the Council, Council Offices, Ilford. Tenders by March 27.

Sydney.—The Municipal Council invite tenders for supply and erection of plant and machinery required for the complete equipment of their proposed electricity supply stations and sub-stations. Particulars may be obtained from Messrs. Preece and Cardew, Westminster. Tenders by May 7 at noon.

Plymouth.—The Corporation invite tenders for Lancashire boilers, with mechanical stokers, steam, exhaust, and other piping, and ejector condensers, valves, etc. Specification, etc., can be obtained from Mr. E. G. Okell, borough electrical engineer, Prince Rock, Plymouth. Tenders by March 25.

Edinburgh.—The Corporation invite tenders for supply of (1) arc lamp carbons and (2) cast-iron pipes, pavement and road box frames and covers, etc., for the electricity supply department for the year from May 15, 1902. Tenders by March 31 and April 12 respectively. Details in our advertisement columns.

Plymouth.—The Corporation invite tenders for the supply of electricity meters, cables (paper insulated), and transformers during the 12 months ending March 31, 1903. Specifications, etc., can be obtained from Mr. E. G. Okell, borough electrical engineer, Prince Rock, Plymouth. Tenders by March 25.

Halifax.—The Tramways and Electricity Committee invite tenders for water-tube boilers, superheaters, etc., 200-kw. rotary converters, 75-kw. transformers, and high-tension switchboard. Specifications, etc., can be obtained from Mr. W. M. Rogerson, borough electrical engineer, Foundry-street, Halifax. Tenders by March 24.

Madrid.—Tenders are invited by the Spanish Government for the supply of 141 tons of iron wire for the Government telegraph service. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m. Tenders by April 2.

Plymouth.—The Corporation invite tenders for the supply of the following stores during 12 months ending March 31, 1903: lubricating engine oils, cylinder oils, grease, etc. Specifications, etc., may be obtained from Mr. E. G. Okell, borough electrical engineer, Corporation Electricity Works, Prince Rock, Plymouth. Tenders by March 25.

George Town (Penang).—The Municipal Commissioners invite tenders for the supply and delivery, f.o.b., of boilers, etc., ejector condenser, pumps, tanks, etc., pipes, steam dynamos and balancer boosters, switchboards, batteries, cables, junction boxes, &c., and arc and glow lamps, posts, and accessories. Tenders by April 28. Details in our advertisement columns.

Oldham.—The Corporation Electricity Committee invite tenders for supplying the whole of the work and material comprised in Contract No. 4, which includes steam, exhaust, feed and drain pipes, feed pumps, feed heaters, tanks, barometric condensers, condenser pipes, oil separators, motor-driven pumps, tools, etc. Tenders by March 25. Details in our advertisement columns.

Edinburgh.—The Corporation invite tenders for the supply of the following materials for the electricity supply department for the year from May 15, 1902: (1) arc lamp carbons; (2) cast-iron pipes, pavement and road box frames and covers, etc. Specifications, etc., can be obtained at the Resident Engineer's Office, 5, Dewar-place, Edinburgh. Tenders, for carbons by March 31, for ironwork by April 12.

West Hartlepool.—The Corporation invite tenders for the supply, delivery, and erection at their electricity works, Burn-road, West Hartlepool, of two Lancashire boilers, 30ft. long, 8ft. in diameter, suitable for a working pressure of 160lb. per square inch, with all necessary valves, fittings, &c., complete. Specification, etc., may be obtained from Mr. H. F. Friederichs, borough electrical engineer, West Hartlepool. Tenders by March 26.

Brighton.—The Council invite tenders for supplying and laying telephone conduits and cables, erecting telephone poles, standards, arms, etc., fixing subscribers' instruments, supply of creosoted telephone poles, manufacture and supply of telephone insulators, oak arms for telephone poles, ironwork used in telephone construction, galvanised iron arm bolts, nuts and washers, hard-drawn, semi-hard, and soft copper wire, silicium bronze wire, iron and steel stay wire, insulated wires, lightning arresters, high-tension guards and test jacks, primary batteries, telephone instruments and telephone switchboard. Tenders by March 24. Details in our advertisement columns.

RESULTS OF TENDERS.

Oban.—The Town Council have accepted the tender of MacKenzie Bros., Edinburgh, for the supply of arc lamp-posts at £11 each.

Portsmouth.—The Corporation have accepted the tender of Crompton and Co., Chelmsford, for supply of Conradty's carbons.

King's Lynn.—The Corporation have accepted the tender of H. and T. Danks, at £782. 10s., for Lancashire boiler and connecting pipes.

Shipley.—The School Board require tenders for the work of installation of electric light. Tenders by April 2. Details in our advertisement columns.

Newport.—The Electricity Committee have accepted the tender of A. S. Morgan and Co., at £22,678. 9s. 1d., for the Corporation-road power station and car-sheds.

Trowbridge.—The Urban District Council invite applications for a lease of their powers under their electric lighting order. Tenders by April 30. Details in our advertisement columns.

South Lancashire Tramways.—The whole of the switchgear equipment, both high and low tension, for the sub-stations as well as the central station, will be supplied by Ferranti Limited, Hollinwood.

Newcastle.—We are informed that the 200 arc lamps now being erected in connection with the Corporation tramways are of the Brockie-Pell patent, manufactured and supplied by Brockie-Pell Arc Lamp, Limited.

Rochdale.—The Corporation have accepted the tender of Messrs. Statter and Co., 109, Colmore-row, Birmingham, for the supply, delivery, and erection at Rochdale, Lancashire, of one complete traction switchboard and accessories.

London County Council.—The Council have accepted the offer of Bilbie, Hobson, and Co. to supply an oil-engine and certain fittings required in connection with the electric lighting of the new buildings at Farmfield Reformatory, at £329. 10s.

Weston-super-Mare.—The Urban District Council have received the following tenders for the electric wiring at swimming-baths, Knightstone: Bryant and Sons, £55 (accepted); Edwards and Armstrong, £79. 6s. 1d.; J. P. Curtis, £85. 10s.; Weston-super-Mare Electric Wiring Company, £124. 19s. 9d.

Manchester.—The Lancashire and Yorkshire Railway Company invite tenders for the supply of signal and telegraph fittings, and signal, telegraph, and electric light wires for 12 months ending April 30. Further particulars may be obtained on application at the Stores Department, Osborne-street, Manchester. Tenders by April 1.

Middleton.—The Corporation invite tenders for the supply, delivery, and laying, in the borough of Middleton, of feeder cables, pilot cables, cast-iron pipes, junction boxes, etc., for tramway feeders, and three-core armoured distributing cables for extensions to lighting cables. Tenders by March 26. Details in our advertisement columns.

Fulham.—The Borough Council have accepted the following tenders: R. Blackwell and Co., for the provision of induced-draught plant at the electric lighting works (Contract 15), £1,656; F. G. Minter, construction of new transformer chambers in the district and the rectifier-room adjoining the engine-room at the electric lighting works (Contract 16), £2,110.

Brighton Tramways.—The order for the first extensions required for the Brighton system has been given to Witting Bros., electrical engineers and contractors, 49, Cannon-street, E.C. There will be 10 complete motorcars, each consisting of a Milnes car body of latest type mounted upon a Brush truck, the electrical equipments being of Witting Bros.' standard pattern throughout.

Walsall.—The Corporation have accepted the following tenders for permanent way and overhead equipment of about six miles of single track and 1¼ miles of double track of tramways on the overhead trolley wire system: W. Griffiths and Co., London, track, £35,827. 9s. 9d.; R. W. Blackwell and Co., London, overhead equipment, £7,480. 7s. 3d.; Callender's Cable and Construction Company, London, cables, £6,444. 12s. 1d.

BUSINESS NOTES.

TRACTION.

Islington.—The Borough Council have withdrawn their opposition to the North Metropolitan Tramways Bill.

Motorcar Industry.—Messrs. Vickers, Sons, and Maxim, it is announced, propose to establish a motorcar business.

Halifax.—The recently completed extension of the city tramway system to Hebden Bridge has been opened for public traffic.

Shields.—In the House of Lords the North and South Shields Electric Railway Bill has been read a third time and passed.

Rawmarsh.—It has been decided by the District Council to petition against the Swinton and Mexborough Tramway Company's Bill.

Swindon.—The Town Council have decided upon an application to the Board of Trade for sanction to borrow £36,000 for tramway purposes.

Redruth.—The Urban Electric Supply Company have commenced to lay the rails for the proposed tramways between Redruth and Camborne.

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Motor Fire-Engine.—The experimental motor fire-engine which the London County Council are constructing for their own use is nearing completion.

Walsall.—It is decided that the electric tramways, for the construction of which tenders have just been placed, will be worked by the Corporation.

Bournemouth.—It is promised that a part at least of the electric tramway system which the Corporation are laying down will be ready for public traffic by August.

West Bromwich.—The Board of Trade have sanctioned the loan applied for by the Town Council for the reconstruction and electrical equipment of the tramways within the borough.

Merthyr.—Tenders for the construction of loop lines by the Merthyr Electrical Traction Company having now been placed, the work of construction will very soon be commenced.

Wallasey.—Major Druitt, of the Board of Trade, having inspected the new tramways which have been constructed at the place, the formal opening of the new system took place on Wednesday.

Motorcar Exhibition.—The Automobile Club's Great International Motorcar Exhibition will be held at the Royal Agricultural Hall, Islington, on Saturday, April 19, to Saturday, April 26.

Bolton.—It is announced that the tramway receipts from April 1, 1901, to date amount to £72,220. 17s. 4½d., as against £65,337. 10s. 2d. in the previous year—an increase of £6,883. 7s. 2d.

Barnsley.—Negotiations are proceeding between the Corporation and the promoters of the Barnsley and district light railway with reference to several questions which have arisen on the scheme.

Rowley.—An agreement has been come to between the District Council and the Birmingham and Midland Tramway Company with reference to the proposed tramway from Old Hill to Black Heath.

Dornoch Light Railway.—An application from the Dornoch Light Railway Company asking the Sutherland County Council to take another £1,000 of shares in this undertaking has been refused.

Penge.—At the request of the British Electric Traction Company the District Council have appointed delegates to represent them when the local Tramways Bill comes before the Parliamentary Committee.

Hetton-le-Hole.—The decision of the Rural District Council to oppose the prolongation of time for the commencement and completion of the Houghton-le-Spring and district tramways has been rescinded.

Drighlington.—A letter has been received from the tramway engineer to the Bradford City Council stating that in two months they would commence laying the proposed tramway from the present terminus to this place.

Yarmouth.—A proposal is before the Council to engage a consulting engineer to report on the laying of the tramway track. One hundred and fifteen applications have been received for the appointment of general and traffic manager.

Appointment.—Mr. William Spaven, traffic manager of the city tramways at Leeds, has been appointed general manager of the Portsmouth electric tramways, at a commencing salary of £300. There were 44 candidates for the post.

Rochester.—The City Council are considering the question of municipal trams. The special committee appointed to deal with the subject are now engaged in deciding upon the routes to be followed, but the scheme is yet in a very initial stage.

Brierley Hill.—In conjunction with the Quarry Bank District Council, the Brierley Hill District Council have decided to make the application for the proposed light railway from Cradley Heath to Quarry Bank and Brierley Hill in May next.

Hounslow.—The Light Railway Commissioners opened a public enquiry at Hounslow on Wednesday as to the expediency of granting the application of the London United Tramways Company for an order to authorise the light railway extension No. 2.

Maidstone.—By a majority of 13 to 3 the Town Council have agreed that Mr. Sellon be instructed to forthwith prepare a scheme, with full details and estimates, for constructing a tramway from High-street to Barming, and also to advise as to the best method of procedure.

Burgess Hill.—The negotiations between the Urban District Council and the promoters of the London and Brighton Electric Railway have, it is understood, resulted in a definite promise on the part of the promoters that a station shall be erected at Burgess Hill should the scheme be carried out.

Aberdeen.—Renewed attention is being drawn to the question of the construction of a tramway to Torry, which would pass along South Market-street. It is believed that preparations may soon be made for making application to Parliament for powers to construct a single line along this thoroughfare.

Heavy Woollen District.—The Heavy Woollen District Electric Tramway Company, whose lines are proposed to run from Cleckheaton down the Spen Valley and over the hill at Staincliffe to Dewsbury, Thornhill, and Savile Town, are about to erect car stations and offices at Heckmondwike and Savile Town.

Shields and Sunderland Tramways Bill.—Seven petitions have been deposited in the Private Bill Office against this Bill. The petitions are on behalf of the South Shields and the Sunderland Rural District Councils, the Fullwell and Harton Parish Councils and ratepayers, and residents in South Shields.

Soothill.—A resolution has been passed by the District Council regretting the action of the railway companies with regard to the light railway scheme from Wakefield to Dewsbury, and that of the Commissioners in refusing an order, and urging the light railway company to present a Bill in Parliament to attain their object.

County Council's Tramway Manager.—The General Purposes Committee of the London County Council have approved the suggestion of the Highways Committee that Mr. Alfred Baker, the tramways manager, shall in future be styled "chief officer of tramways."

Blackpool.—Mr. R. C. Quin, the borough electrical engineer, and Mr. Speight, the assistant electrical engineer, sever their connection with the Corporation at the end of the present month, and at a meeting of the Tramways Committee on Wednesday they were accorded a hearty vote of thanks for their services during their terms of office.

Newcastle.—The Tramways Committee have promised to proceed with all dispatch with the extension of the tramway system to Walker. The Westmorland-road route is now completed for the electric service, and will shortly be visited by the Government inspectors. The Byker Bridge section is expected to be opened in the course of two or three weeks.

Huddersfield.—The work of conversion of the remaining steam sections of the tramways to electric traction is being vigorously pushed forward. A deputation has waited upon the Tramways Sub-Committee to urge the extension of the system to the townships of Holmfirth, Netherthong, and Holmebridge, but the consideration of the matter has been deferred for the present.

Farsley.—A deputation from the District Council is to wait upon the Bradford Town Council to draw attention to the dissatisfaction which exists through the doubling of the tram fare from Thornbury to Stanningley. It is said that since the new conditions were enforced no fewer than 130 persons have taken out passes on the Great Northern Railway between Stanningley and Laisterdyke.

Middleton.—Official information has been received here that Major Druitt and Mr. Trotter will make an inspection of the tramways laid by the British Electric Traction Company to-day (Friday). The track has now been completed, the overhead equipment nearly so, and the Corporation are quite ready to supply the necessary power at any time. Several trial trips have already been made.

Dundee.—The borough engineer reports that the work of relaying the Fairmuir tramway route is proceeding rapidly. With the exception of a small portion at the bridge at Fairmuir, the permanent way from the burgh boundary to Clepington-road is completed, and work is being carried on in Strathmartine-road. A start was made last week with the Constitution-road route, and Barrack-road is now in the hands of the contractor.

Hyde.—In reference to the proposed length of tramway to connect Hyde and Stockport, *via* Bredbury, an agreement has been arrived at between the three authorities concerned and the tramway company. It is proposed that the company, who have all the material at hand, should lay the line. According to the estimate of the Hyde borough surveyor, the cost is expected to be about £8,000. The company undertake to carry out the work within four months of the agreement being signed.

London United Tramways Bill.—This Bill was again before Mr. Campion at the House of Commons this week, when the consents of various local authorities, including that of the London County Council, the Surrey County Council, Hammersmith, Barnes, Richmond, Coombe and Malden, and Croydon, having been proved, and the receipt for Exchequer bonds to the amount of £40,803 as a deposit having been submitted, the Bill passed the examiner and will now proceed.

Automobile Mail-Carts.—A Paris correspondent says that the automobile mail-carts, which have now been running in Paris for upwards of a year, have given such satisfaction that M. Mougeot, the Under-Secretary of State for Posts and Telegraphs, has decided to extend their use. Not only will they gradually entirely replace the horse-drawn mail-carts in the capital, but they are to be introduced into the more important provincial towns, such as Marseilles, Lyons, Lille, Bordeaux, etc.

South London Tramways.—With reference to the South London Tramways Company's relations with the London County Council, the chairman stated at the half-yearly meeting of the company last week that he had heard from an unofficial source that there was a likelihood of some arrangement being arrived at before long, but the directors were not in a position to give particulars. However, incidentally, he remarked that the company would probably be bought up by the County Council within the next six months.

Light Railways.—Copies of orders made by the Light Railway Commissioners and confirmed by the Board of Trade have just been laid before Parliament, authorising the construction of light railways in, among other places, the urban and rural districts of Dartford (Kent), in the parishes of Edgware, Finchley, Friern Barnet, Hendon, Hornsey, Kinsbury, Little Stanmore, Southgate, Tottenham, Wembley, Willesden, and Wood Green; from Lowestoft to Kessingland, Lyndhurst to Lyndhurst Road, Aldershot to Farnborough, and between Northiam and Rye (Sussex).

Manchester and Liverpool Electric Railway.—Another Bill promoted by the originators of the above scheme, came before a Private Bill Committee of the House of Commons presided over by Colonel Bowles this week. As is well known, an Act was passed last session authorising the construction of the railway on the monorail system, and the promoters now sought power to make a deviation from a portion of the route in Salford. Evidence was given as to the necessity for the deviation, and the Chairman said the Bill would be reported to the House, the preamble having been proved.

Todmorden.—In consequence of objection by frontagers, the Corporation have decided to withdraw their Tramways Bill now before Parliament, and as the Halifax Corporation have dropped their proposal to continue their tramways from Hebden Bridge (as reported in our last issue), the anticipated almost continuous line from Leeds to Manchester will be checked at the Todmorden borough boundary, which divides Lancashire from Yorkshire. It is probable, however,

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that the Todmorden Corporation will promote another Bill about two years hence, and the Halifax authority have expressed their willingness to join with them at any time.

Rapid Transit in London.—A proposal was put forward at the Browning Hall Conference on Housing at Westminster Palace Hotel on Wednesday, that a small body of commissioners should be appointed by Parliament which would consider all schemes and fix the principles on which London transit should be worked. The conference adopted a series of resolutions calling the attention of the Government to the need for a central transit authority for London, and suggesting that the duty of this body should be to report to Parliament on all schemes submitted. It was also decided to send a deputation to the Government to explain the proposal.

Proposed "Tube" Extension.—It is stated that the possible idea of the Hampstead and Charing Cross Railway Company continuing their tube railway from Charing Cross to Hampstead right on to Hendon and Edgware is heartily welcomed by the great number of employés of the large firms established in Tottenham Court-road, the Hampstead-road, and neighbourhood, who are preparing petitions to the company to give the proposal a practical shape. The projected extension, it is urged, would bring the districts of Mill Hill, Hendon, and Edgware within easy access of Central London, and would to a certain extent help to reduce the residential pressure in that section of the Metropolis.

Southport and Lytham Tramroad Bill.—This Bill, which asks for an extension of the period limited by previous Acts for the compulsory purchase of lands, and also for an extension of the time for the completion of tramroads between Southport and Lytham, came before a House of Commons Committee, presided over by Colonel Bowles, on Wednesday. The only petitioner against the Bill was Mr. C. H. B. Hesketh, the owner of an estate through which the tramroad runs. After hearing evidence, the committee decided that the preamble was proved. The extension would be for one year as regarded the notice of purchase, and the full time asked for—three years—as regarded the completion of the works.

Bradford.—A meeting of the conductors and drivers employed by the Bradford Tramways Committee has been held for the purpose of protesting against the new check system. It was stated that not only did the innovation cause the conductors unnecessary worry, but that complications arose through passengers changing from the upper to the lower part of the car, or *vice versâ*, resulting sometimes in the conductor having to pay money out of his own pocket. The bell-and-punch system was advocated. Some objection was also taken to the present sub-division of the hours of duty. In the end it was decided to ask the Tramways Committee to receive a deputation of their employés for a friendly discussion of the points raised.

Mountain Ash.—Last week Major Edward Druitt, R.E., conducted a Board of Trade enquiry into the proposal of the Urban District Council to construct and maintain an electrical tramway from Aberewmboy Bridge to the Aberdare boundary of the district to a point opposite the Carne Park Hotel in Carne Park. Mr. Hammond, upon whose report the scheme was prepared, gave evidence to the effect that the proposed tramway would be a little over five miles long, and the total cost £57,524, including £4,000 for sub-stations. The scheme would be a remunerative one in his opinion, the estimated net profit being £2,690 per annum. After speeches by counsel the enquiry concluded, and the inspector's report will be issued in due course.

Belfast.—The following resolution has been adopted: "That as the Corporation is entitled to purchase the Belfast street tramways in August, 1907, on the terms fixed by Act of Parliament, the Council in committee are of opinion that if they can be purchased by agreement in the meantime on a fair and equitable basis it would be desirable to do so; or, failing any such agreement, on the basis of the actual value of the lines, plant, and goodwill, to be fixed by an arbitrator under the Act, with a full allowance for the profits which might be earned by the company during the residue of their term. The amount fixed for the goodwill in the Act of Parliament is a sum not exceeding £3,000." A committee has been appointed to carry out whatever negotiations may be necessary.

Hove.—The Tramways Committee have submitted for the approval of the Town Council the proposed tramway routes, starting from the east end of Church-road and traversing Church-road and New Church-road to Station-road; Holland-road and D'Avigdor-road eastwards; Morton-road, Eaton-road, Blatchington-road, and Portland-road to Rutland-road; and Goldstone-villas to railway station and westward along Clarendon-road and thence through Sackville-road to Church-road. The total length of tramways suggested is 4·70 miles, of which 4·45 miles are double and 0·25 mile single track. The committee recommend that it is desirable to acquire the tramway now running to Shoreham, and to work the same by electricity. The estimated cost of the whole scheme is £85,000. The report will be considered at a special meeting to be convened.

Watford.—The adjourned enquiry into the proposed scheme of light railways for the Watford district was resumed at the Guildall, Westminster, last week, by the Light Railway Commissioners—the Earl of Jersey (president), Colonel Boughey, C.S.I., and Mr. H. A. Steward—the applications considered being those of the Watford and District Tramways Company and the Herts County Council. The tramways company have already secured powers for Watford itself, and by this application seek to extend their system to Rickmansworth on the one hand and to Bushey on the other. The County Council, by their scheme, seek to establish a line from the county boundary at Bushey running to the outskirts of Watford. Since the opening of the enquiry the Rickmansworth Urban District Council have given their support to the company's scheme conditionally upon an agreement to extend the line to Mill End, within their district. At the conclusion of the evidence the Commissioners intimated that they would communicate their decision shortly.

Duty on Electric Motors.—The March circular of the British Chamber of Commerce in Paris states that the Paris Chamber of Commerce has just furnished a report to the Minister of Commerce concerning the advisability of placing a duty upon electric motors weighing less than 10 kilos. As the parts utilised in the make-up of a motor are dutiable, and the spirit of the law of 1892 was to place a duty upon all appliances imported for use in a commercial sense, the Customs Committee of the Paris Chamber gives its opinion as favourable to these small motors being classified with motors of from 10 to 50 kilos, and consequently paying the same duty—viz., 80fr. the 100 kilos (tariff minimum). The main argument advanced for this proposed new duty is that the French constructor is unable to make small motors at a normal price owing to having to pay duty on the parts imported, whilst the complete motors are allowed to enter the country free.

Cardiff.—The local branch of the Amalgamated Society of Engineers have passed a resolution declaring that they view with regret and disapprobation the proposal before the Corporation for running the tramcars on Sundays, and that they are of opinion that it would be inimical to the best interests of the workers and residents of Cardiff that the municipality should recognise or countenance Sunday labour. A bogie of the pattern adopted on the new cars to be used on the electric tramway system was tried on the lines on Wednesday. The chief object of the trial was to test the gauge, and Mr. Arthur Ellis, the electrical engineer, put the bogie over a long track to test it thoroughly. It is expected that 20 of the new cars will arrive in Cardiff during next week. Work at the power station is progressing satisfactorily, but several weeks must elapse before the cars can be run for traffic. It is understood that the Cardiff District and Penarth Harbour Tramway Company are prepared to accept £18,000 for the Splotlands line, but it is by no means certain that the Corporation are prepared to pay this price. The Council have parliamentary powers to extend their electric service to Splotlands.

Manchester and Salford Bills.—The Salford Corporation and the Manchester Corporation Tramways Bills came before a Select Committee of the House of Commons presided over by Colonel Bowles last week, and the enquiry has been continued this week. Our readers will recall that for some months now there has been a deadlock between the two Corporations in tramway matters, the dispute being as to the interchange of through traffic between Manchester and Salford. The matter has at last, we are pleased to say, been amicably settled. At the close of the proceedings before the Select Committee on Monday it was stated that an agreement had been arrived at between the parties in the following terms: "That there shall be an interchange of through traffic, so far as reasonable, upon such routes or portions of routes and upon such terms and conditions as may be agreed upon, or, failing agreement, as shall be settled by the Board of Trade." It was further stated that Salford had withdrawn its application for running powers over Manchester lines and its proposal for a joint board, while Manchester had withdrawn its application for running powers over Salford lines. The other matters raised in the Bills relating to new lines were then enquired into.

Manchester.—The Corporation Tramways Department is just now being attacked on the ground that the regulations under which the electric cars are run in the city do not form a sufficient protection to the public. The origin of this outburst is to be found in the fact that since the electric cars commenced to run three people have lost their lives by being knocked down by them, and it is contended that the car drivers break the law by running at an excessive speed. A number of letters have lately appeared in the local Press on the subject, and it is urged that in no case should the cars be driven at a speed of more than 10 miles an hour. One of the correspondents, Mr. Chas. A. Wood, draws attention to a book called "The Novice's Guide to Electric Car Driving," by Mr. Edwin W. Elsley, late motor inspector of the Leeds city tramways, and now holding a similar position with the Manchester Corporation. This book Mr. Wood recommends should be read by every driver before he is allowed to turn out with an electric car, and in view of the present agitation against the conduct of the tramway system in Manchester he urges that the time is opportune for both that Corporation and the Corporation of Salford to secure copies for their tramway employés.

Wolverhampton.—The full report of Mr. Henry Lea, the expert called in by the Corporation to pronounce an opinion upon the Lorain system of electric traction, has now been made public. The gist of the report was given in our last issue, and Mr. Lea now confirms his previous opinion that there are no inherent defects which should prevent the Corporation from authorising the contractors to proceed with the equipment of the remaining 11 miles of route with the Lorain system. But, he adds that the utmost care and most careful observation, and the keeping of the fullest possible records during the succeeding 12 months' trial of the system, will be necessary in order that a definite conclusion may be arrived at by the time that period has elapsed. He regards the period of 12 months, however, as being all too short for a complete investigation into the practicability of any surface-contact system, beset with difficulties as it undoubtedly is. Mr. C. E. C. Shawfield, the borough electrical engineer, has also prepared a report giving the results of tests he has made as to the efficiency of the system. He also states that he has been unable to discover any inherent defect in the system during the 30 days' trial, but he agrees it is impossible to say anything further on the subject until he has seen the system in regular commercial operation for at least a year. He considers the only practical basis on which a definite opinion as to the merits or demerits of the system can be formed, is its ability or otherwise to successfully withstand the heavy traffic of the approaching summer, and the frost, snow, and mud of the winter 1902-3.

London County Council.—The Highways Committee of the London County Council recommend that Messrs. Baker and Rider, the Council's tramway manager and electrical engineer respectively, who recently returned from America, should pay another visit to foreign cities to

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see the latest developments in electric traction. This time it is proposed that these officials should go to Paris, Budapest, and Munich and examine the actual working conditions of the shallow underground system of tramways in operation in the two first-named cities, and also the systems of electrical traction, the surface-contact especially in use in Munich. The visit is to be made during the Council's Easter vacation, and a sum not exceeding £100 is to be allowed to cover the expenses of the tour. Mr. Beachcroft has given notice of this motion: "That it be an instruction to the Highways Committee to report: (1) as to the cost of construction per mile of single track (exclusive of cars and power stations) of a tramway on the overhead system as compared with the conduit; (2) as to the saving, if any, in working expenses and time occupied in construction in the one system as compared with the other; (3) as to the objections, if any, to a mixed system of overhead and underground traction, and the practicability of an exchange between the two systems; (4) whether, inasmuch as the overhead system will inevitably prevail outside the county of London, there is any solid reason why the Council should not adopt the overhead system inside the county in those districts which are sufficiently removed from the crowded centre of London and where the local authorities concerned do not object."

London County Council Tramways.—The following is a complete list of the tramways which will be proceeded with under the London County Council (Tramways and Improvements) Bill, and in respect of which compliance with the Standing Orders of Parliament has been proved: from Hammersmith-broadway, *via* Queen-street, Fulham Palace-road, High-street, and Putney Bridge, to the Lower Richmond-road (double); from near western end of Westminster Bridge, along the Victoria-embankment to near Blackfriars Bridge (double); from Herbert Hospital, along Woolwich-road, Military-road, Mill-lane, New-road, Green's-end, Thomas-street, to Woolwich (single); from Herbert Hospital, along Woolwich-road to Eltham (double); from the existing tramway at Camberwell-green, *via* Denmark-hill, Champion-park, Grove-lane, Dog Kennel-hill, Grove-vale, and Lordship-lane, to its junction with Crystal Palace-road (double); junction between tramway in Denmark-hill and the existing line in Coldharbour-lane, (double)—making a total mileage of just over nine miles. The proposed lines which have been struck out of the Bill owing to non-consent of the road authorities concerned are as follows: from Seven Sisters-road to Upper Clapton-road (double); from Hampstead-road, *via* Tottenham Court-road, to Oxford-street (double); from county boundary in Shoot-up-hill-road, Cricklewood, *via* High-road, Kilburn, Maida-vale, and Edgware-road, to near Marble Arch (double); from Harrow-road to Maida-vale (double); from Bridge-road, Chelsea Bridge, along Grosvenor-road, to Grosvenor Wharf (double); junction between tramway in Grosvenor-road and existing line in Vauxhall Bridge-road (double); junction between tramway in Grosvenor-road and authorised tramway over Vauxhall Bridge (double); from county boundary in Kingston-road to existing tramway on south side of Clapham Common (double); from existing tramway near the Tate Library, *via* Streatham High-road, to the county boundary at Norbury (double); from existing tramway in Trafalgar-road to the open approach to Blackwall Tunnel (double); from existing tramway over Deptford Bridge, *via* Blackheath-road, to join proposed line in Woolwich-road (double); and from existing tramway in New Cross-road, *via* Lewisham High-road, to existing line in High-street, Lewisham—making the total length of the lines rejected just over 20 miles, as compared with nine miles passed

Darlington.—The following is an abstract of the report of Prof. Kennedy to the Corporation Tramways Committee on the electric tramway scheme for the town: The proposed lines are from Cockerton to Eastbourne, North-road, and Haughton, covering 5·6 miles. The actual additional cost of a conduit line over that of an overhead one on a straight piece of line, without turn-outs or any special work, would come to about £3,500 per mile, but with the frequent passing places which would be necessary in Darlington this difference would be enormously increased. The estimates given add the cost of purchase of the existing tramways, widening of bridges, rolling-stock, car-sheds, etc. On this basis a single line on the overhead system is estimated to cost £79,209; part single and part double line, £92,500; double line throughout, £104,500. If the combined conduit and overhead systems were adopted, a single line with passing places would cost £94,700. If the conduit system simple were adopted, a single line with passing places would entail a cost of £133,200. The capital charges, were a single overhead line adopted, would—taken at 5½ per cent. covering interest and sinking fund—be £4,400; for a double overhead line throughout the amount would be £5,775. Assuming that the cars ran eight hours per day at intervals of five minutes in the town, and 10 and 15 minutes in the outlying portions, the total number of car miles run per annum would be 350,400. The expenditure might be taken for 350,000 car miles, at 6½d. per mile, to be £9,500; adding £4,400 for interest and sinking fund the amount for a single line would be £13,900. Taking the double line, with the interest cost £5,775, the amount would work out to £15,275. In order that receipts might just balance costs there would have to be earned 9½d. per car mile for the single-line estimate, or 10½d. for the double-line estimate. There was no doubt that figures like these were reasonable. In Prof. Kennedy's opinion, a double line would be more likely to attract traffic, as it would avoid the little delays at passing places which would make the travelling more popular and comfortable. Practically it would seem if the double lines could earn 1d. per car mile more, the additional expense would be counterbalanced. No doubt, however, a very large portion of the advantage of the double line could be obtained by using it only in the central portion of the town. He accordingly recommends that double lines should be adopted on the overhead trolley principle. The report will shortly be considered by a full meeting of the committee.

LIGHTING AND GENERAL.

Southend.—A successful trial has been made with the Reno elevator.

Luton.—The electric light cables are to be extended to Bedford-road at a cost of £900.

Brierfield.—The surveyor has been instructed to light the whole of the main road with electricity.

Kent Electric Power Bill.—This Bill passed a committee of the House of Commons on Thursday of last week.

Manchester.—Contracts to the extent of £30,000 have just been let by the Electricity Committee of the Corporation.

Eastern Telegraph Co.—Payment is announced of an interim dividend of 1½ per cent. for the quarter ended Dec. 31 last.

Horsham.—A memorial calling attention to the smoke, vibration, and noise from machinery at the electric lighting station is before the Works Committee.

Government Appointment.—The Home Secretary has appointed Mr. Gilbert Scott Ram, M.I.E.E., to be electrical inspector of factories and workshops.

Ayr.—The Town Council on Monday agreed to charge 2d. per unit of electricity for street-lighting in place of the present charge of £20 per arc lamp per annum.

Kirriemuir.—The Lighting Committee are delaying their report in reference to the electric light, as their correspondence and information are as yet incomplete.

Heywood.—The Town Council are issuing circulars illustrating the advantages to be derived by the use of electricity for both motive power and lighting purposes.

Long-Distance Telephones.—Successful experiments have just been made with the long-distance telephone between Marseilles and Brussels, which are 760 miles apart.

Dartmouth.—Mr. G. E. Smith, chief assistant to the Guernsey Electricity Supply Company, has been appointed resident engineer to the Urban Electric Supply Company's Works.

Paisley.—We understand that on Tuesday the Council decided to instruct Mr. Parkinson, the electrical engineer, to furnish Mr. Cunningham with a satisfactory testimonial.

Kilmarnock.—At the last meeting of the Town Council the Electric Lighting Committee were instructed to consider the whole question of electric lighting and traction afresh.

Whitehaven.—An application for a supply of current to the Methodist Chapel in Catherine-street has been granted, and the street-lighting wires will be relaid at the same time.

Automatic Meters.—Penny-in-the-slot meters for supply of electricity are now in use at Barking, Blyth, Dartford, Durham, Ealing, Guernsey, Ilford, Sutton Coldfield, and West Ham.

Smoking Concert.—Another of the series of successful smoking concerts arranged by the Brighton electricity department was held on Monday evening at the Unicorn Hotel, North-street, Brighton.

Upper Swaledale.—The introduction of the Post Office telegraphs took place on Wednesday. A new line of poles and wire to the extent of 13 miles has been erected, and telegraph offices have been opened.

New Issue.—The British Thomson-Houston Company are issuing, at £104 per cent., £200,000 4½ per cent. mortgage debenture stock, redeemable after March 1, 1912, at the company's option, at 105 per cent.

Poole.—The Town Council and the Branksome Urban District Council are corresponding as to the lighting Ashley-road and the Poole-road between Bourne Valley and the County Gates with electricity.

Newport (Mon.).—The Electricity Committee have been authorised to lay down plant for the supply of electrical power to the different manufacturers of the borough. An accepted tender will be found in our columns.

Ynyscynhaiarn.—The Urban District Council have decided not to accept the offer for the electric lighting of the town made by Mr. E. R. Davies, on behalf of an electric lighting company, as the Council have not yet decided to use that light

Jarrow.—The Durham County Electric Supply Company, who have power to light the borough, are now well forward with the work of laying the mains. An offer to lay the cables to the bandstand in the park free of charge is being considered.

Sutton.—The West Cheshire Electric Lighting and Traction Company have obtained sanction to erect three or four electric lamps at Heswall on condition that the lamps be taken down when a desire for their removal should be expressed by the Parish Council.

Oban.—Mr. M. P. Plunkett, London, has been appointed to the post of resident electrical engineer at a salary of £150 per annum. A set of regulations to be observed in relation to the installation of electric wiring and fittings has been adopted by the Town Council.

Stoke Newington.—Arrangements are being made to raise £3,000, being £2,300 for street mains, etc., £370 for street lighting, and £300 for meters. The laying of electric lighting mains in the High-street and Stoke Newington-road is to be proceeded with immediately.

Stock Exchange.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Westminster Electric Supply Corporation's 30,000 5 per cent cumulative preference shares of £5 each, £2. 10s. paid.

Aberdeen.—The Town Council have now made their application to the Postmaster-General for a license to establish and carry on a municipal telephone service, the license to extend to Dec. 31, 1913. It is proposed that the new service be on the twin-wire underground system.

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Wireless Telegraphy.—A Central News dispatch from Ottawa states that Mr. R. N. Vyvyan, Mr. Marconi's chief engineer in Canada, has expressed the opinion that wireless telegraphic communication will be established between the Dominion and England about the beginning of June next.

Midsomer Norton.—The Urban District Council are corresponding with representatives of the company who propose erecting electricity generating stations on the Somersetshire coalfields. The district is included in the proposed area of supply, and it is said that the scheme is now almost fully matured.

Leicester.—The total profit on the electric lighting last year was £1,906. 12s. 7d., and total net profit on the working of the department since its commencement £3,556. 3s. 7d. Out of this £2,311 has been paid on capital expenditure, which leaves a net profit of £1,245. 3s. 7d. to be carried forward.

Islington.—At to-night's meeting the Lighting Committee will recommend that as from the commencement of the June quarter the charge for electricity consumed by all places used for the purposes of divine worship be 5d. per unit, also that the laying of three mains at a cost of £575 be proceeded with.

Radcliffe.—We understand that the general conditions of contract prepared by Messrs. Lacey, Clirehugh, and Sillar for steam dynamos have been approved and adopted. A complete specification for the contracts for boiler, switchboard, boosters, condensers, steam-piping, etc., is being prepared by that firm.

Swinton.—The District Council are negotiating with the Lancashire Electric Power Company with the view of purchasing electricity in bulk from that company. They are also conferring with the Salford Corporation Electricity Committee, who propose to supply electricity in bulk to the Swinton and Pendlebury district.

Southwark.—The Hon. T. H. W. Pelham has held an enquiry into an application by the Borough Council of Southwark for an extended provisional order under the Electric Lighting Acts, the Council already possessing the powers of the old vestries, the various parishes having been acquired under the London Government Act of 1899.

Bath.—On Tuesday the Corporation, while not committing themselves to selling or letting their electric lighting undertaking, resolved to receive any tenders which might be sent them. Among those desirous of tendering were the Bath Gas Company, but the Council declined to afford them facilities, fearing to create a monopoly.

South Africa.—We note that the engines for the East London Town Council, and also for the "Red and White Rose" Mine, Rhodesia, are being supplied by Messrs Belliss and Morcom, Limited, Birmingham. The engine for the first-named plant is now well in hand, and will be shipped shortly. The engine for the Rhodesian mine plant is already on its way out.

Rockhampton Gas and Coke Co.—The report of this Company, who also supply current and fittings for electric lighting purposes, for the half-year ended Dec. 31, 1901 (fifty-eighth half-year) shows a net profit for the half-year of £1,192. 10s. 9d., and a dividend at the rate of 5 per cent. per annum upon the ordinary shares and 9 per cent. per annum upon the preference shares, free of dividend duty, is recommended.

Broughty Ferry.—The Town Council on Tuesday resolved to commence at once with the erection of the buildings for the installation of electric lighting for the burgh. Mr. George Balfour, the engineer, Dundee, who was present, submitted plans of the proposed buildings at the electric station at the gasworks, which were approved by the meeting. It is expected that the electric works will be complete about the middle of September.

Camberwell.—The Hon. T. H. W. Pelham has held an enquiry into an application of the Borough Council for a provisional order under the Electric Lighting Acts enabling them to supply electric energy throughout the whole of their district, part of which is already within the district supplied by the Crystal Palace District Electric Supply Company, and other parts within the supply area of the County of London and Brush Electric Company and the London Electric Supply Corporation.

Kingston.—At a recent meeting of the burgesses of Kingston the following resolution was passed: "That in the opinion of this meeting the present financial position of the borough electric light undertaking demands searching investigation, and the Town Council are hereby requested to take into their earnest consideration (1) the advisability of discontinuing the whole system of arc lighting in the streets, and (2 the means to be taken to make the electric light undertaking a commercial success."

Swindon.—The Corporation have fixed the price of current at 5d. per unit as a flat or uniform rate, and 7d. per unit for 100 hours per quarter, and 2d. per unit for subsequent units on the maximum demand system. With regard to the price for power purposes, the Corporation think this can be better fixed when it is known what the day load is likely to be, but they think that a fair charge would be found to be 2½d. per unit, with the undertanding that special terms would be made with those likely to take a large amount of current regularly during the daytime.

Loughborough.—The General Purposes Committee on Monday resolved, as the Loughborough and District Light Railway Syndicate had not, in accordance with their undertaking, intimated within a month whether they would take over the electric lighting powers of the Corporation on the terms provisionally offered to them by the representatives of the Town Council, that they be informed that the offer must be taken to be withdrawn if a definite answer is not received by the Corporation within seven days from date, and that a meeting of the committee be held on the 24th inst.

Cardiff.—At the meeting of the Electrical and Lighting Committee on Tuesday Mr. Arthur Ellis reported that there were now 544 consumers whose premises were connected to the mains. The calculated revenue was: public supply, £161. 17s. 11d.; from private supply, £1,622. 6s. 1d.—total, £1,784. 4s. The calculated revenue for the corresponding month of 1901 was £1,350, being an increase of 32 per cent. The private and public supply had been fully maintained, and no complaints had been received. Considerable extensions of mains had been made to enable the department to supply various consumers. As far as he could judge at present, the cost of maintenance of all plant at the Eldon-road works for the 12 months ending March 31 would be about £550. He estimated the profit on the working of the department for the 12 months ending March 31 at £1,000. This was equivalent to 7 per cent. on the outlay. The interest and repayment of principal for the year amounted to £5,000. The committee considered the report most satisfactory.

Weston-super-Mare Tramway Cables.—The two accompanying illustrations show that electric tramways are being rapidly constructed at Weston-super-Mare. The cable contract for the tramways has been placed with the Callender's Cable and Construction Company, Limited.

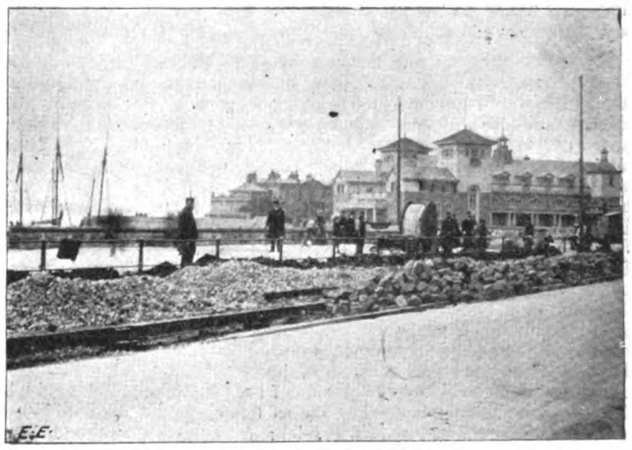

FIG. 1. Laying Callender Cables for the Weston-super-Mare Tramways.

The contract provides for some five miles of cable in all, and three miles have been already laid. The mains are of the single-conductor type manufactured by the above company. The cores have either 0·2 or 0·15 of a square inch sectional area of high-conductivity copper. They are insulated with vulcanised bitumen, taped with two fine

FIG. 2. Drawing in Cables for Tramways at Weston-super-Mare.

bitumen tapes and then heavily taped and insulated over all. The cables are partly drawn into 3in. earthenware pipes and partly laid on the solid filling-in system. One of the photographs shows the cable being drawn into the pipe system which was already laid.

Presentations.—A presentation to Mr. G. K. Nowlan took place at the electricity offices of the Harrogate Corporation on Monday evening last on the occasion of his leaving the employ of the department to take up a position with the British Insulated Wire Company, Limited, of Prescot. Mr. Wilkinson, the engineer-in-chief of the department, in making the presentation, referred at some length to the conscientious and able manner in which Mr. Nowlan had discharged his duties whilst under him, and ended by asking him, on behalf of all the subscribers, to accept a silver cigarette case with a suitable inscription, together with a silver match-box suitably initialled, as a small token of the esteem and regard borne towards him by the officials and employés alike.—Mr. M. B Mountain, who for the past three years has been shop manager at Messrs. Crompton and Co.'s electrical works at Chelmsford, is leaving for a higher post with the Westinghouse Company. Mr. P. S. Cheverton was the secretary of a committee representing 400 subscribers employed by the firm, and at a smoking concert on Saturday Mr. Mountain was presented with a full gold hunter watch suitably inscribed, and Mrs. Mountain similarly received two handsome plated entrée dishes. Mr. S. L. Bunker presided. Mr. Cheverton expressed the employés' feelings of good fellowship towards the recipients. A number of other toasts followed interspersed with musical selections and recitations.

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Private Bills.—A Select Committee of the House of Commons have passed the preamble of the Bill of the Newcastle-upon-Tyne Electric Supply Company, and rejected that of the Northumberland Electric Power Company. The London County Council's Electric Supply Bill has passed the second reading in the House of Commons by a majority of 30.

Beckenham.—The clerk reported at the last meeting of the Urban District Council that at a meeting of delegates from various Kent local authorities the opposition to the Kent Electric Power Bill was withdrawn on terms. Beckenham had secured complete protection, the company agreeing not to supply current in the district without the consent of the Council.

Hull.—The Standard Timepiece Company, London, are considering the question of obtaining suitable premises in Hull for the installation of the electric current (at a central station) for the maintenance of 1,000 clocks in a state of uniformity. The company, which has an installation in London, will supply a subscriber of £3. 3s. with a 12in. electrically-wound clock.

Weybridge.—The Electric Supply Company have offered to provide and maintain the necessary plant, and to light 100 25-c.p. lamps at £2. 15s. per annum, and 77 32-c.p. lamps at £3. 5s. per annum, a total of £525, on condition that the Council enter into a five years' contract. Mr. J. S. Crawshaw is reporting to the Urban District Council on this and other offers.

Bexhill.—The Electric Light Committee's report, adopted on Tuesday, stated that the committee had decided to reduce the price of electric light per unit for the second hour of the maximum from 3d. to 2d. The extension of the cables to Collington-lane at an estimated cost of £600 was agreed to, and application will be made for a loan subject to Mr. Bond entering into an agreement.

Sport.—Glover's Association Football Club played the return match with Royce's Works at Manchester on the 15th, and won by two goals to one. The teams afterwards had high tea together, which meal, by previous arrangement, was provided by the losers. After tea a ping pong match was played, the cable-makers again worsting the dynamo-builders by 78 points to 65. The previous football match was won by Royce's, and on that occasion tea was provided by Mr. E. A. Claremont, a director of both companies.

Walsall.—The Electric Lighting Committee reported on Monday that their balance-sheet showed a profit, after paying interest and sinking fund, of £381. 9s. 7d. for the year ending Dec. 31, 1901, as against £119. 8s. 5d. for the previous year, and after wiping off the balance of the deficit of £275. 3s. 6d. incurred on the undertaking in previous years, they had resolved to place the balance of £106. 6s. 1d. to the credit of a reserve fund. The committee expect to be able to reduce the cost of the light by supplying the tramways, and thus obtaining a constant run on their supply.

Ashton.—The Electricity Committee are offering the following terms to the Governors of the District Infirmary—viz.: (1) £7 per annum per kilowatt of maximum demand as registered by the indicators, which demand is to be the average of monthly readings taken during the six winter months, the charge under this head not to exceed £100 per annum in respect to the present buildings; (2) a charge in addition to the above of 1½d. per unit supplied as registered by the meters; (3) the agreement to be for a period of five years. The distributing main in Oldham-road is to be replaced by a larger one.

Doncaster.—The borough electrical engineer's last report states that between Feb. 3 and March 3 six applications were received, being equivalent to 759 8-c.p. lamps. The number of consumers on books is 193, and the lamps applied for up to the present date total 12,718 8-c.p. lamps. There are at present connected 10,848, while 14 consumers and 1,870 8-c.p. lamps are awaiting connection. A proposal for alteration to the steam-piping at the works, and an estimate from Messrs. D. Bruce Peebles and Co. to carry out the alterations, have been adopted, also a tender for an economiser by Messrs. E. Green and Son.

Lowestoft.—The last report of the Electric Lighting Committee states that there are now 10,796 8-c.p. lamps connected to the mains, 446 additional lamps having been connected during the past month, representing 10 more consumers, thus giving 224 as total number of consumers on supply. Application is to be made for sanction to borrow the sums of £1,400 and £7,143, urgently required for condensing plant, and £5,000 for a dynamo, etc. The engineer has submitted a plan of the new switchboard on each side of the harbour, and is to obtain estimates for same and report to the next meeting of the committee.

Heckmondwike.—At Monday's meeting of the District Council it was explained with reference to a letter which had appeared in a local paper suggesting that the actual cost of the electric lighting plant had considerably exceeded the original estimates, that the total estimates for land, building, and machinery were £14,343, £10,280 of which was for machinery alone, whilst the actual cost of machinery had been £10,350, or only £70 in excess of the estimate. The original estimates for the electricity works were on the basis of a supply for domestic purposes only, the British Electric Traction Company not, at that time, having obtained their order to include Heckmondwike in their tramway system.

Removals.—Messrs. George Schultz and Co. have removed from 90, Cannon-street to 22-23, Laurence Pountney-lane, E.C.—Prof. Henry Robinson has removed from 13, Victoria-street to Parliament-mansions, Victoria-street, Westminster, S.W.—Messrs. H. R. Griffin and Co., export agents for Dolberg Griffin's portable railway, have removed from 1, Finsbury-square, E.C., to 2, Southwark Bridge-road, S.E.—The Horsfall Destructor Company, Limited, have secured offices on the first floor at 19, Old Queen-street, Westminster, S.W., in which they expect to be installed after March 25.—Mr. H. F. Parshall, M.I.C.E., M.I.E.E., consulting engineer, is removing his offices from Princes-street to Salisbury House, London-wall, E.C.

Mundesley.—In amplification of our note on the lighting of this village, we learn that the following resolution has been carried by the Parish Council in committee: "After a lengthy discussion upon various schemes, we recommend to the parish meeting that the parish of Mundesley be lit by electricity; that Messrs. Ridout and Co.'s scheme be adopted, but on condition that 10 standard lamps be placed at stated intervals through the parish; and, further, that the cost of the said public lighting does not exceed the sum of 3d. in the pound, and that the works be carried out and completed within the space of the next six months, as per an agreement to be drawn up as between the Parish Council and Messrs. Ridout and Co." The matter was to be discussed at a parish meeting on the 14th inst.

Rochester.—At the last meeting of the Town Council it was resolved that the consideration of the question as to the emission of black smoke from furnace chimneys be adjourned for 12 months, and that Mr. E. Charles Raphael be appointed as electrical inspector for this city under the terms of the provisional order constituting the Chatham, Rochester, and District Electric Lighting Company. The Town Clerk read a proviso to Clause 54 of the Kent Electric Power Bill, which he had submitted to the promoters, and which had been agreed to by them, and it was resolved that the proviso be accepted as satisfactory, and that as to the general clauses the Corporation be bound by any decision come to, or arrangement made with the promoters, by the committee of county authorities which have the matter in hand.

Gravesend.—Consumers are to have the option of paying for the electric current consumed by them for lighting purposes, not only upon the maximum demand system at the rate of 7d. and 3d. per unit, but also upon the flat system, that is of paying a fixed charge—namely, of 6d. per unit of the whole quantity consumed. With reference to an application from Russell's Gravesend Brewery, Limited, to know the terms upon which the Corporation would supply electric light to 300 lamps, the engineer reported that it would necessitate a cable being laid from the New-road to West-street, at a cost of about £165, and the Council are prepared to do this conditionally upon the brewery company agreeing to take current to a maximum amount, to be mutually fixed for a reasonable term of years at the price payable by consumers generally.

Glasgow.—At the meeting of the Corporation on Tuesday the following motion was adopted without discussion: "That it be remitted to the Watching and Lighting Committee to consider and report upon the public lighting of the city of Glasgow—(*a*) in comparison with other cities in this country and on the Continent; (*b*) on the nature and cost of improvements necessary to provide more efficient lighting; (*c*) on the rates charged by the Corporation gas and electricity departments for the gas and electricity supplied to the Watching and Lighting Committee, and on the charges and conditions under which gas and electricity are supplied to other corporations for public lighting; and (*d*) on any other matters pertinent to the improvement of public lighting, with powers to correspond with other cities, and to obtain information from and confer with any of the departments of the Corporation or their officials."

Grimsby.—On Friday Mr. M. K. North held an enquiry into an application of the Corporation for sanction to borrow £17,000 for electric lighting purposes. The deputy town clerk (Dr. E. L. Grange) stated that since 1894 £55,000 had by sanction been borrowed for electric light and traction, and the present sum of £17,000 asked for was £4,100 (deficiency and overspent in capital account for works now carried out), and £12,900 for the erection of an additional engine, with necessary boiler, dynamos, and other things, to be added to the present plant at the electric lighting station. The rate at which electricity was being consumed justified this expenditure in the opinion of the Corporation. Mr. H. G. Whyatt (borough engineer), Mr. W. A. Vignoles (borough electrical engineer), and Alderman Dobson (chairman of the Electric Lighting Committee) also gave evidence in support of the application.

Accrington.—We have received an account, prepared after figures of the borough engineer (Mr. W. J. Newton) and the borough electrical engineer (Mr. H. Gray), showing the units of electricity generated from refuse alone each day during the month of November, 1901, at the destructor and electricity works. A Horsfall destructor is used in conjunction with a Lancashire boiler, and the steam is delivered to the electric light engines. During the period in question no fuel other than refuse was required. This shows that from Nov. 3 to 30 (24 working days) 18,796 units were generated, or an average of 783 units per day, while 11,638 units were delivered. The refuse treated amounted to 2,132,256lb., or 112·9lb. per unit generated. The maximum units generated in one day was 1,039, and the highest load observed came to 472 amperes at 235 volts, 148·6 e.h.p. These figures are exclusive of steam used for forced blast, pumps, etc.

Welsh Telephones.—Thanks to the initiative of Colonel Pryce-Jones, M.P., an agitation has been in progress for some time for the extension of the telephonic system to Aberystwyth, with exchanges at Welshpool, Montgomery, Newtown, and Machynlleth. The matter has also been taken up by Mr. Denniss, the general manager of the Cambrian Railways, who last week received a letter from the Postmaster-General in which he says that it may be practicable to provide a satisfactory service for the towns mentioned by means of three circuits, involving a guarantee of £455 only. For the Shrewsbury, Montgomery, and Newtown circuit a guarantee of £170 would be required; for the Newtown, Machynlleth, and Aberystwyth circuit, £245; and for the Montgomery and Welshpool circuit, £40. This guarantee is considerably lower than the one first suggested by the Postmaster-General, and as the Cambrian Railways Company is prepared to join with local authorities in making up a guarantee, there should be little difficulty in carrying the matter through.

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Finchley.—At the last meeting of the Urban District Council called specially to consider the electrical engineer's scheme for establishing over the parish a system of lighting by means of electricity, Mr. Paul gave particulars of the scheme, and mentioned that the provisional order obtained by the Council would expire shortly, and therefore it was necessary to proceed with the scheme. The gas supplied was very expensive, and not of the best quality. It had not been thought advisable in the interests of the parish to contract for the supply of electricity, but the committee were of opinion that this scheme should be in the hands of the Council. They had land for the generating station, and their electrical engineer had been at work for some time. His estimates worked out roughly at £8,000 for buildings, £10,600 for machinery and apparatus, £14,150 for mains and services, and £2,250 sundries—a grand total of £35,000. It was decided to apply for sanction to the borrowing of that amount for the purpose of carrying out works in connection with electric lighting by the Council under the order obtained by them in 1899.

Dundee.—At a meeting of the Tramway Committee of the Town Council on Tuesday the electrical engineer submitted a report on the proposed additions to the plant at the electric station. From the report it appeared that the existing plant was equivalent to 3,770 h.p. During the past winter the quantity of electricity required to supply the demands of the consumers was equal to 2,556 h.p., while next winter it was estimated that 3,368 h.p. would be needed. The limit of pressure on the return feeders allowed by the Board of Trade had been reached, and it would therefore be necessary to instal boosters. He therefore recommended the addition of one 750-kw. engine and dynamo at an estimated cost of £6,000; two 600-h.p. tubular boilers fitted with mechanical stokers and forced-draught apparatus for burning cheap fuel, at £2,000; and boosters and switchgear at £1,000—in all, £9,000. After discussion, it was agreed to approve of the engineer's report. A number of applications for electric lighting were agreed to necessitating extensions estimated at £847, and estimated to bring in a revenue of £120. 10s. per annum.

Poplar.—At the last meeting of the Council the following statement and recommendation from the Electricity Committee was discussed: "A charge of £15,330 for cable trench work carried out by the surveyor's department to Sept. 29 last has been made, including a sum of £2,015 for new stone required to make good the footways and roadways disturbed. The chairman of the Works Committee has met the chairman of the Electricity Committee and the officers concerned to consider how far these charges can be fairly placed upon the electricity undertaking, and have reported in favour of transferring the charge for new stone to the general paving account. It is felt that the provision of new stone to replace worn-out or broken stones is a matter of general benefit to the borough, and not of advantage to the electricity undertaking, and that such replacements would in any case have had to be undertaken at the cost of the borough within a short period. We recommend that the sum of £2,015, charged to the electricity undertaking for provision of new stone for trench work, be transferred to the general paving account of the borough." After considerable debate the recommendation was rejected.

London County Council.—At the meeting of the Council on Tuesday it was agreed to lend the Poplar Borough Council £15,400 for electric light installation, and sanction was given to a loan to the Islington Borough Council for £10,438 for electric light installation. Notices were received from the Lewisham and District Electric Supply Company, under the Lewisham District Order, 1901, of intention to lay high and low tension mains (*a*) along a portion of High-street, Lewisham, (*b*) along a further portion of High-street, and (*c*) along Rushey-green and Catford-road. The Highways Committee reported that the company had no electricity generating station within the area of supply under the order, and they had no reliable information as to whence the company would obtain a supply of electrical energy for the mains referred to in the notices, and recommended that the works be disapproved. Notices from the Blackheath and Greenwich District Electric Light Company, under the Blackheath and Greenwich District Order, 1897, of intention to lay low-tension mains along portions of Oakcroft-road and Granville-park; and from the County of London and Brush Provincial Electric Lighting Company, under the County of London (Northern Extensions) Order, 1897, to lay high and low tension mains in Hatton-wall and across Great Saffron-hill, and also to construct a transformer box in Hatton-wall, were approved. A notice was also received from the Hampstead Borough Council, under the Hampstead Order, 1893, of intention to lay mains along portions of West End-lane, Lymington-road, Wadham-gardens, Merton-road, Minster-road, Edgware-road, Shoot-up-hill, High-road, Kilburn, and Iverson-road, and to construct a sub-station at the junction of Minster-road and Westbere-road. The Borough Council was the undertaker under the order, and the Council had no power of approval or disapproval of works.

King's Lynn.—The engineer's last report states that during the month applications have been received for 130 additional lamps of 8 c.p. or equivalent, making a total from private consumers of 11,536, this number including a supply for nine motors. The working expenses for the month of January were as follows: units generated, January, 1901, 36,076, January, 1902, 41,264; total units sold to private consumers, 1901, 11,533, 1902, 15,105; units sold at power rate, 1902, 143; fuel, stores, repairs, and wages at station (cost of), 1901, £198. 1s. 11d., 1902, £139. 9s. 5d.; cost per unit generated, 1901, 1·3178d., 1902, 0·1109d.; wages of lamplighters and outside staff, 1901, £14. 13s. 11d., 1902, £15. 1s. 3d. He also stated that the following charges for lighting had been in use during the financial year—namely, 5d. per unit, with a reduction to 3d. after 10 units per 8-c.p. lamp fixed had been consumed during each winter quarter; 3d. per unit during the four light months of the year. In order to enable the prices to be adjusted for the ensuing 12 months, he had estimated that the revenue for that period would amount to £4,901. 10s., and the expenses to £5,109. 18s. This estimate was based on a revenue of 4⅞d. per unit from private consumers, and in order to obtain this, the best and easiest way of dealing with the matter would be to set a uniform rate of 5d. to the general consumer and 4¾d. to those business premises that remained open after 8 p.m. on at least five nights per week, which would be equivalent to a reduction of 5 per cent. to the profitable long-hour consumers. The recommendations were accepted at the last Town Council meeting. It was also reported that the Board of Trade had now sanctioned the transmission of energy by overhead wires, and that this should make it quite feasible to supply the power required in connection with the extension of the waterworks at Gayton, dealt with in another note.

King's Lynn Waterworks.—The Waterworks Committee have a report from the electrical engineer, in which it was suggested that the new works proposed at Gayton should be carried out by means of electrical power transmitted from the electricity works. In this he says there are at least two methods of producing the high-presssure current at the electricity works—viz.: (1) by using a motor-generator and taking current from the existing machines; (2) by putting down another steam dynamo with a high-pressure generator on the same shaft. The first method would be the least costly in capital cost, but would not be so efficient as the second. The expenditure would be as follows: one 85-h.p. motor-generator, £800; foundation switches and connections, £130; one 70-h.p. motor, £420; overhead line, £600; pump, £400; house, £100; well (as per Mr. Weaver), £1,275—total £3,725. The second scheme is higher in capital cost, but is 15 per cent. more efficient, inasmuch as the losses in the motor-generator are not incurred. The cost would be as follows: one 140-kw. direct-current steam generator, £1,450; one 80-h.p. high-pressure generator, £500; foundation pipes, etc., £346; high-pressure switches, etc., £50; alteration to existing switchboard, £30; one 70-h.p. motor, £420; overhead line, £600—£3,396. The portion of this expenditure which would be used also for lighting purposes is £1,826; waterworks expenditure, £1,570; pump, £400; house, £100; well (as per Mr. Weaver), £275—waterworks total expenditure, £3,345. Two gas-engines could be sold to make room for the new plant, and it is estimated that by the the sale of two gas-engines, two dynamos, and two gas producers, it might be possible to realise £1,200, so that the plant in the station is increased by 60 kw. at a cost of about £626. An alternative way is suggested at a capital expenditure of £1,950—viz., to couple motors to the existing pumps and throw the engines out of gear, at the same time leaving the engines and boilers in their present positions as stand-by to be used in case of failure to the electric supply. Upkeep, cost of cleaning, etc., is put as follows: £560, the cost to the electricity works at £460, and the capital charges at £685. 4s. 2d.

Bolton.—Colonel Durnford has just held an enquiry into the application of the Town Council for sanction to borrow £125,000 for purposes of electric lighting. Councillor Panton (chairman of the Electricity Committee), the town clerk (Mr. R. G. Hinnell), the electrical engineer (Mr. Day), and Mr. G. Temperley (architect) gave evidence. The statement of expenditure and requirements showed the following: for new buildings the sum of £29,616 was required, including extension to engine-house, new boilers, cooling tower, reservoir extensions, store buildings, and new workshop; for machinery, £67,305, including engines and dynamos (£29,000), Lancashire boilers, steam-pipes, and other apparatus (£24,705); mains, £22,550, including extension of high and low tension network connecting boxes, meters, sub-station, and sub-station switchboard. Mr. Day explained the necessary details of requirements for the works at Spa-road. They included two 2,000-h.p. engines and two 1,200-kw. dynamos, 20 30 by 8 Lancashire boilers, steam-pipes, superheaters, valves, mechanical stokers and shafting, hopper and economiser with 4,000 pipes, switchboard extension, conveyor, machine cables for 2,400-kw. generators, and sinking well with pump. There was an increasing demand for motive power. Mr. Temperley detailed the requirements amounting to £29,616, including £10,868 for future boiler-house, flues, cleaning-out places, economiser beds, dampers, and 15 boiler seatings; £5,060 for extension to engine-house, new flues, manholes, etc.; £4,400 for cooling tower and other extensions. Councillor Panton said the number of consumers had increased from 65 in 1895 to 1,050 at the present time, whilst the units sold had increased from 35,128 in 1895 to 2,431,737 in 1901. The profits had increased from £945 in 1895 to £10,554 in 1901, whilst the sums voted in aid of rates had been—1899, £1,000; 1900, £1,000; and 1,901, £857. The total depreciation amounted to £13,553, and the sum of £7,600 had been passed at the last meeting of the committee, making a total of £21,153. The reserve fund amounted to £962, the total being £22,115, whilst the original cost of the works was £22,700. The Electricity Committee propose that the following prices be adopted from April 1 next: motors under 4 h.p., and intermittent users of larger motors, price 1¾d. per Board of Trade unit, less 10 per cent., 1·575d. net.; motors used continuously 4 h.p. and over, 1¼d. per Board of Trade unit, less 10d. per cent., 1·125d. net.; customers using with a guarantee of not less than 25 h.p., for 48 hours per week, or 48,000 Board of Trade units per annum, 1¼d., less 20 per cent. for cash monthly, or 1d. per unit net; price for tramways, 1¼d. net.

PROVISIONAL PATENTS, 1902.

MARCH 10.

5831. Improvements in systems and apparatus for regulating electric currents. Reginald Charles Clinker, 235, Clifton-road, Rugby.

5851. Improvements in prepayment gas or other fluid or electricity supply controlling apparatus. Henry Cooney, 15, Water-street, Liverpool. (Complete specification.)

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5888. Improvements in magneto-electric therapeutic appliances. Leo Sahŭ Osman, 6, Lord-street, Liverpool.

5891. Improvements in electrical wattmeters. Vittorio Alessandro Arcioni, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

5897. A new or improved electric circuit interrupter. James William Thomas Cadett and Edward Sanger Shepherd, 43, Southampton-buildings, Chancery-lane, London.

5907. Improvements in the winding of revolving magnets. The Hon. Charles Algernon Parsons, 18, Southampton-buildings, Chancery-lane, London.

MARCH 11.

5913. Improvements in thermo-electric material. Hugo Bremer, 34, Neuenweg, Barmen, Germany. (Complete specification.)

5934. A new and improved combination clock, electric battery and lamp with self-contained case for the same. Henry Waterson, 67, Albert-road, Aston, Birmingham.

5944. Improved telegraph systems. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (James Harvey Peirce, United States.) (Complete specification.)

5952. Improvements in and relating to electric arc lamps. William Phillips Thompson, 322, High Holborn, London. (Eberhard Sander, Germany.)

5960. Fuse box for electric currents. Walter C. Hunniball and George Carr, 99, Victoria-road, Charlton, Kent.

5962. An improved gear for electric or other power-driven lifts. Matthew Thomas Medway, 175, Shardelves-road, New Cross, London.

5972. Electrical arrangement for enabling sounding signals to be exchanged between locomotives in motion and the stations, stopping places, etc., and between the locomotives, for the purpose of preventing railway collisions. Edouard Danneels, 56, Ludgate-hill, London. (Complete specification.)

5978. Improvements relating to rectifiers for single or polyphase alternating currents. Albert Nodon, 45, Southampton-buildings, Chancery-lane, London.

5981. Improvements in rail bonds or connections for electric railways. George Barstow Blanchard, 45, Southampton-buildings, Chancery-lane, London.

5982. Improvements in electric telegraph systems and relating more particularly to wireless systems. Harry Shoemaker, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

5988. An automatic electrical cut-out. David Robertson Bruce, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

5997. Improvements relating to the controlling of electric circuits. Sebastian Ziani de Ferranti, 18, Southampton-buildings, Chancery-lane, London.

6000. Improvements in apparatus for producing high electrical potentials, and in means for utilising the same for the ignition of explosive mixtures or compounds in explosion motors. Ernst Eisemann, 6, Lord-street, Liverpool. (Complete specification.)

6009. Improved fire-alarm telegraph repeater apparatus. Leonidas G. Woolley, 322, High Holborn, London. (Complete specification.)

6024. Improvements in or relating to electric arc lamps. Charles Oliver, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

6026. Improvements in magneto-electric generators. James Mordington Wilson, 18, Buckingham-street, Strand, London. (Complete specification.)

MARCH 12.

6033. Improvements in magnetic compasses and surveying instruments. Henry William Lake Steward, 406, Strand, London.

6093. Improvements in apparatus for testing electrical circuits. John Edward Preston and Stephen Stiles Alcock, 4, New Compton-street, London.

6121. Improvements in electric arc lamps. John James Rathbone, 173, Fleet-street, London.

6122. Improvements in electric switches or circuit closers and breakers. Otis Elevator Company, Limited, 55, Chancery-lane, London. (Otis Elevator Company, Incorporated, United States.)

6143. Improvements in automatic regulation of voltage in alternating electric current systems. The British Thomson-Houston Company, Limited, and Hans Sigismund Meyer, 83, Cannon-street, London.

MARCH 13.

6147. Improvements in portable hand-combination telephones. August Eckstein and Arthur Brooker, Peel Works, Adelphi, Salford, Manchester.

6148. An improved thermostatic cut-out for electric heating circuits. August Eckstein and Charles Herbert Archer, Peel Works, Adelphi, Salford, Manchester.

6149. Improvement for transmitting motion and power by magnetic means. Francis Langham Wilder, 5, Blenheim-parade, Evesham-road, Cheltenham.

6155. An improved device for cleaning overhead electrical conductors. Edward Massey Hollingworth, Alexandra Villa, Prescot-road, St. Helens.

6165. An electric trolley head with wire-finding combination. John Thomas Cherry and Edward Henry Clive, 2, Bedford-park, Plymouth.

6184. Improvements in section insulators for electric trolley conductors. Hugo Hirst and William Wood, 165, Queen Victoria-street, London. (Complete specification.)

6193. An apparatus for the measurement of high electrical resistances. Oswald Cox, 22, Rosslyn-hill, London.

6209. Improvements in or relating to electric arc lamps. Samuel Henry Johnson, 111, Hatton-garden, London. (Complete specification.)

6233. Improvements in and relating to automatic electric circuit breakers. Sebastian Ziani de Ferranti, Charles Cornfield Garrard, and Henry William Clothier, 18, Southampton-buildings, Chancery-lane, London.

MARCH 14.

6264. Improvements in gas and electric light illuminations for advertising purposes, and devices for public decorations. John Whitehead, Elizabeth Whitehead, and Herbert John Whitehead, 11, Barker-street, Handsworth, Birmingham.

6295. Improvements in or relating to brakes for electric tramcars and like vehicles. Gustave Adolph Trube and William Chapman, Westinghouse Building, Norfolk-street, Strand, London.

6304. Improvements in and relating to the manufacture of electric accumulator plates. Accumulator Industries, Limited, and Joseph Johann Heinrich Hunte, 322, High Holborn, London.

6306. Improvements in systems of electric alarm signals for railways. William Phillips Thompson, 322, High Holborn, London. (Pasquale Penza, Italy.)

6328. Improvements in electricity meters. William Morris Mordey and Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

6331. Improved electrical cooking apparatus. Maurice Bayno, 40, Chancery-lane, London. (Complete specification.)

6345. Improvements in electric light signals. Wladimir Taboulewitsch, 5, Hatton-garden, London. (Complete specification.)

6346. Improvements in and relating to electromagnetic circuit breakers or cut-outs. Edward Lionel Joseph and George Gardner, 322, High Holborn, London. (Complete specification.)

MARCH 15.

6347. Improvements connected with electric railways. James Swinburne, 82, Victoria-street, London.

6376. Improvements in and relating to arc lamps. William Paterson, 14, Killarney-road, Wandsworth, London.

6379. A continuous burning arc lamp with inclined carbons. Joseph Albert Rignon and Ernest Eisenmann, 28, New Bridge-street, London. (Complete specification.)

6383. Automatic electric battery regulating switch. James Ernest Spagnoletti and James Lawrence, Goldhawk Works, Goldhawk-road, London.

6396. Magnetic contact box for electric tramways. Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Alfredo Diatto, Italy.)

6406. Improvements in automatic regulators for constant-current dynamos. Felix Bernard O'Hanlon, 18, Southampton-buildings, Chancery-lane, London.

6430. A new or improved system of overhead construction for electric railways. Edward Henry Tyler, Norfolk House, Norfolk-street, Strand, London.

6434. Method and device for testing or gauging steel magnets in respect of their magnetic power. Bertil Brander, 7, Hillaries-road, Gravelly-hill, Birmingham.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published April 3.

1901.

5589. Electric telegraphy. Muirhead.

5766. Working and controlling of electrically-driven cars. Siemens Bros. and Co., Limited, Siemens, and Duke.

5908. Ships' telegraph for gunnery purposes. Evershed and Evershed and Vignoles, Limited.

6770. Alarm apparatus for engine-room telegraphs or the like. Higgs and Anti-Collision Alarm Telegraph Company, Limited.

6862. Electric distribution system. Holden.

7868. Safety devices or guards for use in connection with electric traction cars and the like. Charlesworth.

9675. Arc lamps. Jandus Arc Lamp and Electric Company, Limited, and Jones.

10062. Moving-coil electrical measuring instruments. Eckstein and Panter.

10120. Electric telegraphy. Muirhead.

13017. Recording apparatus for electrical measuring instruments. Hill.

16955. Electrical intercommunication. Van Wagenen.

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17070. Incandescent electric lamps. Reinmann.

23429. Electrical propulsion for railway and other cars. Thompson. (Scott, Janney, and Le Bar.)

25724. Spiral sheave or trolley for use in electric overhead tramcars and the like. Hunt.

1902.

155. Lens combinations for telephoto purposes. Goerz.

3154. Sockets for uniting two telegraph wires. Frank.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	Mar. 8	585	581	+ 3	29,164	27,036
Birmingham Tramways	—	—	—	—	—	—
Blackburn Corporation	,, 15	613	604	+ 9	6,203	5,644
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 15	203	180	+ 23	1,724	1,574
Bolton Corporation	,, 16	1,473	1,271	+ 202	13,433	12,499
Bradford Corporation	,, 16	2,784	826	+ 1,958	19,732	8,367
Bristol Tramways Company	,, 14	3,996	3,842	+ 154	—	—
Carlisle Tramways Company	,, 15	122	123	− 1	1,282	1,192
Central London Railway	,, 15	6,782	6,157	+ 625	72,895	66,819
City and South London Railway	,, 16	3,000	2,028	+ 972	33,472	22,226
Cork E. T. and L. Company	,, 13	386	366	+ 19	3,533	3,557
Darwen Corporation	,, 14	190	171	+ 19	1,845	1,664
Darwen-Hoddlesden	,, 14	26	—	—	—	—
Dover Corporation	,, 15	172	156	+ 16	1,782	1,689
Dublin & Lucan Electric Railway	,, 16	90	73	+ 17	905	784
Dublin U. T., electric cars	,, 14	3,341	3,168	+ 173	—	—
Dublin S. District, Electric	,, 14	737	711	+ 26	—	—
Dundee Tramways Company	,, 12	638	570	+ 68	—	—
Glasgow Corporation	,, 15	10,941	8,500	+ 2,441	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 15	1,657	1,539	+ 118	84,071	69,783
Liverpool Corporation	,, 8	8,843	7,998	+ 845	86,359	77,857
Liverpool Overhead Railway	,, 16	1,450	1,574	− 124	15,059	16,269
Newcastle-on-Tyne Corporation	,, 15	1,913	—	—	—	—
Portsmouth Corporation	,, 15	1,141	544	+ 597	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 17	3,738	—	—	—	—
Southampton Corporation	,, 13	779	626	+ 153	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £387 decrease.
Barcelona Ensanche y Gracia, £12 increase. Barcelona, £432 increase.
Brisbane, £222 increase (month of Feb., £1,341 increase).
Buenos Ayres and Belgrano Electric, £65 increase.
Calcutta, £20 decrease.
Cape Town (month of Feb.), receipts, £15,896; expenditure, £6,780.
La Capital Traction and Electric, Buenos Ayres (month of Dec.), £1,394 increase.
Mexico Electric (month of Feb.), receipts, £16,500; expenditure, £9,800.
Perth Electric, £157 increase.
Port Elizabeth (month of Feb.), receipts, £3,559; expenditure, £1,784.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Tramways.—	£	£
Anglo-Argentine, 1-260,007	5 ..	4-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	124-127
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramways Invest., Lim., Ord., 1-75,000	5 ..	2⅞-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4⅛-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6¾-7¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	101-103 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13-14
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12¼-12¾
—— 5 per cent. Perpetual Debenture Stock	100 ..	127-130
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅛-1¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5⅛
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5⅛
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11-12
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	97-100
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	102-104
New General Traction, Ordinary	5 ..	2½-3½
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10¾
—— 5 per cent. Cum. Pref.	10 ..	11½-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	99 102
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	10¼-11½
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	10s. ..	½
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	50 p.c..	50 p.c.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅜-½
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅛-⅜
—— Ordinary, 1-125,000	1 ..	⅛-⅜
British Insulated Wire, Ord., 1-70,000	5 ..	9½-10½
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5⅜-6¼
—— 5 per cent. Mortgage Debentures	100 ..	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5⅜-6
Brush Electrical Engineering, Ordinary	2 ..	1⅜-1⅝
—— Nos. 90,001-105,731	2 ..	1⅜-1⅝
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-2⅛
—— 4½ per cent. Debenture Stock	100 ..	101-104
—— 4½ per cent. 2nd Debenture Stock	100 ..	97-100
Callender's Cable, Debentures	100 ..	111-115
—— Ordinary	5 ..	17½-18½
—— 5 per cent. Pref.	5 ..	5¼-6
Crompton and Co.	3 ..	3-3½
—— 5 per cent. Debentures	— ..	99-104 p.c.
Edison and Swan United, Ordinary	3 ..	⅛-⅜
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	78-83
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	83-88
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1⅛-1⅜
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9⅜-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	100-103
W. T. Henley's Telegraph Works, Ordinary	5 ..	17½-18½
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	100-103
Parker, Thos., Limited, Ordinary	10 ..	15¼-16½
Telegraph Construction and Maintenance	12 ..	35-38
—— 5 per cent. Bonds	100 ..	102-105
Telegraph Manufacturing, Ordinary	5 ..	10¼-11½
—— 5 per cent. Cum. Pref.	5 ..	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	9-10
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	100-105
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	9¼-10¼
—— Debenture Stock, Red.	100 ..	103-106
Brompton and Kensington, Ordinary	5 ..	8⅜-9¼ xd
—— 7 per cent. Preference	5 ..	8⅜-9¼ xd
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	8¼-9½
—— Nos. 20,001-30,000	5 ..	8-9
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
,, ,, ,, £10 Ord.	6 ..	10⅝ xd
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	106-108
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	104-106
Chelsea Electricity Supply	5 ..	5-5½ xd
—— 40,501-50,936	5 ..	5-5½ xd
—— 4½ per cent. Debentures	100 ..	110-113
City of London, Ordinary	10 ..	8¼-9¼ xd
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	101-104
County of London and Brush Provincial, Ordinary	10 ..	8¼-9⅛
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6-6¼
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	106-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4-4½
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8 xd
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10¾-11¼ xd
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9⅜-10⅛
London Electric, Ordinary	3 ..	1⅞-2¼
—— 6 per cent. Pref.	5 ..	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	95-100
Metropolitan, Ordinary	10 ..	14½-15½
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9½
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	14½-15½
Oriental, 1879	1 ..	1⅛-1⅜
—— £5 Shares	5 ..	7½-8
—— £4½ Shares, New	4½ ..	6¾-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6 xd
—— 4 per cent. Debenture Stock	100 ..	98-101
River Plate Electric Light and Traction, Deb.	100 ..	65-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1½-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2-2½
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	98-101
Westminster, Ordinary	5 ..	11½-12½
Electric Railways.—		
Central London, Ordinary	100 ..	100-103
—— 4 per cent. Pref.	100 ..	103-106
—— ,, deferred	100 ..	98-101
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-118
City and South London, Consolidated Ordinary	100 ..	65-68
—— Ordinary	10 ..	—
—— Nos. 60,001-70,000	10 ..	—
—— 4 per cent. Debenture Stock	100 ..	112-116
—— 5 per cent. Pref. Stock '91	100 ..	128-133
—— ,, ,, '96	100 ..	122-126
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	92-95
Telephones.—		
National Telephone, Preferred	100 ..	95-99 xd
—— Deferred Stock	100 ..	60-64 xd
—— 6 per cent. Cum. First Pref.	10 ..	13-15 xd
—— Preferred, 590,001-790,000	3½ ..	3⅛-3⅜
—— 6 per cent. Cum. Second Pref.	10 ..	13-15 xd
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4⅞-5⅛ xd
—— 4 per cent. Deb. Stock, Red.	100 ..	93-96
—— 3½ per cent. Deb. Stock, Red.	100 ..	101-105
Oriental Telephone and Electric Company	1 ..	¾-1

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NOTES.

Tunbridge Wells Telephones.—We hear that the National Telephone Company are again trying to get the municipal telephone system at Tunbridge Wells into their own hands. They have addressed a letter to the Town Council on the subject, in which the old argument is put forward that the municipal rate is unremunerative, and must result in a considerable loss.

Faraday House.—We are informed that increased accommodation having been obtained at Faraday House, the Board have made arrangements to commence a new session at the beginning of the summer term—*i.e.*, on Monday, April 7. The entrance examination will be held at 11 a.m. on Wednesday, April 2. Students wishing to enter upon that date should communicate with the secretary, Mr. Howard Foulds, by March 31.

Wireless Telegraphy.—A message from Halifax states that Mr. Marconi has selected Table Head, Glace Bay, as the site for his Nova Scotian wireless telegraph station, which is to be completed in three months. It is also reported that Mr. Marconi has arranged with the Town Council of Halifax to keep the electric tramways one-third of a mile from the proposed station for five years, so that there shall be no fear of interruption to his system from stray electric currents from the tramways.

North-East Coast Institution.—The March number of the *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders is just to hand. It contains, among other things, the following three papers on engineering subjects: "The Speed of Machine-Shop Tools," by Mr. J. W. E. Littledale; "The Ballasting of Modern Tramp Steamers," by Mr. E. C. Chaston; and "Some Notes on Steam Turbines," by Mr. F. J. Warburton. An account of the institution annual dinner, which was held at Newcastle-on-Tyne on Jan. 30, is also included in this issue.

The Albert Medal.—Announcement is made that the council of the Society of Arts will proceed to consider the award of the Albert Medal for 1902 early in May next, and they therefore invite members to forward to the secretary on or before April 5 the names of such men of high distinction as they may think worthy of the honour. The medal was struck to reward "distinguished merit in promoting arts, manufactures, and commerce," and has been awarded in the past five years respectively to Mr. G. J. Symons, F.R.S., Prof. R. W. Bunsen, Sir Wm. Crookes, F.R.S., Mr. Henry Wilde, F.R.S., and to his Majesty the King.

A Dutch-German Cable Scheme.—A message from the Hague states that the Government there have submitted for the approval of the States-General a telegraph convention with Germany providing for a joint subsidy for telegraph cables to the Dutch colonies in the Far East. The proposal is to connect Menado, in the Celebes, with the proposed American cable, which would connect the West Coast of North America with the Philippine Islands. The route would be by way of the Pelew Islands, which would also be connected with Shanghai. It is thus intended to establish telegraphic communication between the Far East and Europe by way of America, and by cables belonging to companies of various nationalities.

Central Technical College.—The council of the City and Guilds of London Institute have just issued a little booklet which will be of great interest to young electrical engineers. It is, in fact, a complete list of the names of past students of the Central Technical College, Exhibition-road, W., together with a short account of their careers and the posts they now occupy. Glancing through the list we see that old students of the college are spread throughout the length and breadth of the Empire, many having secured responsible appointments in the Colonies as well as in the Mother Country. A list such as that before us conveys more information as to the good work which the institute is doing than anything else, and it is especially gratifying to electrical engineers to find that the Central College is contributing in such a marked fashion to the advancement of the industry.

Govan Electricity Undertaking.—The electricity department of the burgh of Govan has just issued a new set of rules, which have been drawn up by Mr. James Brown, the electrical engineer, for governing the supply of electricity for lighting and power purposes within its area. Glancing through the same, we notice a new departure which has been taken in regard to lighting of common staircases in tenements or buildings into which the service mains are laid for the supply of private consumers. For this lighting a fixed annual charge is made according to the candle-power of the lamp installed. Thus, reckoning the number of lighting hours in the year at 3,950, the charge per annum for a 5-c.p. lamp is £1. 5s., for an 8-c.p. lamp £1. 7s. 6d., and for a 16 c.p. lamp £1. 17s. 6d. This works out at just under 2d. per unit, and we think the electricity department is to be congratulated on its progressive spirit. The inducement thus held out to consumers to come on to the mains on such favourable terms is sure to bear good fruit sooner or later.

Electrical Steam-Boiler.—Mr. C. E. Griffing has been granted a patent in the United States for a boiler in which the necessary heat is generated by electricity. The boiler has no furnace, and contains only a small quantity of water. It consists of a shell of iron or steel of the usual proportions, having two heads at each end. Inside the boiler are two water-legs connected together by tubes, and into which water is admitted. Connecting with the water legs are the feed pipes, which pass through the steam space so as to raise the temperature of the water nearly to that of the steam before being introduced into the boiler. The tubes connecting the water-legs are perforated on the lower side, the perforations emitting very small streams of water. Within the shell of the boiler is a number of tubes, to which are connected the ends of electrical conductors, the opposite ends of which are connected to the generator or other source of electrical current. The current supplied by the conductors is intended to heat the water as it issues from the small perforations, and to thus generate steam. The pressure may be regulated by varying the strength of the electric current and by the amount of water admitted to the heating tubes. Finally, the boiler is covered with a thick layer of non-conducting material in order to prevent radiation.

Frequency Measurements.—Several new methods for measuring the frequencies of rapidly alternating currents have lately been devised by Mr. K. E. F. Schmidt, an account of which is given in an abstract from the *Annalen der Physik*. It seems that in one of these methods a telephone is made to produce stationary sound waves in a glass tube, and two positions of minimum resonance are determined by means of a piston. The telephone is excited by the current to be studied, and the position of the piston, together with the known velocity of the sound in air, suffice to determine the frequency sought. The author has also successfully employed Kundt's dust figures for the same purpose. Both methods are only suitable for frequencies which are considerably higher than those ordinarily used. For ordinary frequencies the author employs an incan

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descent lamp fed by the current under investigation. This is photographed by a camera attached to a pendulum, and the negatives show alternate bright and dull stripes in accordance with the maxima and minima of the current traversing the lamp. An interesting application of this principle is obtained by simultaneously photographing two lamps in this manner, one of which has a difference of phase with respect to the other, as in the primary and secondary circuit of a transformer. The difference of phase expresses itself in a displacement of the stripes with respect to each other.

Students' Visit to Newcastle.—The programme of the visit to the Newcastle-on-Tyne district arranged for the students' section of the Institution of Electrical Engineers next month, is now complete. The party will arrive in Newcastle on Monday evening, April 7, in time to attend the meeting of the local section, to be held at the Durham College of Science, at 7.30 p.m., those travelling from London leaving King's Cross Station at 10 a.m. The following is the complete list of the engineering works which will be visited while the party are in Newcastle: Tuesday, April 8—the works and sub-stations of the Newcastle Electric Supply Company, Limited; the works of the Sunbeam Electric Lamp Company, Limited. Wednesday—the works of Messrs. Ernest Scott and Mountain, Limited; the Elswick Works of Sir W. G. Armstrong, Whitworth, and Co., Limited. Thursday—The Sunderland Corporation electric light and tramway system; the works of the Sunderland Forge and Engineering Company; the works of Messrs. J. H. Holmes and Co. Friday—The three-phase tramway system at Stockton-on-Tees; the Stockton-on-Tees Corporation electricity works; the Forth Bank works of the Newcastle and District Electric Lighting Company, Limited. Saturday, April 12—The works of Messrs. Palmer's Shipbuilding and Iron Company, Limited. Each of these visits is necessarily restricted to students of the Institution, and only to those who shall have sent in their names before April 2 to the honorary secretary of the students' section.

Locomotive Headlights.—The *Western Electrician* records some interesting experiments which are being made with a new electric headlight for locomotives on one of the large railroads in the States. The results so far are said to be very satisfactory. The headlight, besides throwing a strong light along the track, by means of which objects may be discerned over half a mile away, also casts a strong beam of light in a vertical direction, which can be seen at long distances up to 10 miles, and over hills and other objects. The outfit comprises a steam turbine engine directly connected to a dynamo. Normally, the engine and dynamo operate at 2,000 revolutions per minute, and the wheel, it is said, will successfully withstand a speed of about 10,000 revolutions per minute. The steam is allowed to expand down to nearly atmospheric pressure in the nozzle before it comes into contact with the wheel buckets. This results in throwing all, or nearly all, of the energy of the steam into effluent velocity, and a very fair degree of steam economy is thus gained. Steam is led to the engine through a ¾in. copper pipe from the locomotive cab, and the exhaust is carried into the smoke arch by means of a 1¼in. wrought-iron pipe. The dynamo is of special construction, being designed particularly for this light. The field is differentially wound, and the circuits so arranged that a burned-out armature is almost impossible. The dynamo gives a current of 30 to 33 amperes at the arc with a pressure of 30 to 33 volts. The light produced is said to be of about 6,000 c.p., and at the head of a locomotive brilliantly illuminates the track for at least half a mile.

Electrical Contrivance to Prevent Collisions at Sea.—A novel device which aims at the prevention of collisions at sea by electrical methods is the invention of a Russian engineer, one Nicholas Gherassimoff. The object of the arrangement is to ensure against collision between the ship and any moving or stationary body in the path of the ship, either at the surface or at a depth less than the draught of the ship, and also to give warning of shoals. The inventor's idea is to have electrically-propelled bodies or "feelers" moving in advance of and at substantially the same rate of speed as the ship, and at such a depth under water as to come in contact with any obstruction at a depth less than the draught of the ship. There are three of these "feelers," one of which moves in a line with the keel and the other two in paths to the right and left of this line respectively. The three electric cables controlling the feelers are united at a point in such a manner that this point and the position of the three feelers are at the corners of a square. A cable from the junction point is then connected with indicating apparatus aboard the ship The feelers are controlled by an electric current from the ship, and are provided with mechanism connected with the indicating apparatus before mentioned to show the deviation in one direction of the two outside feelers, and the deviation in either direction of the third or leading feeler. Each feeler is also supplied with a luminous floating signal carried by a buoy at the surface of the water. The indications aboard ship denote also whether a feeler has come into contact with a floating obstruction or is over a shoal.

Telegraphs through Persia.—The Foreign Office have just published the terms of the convention made last August between the English and Persian Governments, extending the system of telegraphic communication between Europe and India through Persia. It is agreed, with the view of securing uninterrupted communication between Europe and India, that, in addition to the present line of telegraph from Teheran to Bushire on the Persian Gulf and submarine cable thence to India, a three-wire line of telegraph shall be constructed by Persia, under British supervision and with British material, from Kashan to the Baluchistan frontier by way of Yezd and Kerman, traversing wherever possible inhabited districts. With regard to the use of British materials our Government agrees to procure for the Persian Government at a reasonable price all the posts, wire, insulators, etc., that may be required, and to arrange for the carriage of the stores to their destination, receiving payment for the same without interest. The line will be the property of the Persian Government, and will be leased to the Indo-European Telegraph Company at a rental of 4 per cent. on capital expended in construction. Of this rental three-fourths will go to the British Government to recoup them for advances made, and one-fourth to the Persian Government, subject to a minimum of £1,000 to be paid annually. The agreement, which remains in force until January, 1925, also provides for an additional wire along the existing line between Teheran and Kashan to be placed by the Indo-European Company.

Royal Meteorological Society.—The monthly meeting of this society was held on the 19th inst., when Mr. W. N. Shaw, F.R.S., read a paper on "La Lune mange les Nuages," which was really a note on the thermal relations of floating clouds. He also exhibited an arrangement of apparatus whereby the conditions applicable in the case of a floating cloud could be experimentally realised. Mr. F. J. Brodie read a paper on "The Prevalence of Gales on the Coasts of the British Islands during the 30 years 1871-1900." At all seasons of the year, excepting the summer, the prevalence of gales from south-west is

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greater than from any other quarter. The minimum of such gales is reached in the spring, when rather less than 20 per cent. are from south-west, more than half the storms being, however, from points between south-west and north-west. The prevalence of gales from polar directions is then at its maximum, more than 21 per cent. blowing from points between north and east. In the spring of 1883, out of a total of 11 gales no fewer than seven were from these quarters, the proportion being about three times the average. The highest velocities recorded were those at Fleetwood during the westerly gales on Dec. 22, 1894, and on Jan. 12, 1899. On the former occasion, for nine hours, from 7 a.m. to 3 p.m., the mean velocity was 64 miles per hour, and at 9 a.m. it reached a maximum of 78 miles. It appears that on the average 43 per cent. of the storm systems which visit our coasts advance from some point of the compass lying between south and south-west, and travel towards some point lying between north and north-east. Thirty-nine per cent. have an easterly motion, while less than 1 per cent. move westwards.

The World's Fair, St. Louis.—The World's Fair, planned to be held at St. Louis next year, is known officially as the Louisiana Purchase Exposition. It will celebrate the centennial of the acquisition from Napoleon by Jefferson of the territory of Louisiana, out of which have been made 12 states. The actual work of construction is proceeding rapidly even during the winter months, as St. Louis, by reason of its mild climate, lends itself well to this. The plans for the principal buildings have been accepted, and many contracts have been let. The fair authorities have arranged to occupy the new grounds of the Washington College, comprising 110 acres, which connect with the fair site proper in Forest Park. Upon these grounds important buildings are either finished or in course of erection. With this addition the site chosen will cover over 1,000 acres. It is easy of access, the various street railway systems, of which the city has about 500 miles, converging at the different gates and entrances. All the 24 railways entering St. Louis will be connected directly with the site, while electric lines will be constructed to carry passengers from one department to another within the grounds. Of the invitations extended to foreign countries 12 or 15 have been accepted, of which Japan and France are the principal. Perhaps no feature of the exhibition will be more novel and interesting than that based upon the plans for a congress of aerostatics. The leading aeronauts and the clubs interested in the question are taking steps to participate in an aerial tournament. The Aeronautical Society of Great Britain has taken up the work, and Sir Hiram Maxim has promised to take an active part. M. Santos-Dumont is also expected to be a central attraction, and to take a leading part in the tournament. Those who are interested in the coming exposition may procure information from the resident representative, Mr. George F. Parker, at Sanctuary House, Tothill-street, Westminster, S.W.

Interesting Steam Plant at San Francisco.—The *Journal of Electricity, Power, and Gas* recently had a very interesting account of the new steam plant installation of the Independent Electric Light and Power Company at San Francisco. The most prominent feature of the installation, apart from the fact that it is said to be typical of the latest and best American ideas in modern steam station practice, is its generators. There are already installed in this station three 1,500-kw. Westinghouse-McIntosh and Seymour engine sets in addition to one 500-kw. engine type generator. These 1,500-kw. generators run at a speed of 116 revolutions per minute, and as they have 62 poles each the frequency of the system is 7,192 alternations per minute; the E.M.F. delivered from the generator being 500 volts in two-phase current. The machines are of the engine type and they are as well of the rotating armature type, the rotating member being built upon a cast spider pressed upon the engine shaft. The external frame is divided in a vertical plane, so that it may be removed away from the shaft to allow access to the windings. The separately excited field required is 190 amperes at 100 volts. The pole-pieces of the fields are of laminated steel, faced with copper plates, and so proportioned as to reduce the armature reaction and self-induction to a low limit. The field coils are of strip copper wound on edge, and permit good air circulation, while the armature is of the slotted-drum type, built up of laminations held together between end plates. A load of 1,500 amperes per terminal at 500 volts, it is said, may be thrown off the generator without effecting a rise of more than 6 per cent. in its E.M.F., with constant speed and constant separate excitation. The full-load efficiency of the generator is 95 per cent., and the temperature rise for 24 hours at full load does not exceed 40deg. C., while at 50 per cent. overload for one hour the rise in temperature does not exceed 60deg.

The Future of Electric Traction.—Mr. J. Clifton Robinson read a lengthy paper before the Society of Arts on Wednesday week, his subject being "Electric Traction: London's Tubes, Trams, and Trains, 1902." The first part of the paper is concerned mainly with the earlier history of electric traction in London, and by gentle stages the author ultimately brings us to the present—describing incidentally the schemes which his own company, the London United Tramways, Limited, have under consideration—and then takes a look into the future. With regard to this latter, he expresses his conviction that the overhead trolley as applied to surface tramways has as yet no rival in economy of construction, in simplicity of operation, in safety, and in economy as regards passengers. He admits, nevertheless, that the surface-contact system is one of the "possible rivals" of the overhead trolley, and in view of the recent introduction of that system under the Board of Trade license at Wolverhampton he deems it worthy of consideration. But his experience so far, however, is wholly opposed to any surface-contact system yet in practice. He asserts, for instance, that "the rattle and row of the 'skates' as at Monte Carlo would not be tolerated in this or any other country." Yet, as our readers are aware, the Corporation of Wolverhampton, under the advice of their electrical engineers, have entered on a scheme of allowing 11½ miles of tramway to be equipped for surface-contact working, and so far as we are aware there have been no complaints as to noise in the working of the experimental line, such as Mr. Robinson suggests. Discussing the system further, he asks, "How is the danger of the stud remaining 'alive' to be securely guarded against?" For information on this point we would refer Mr. Robinson to the report of the borough electrical engineer of Wolverhampton, which shows that in only two cases in a space of 30 days was a stud left "alive" after the car had passed over it, and then only a very slight slight pressure of about one volt was discovered. Mr. Robinson proceeds to discuss the question: Will electricity itself be one day superseded by another power? This is a very wide question, and one which is rather premature, seeing that electric traction has only been with us for little more than a decade. Not unnaturally, therefore, the author advises that we should be a little careful as to prophesying. He should be much surprised, however, if even 10 years hence anything better can be found for London than the idea put forward by last year's Joint Committee on Under-

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ground Railways as to how the terrible problem of London intercommunication can best be dealt with.

Compulsory Working of Patents.—Two influential deputations waited upon Mr. Gerald Balfour at the Board of Trade on Thursday week to urge that no compulsory working in regard to inventions should be incorporated into the patent laws—the first representing the Chartered Institute of Patent Agents, and the second from the Manchester Chamber of Commerce. The former deputation was headed by Mr. Philip M. Justice, the president of the institute, who gave as the principal reasons against compulsory working the difficulty usually experienced in getting a new invention or manufacture taken up, and the cost and the lack of demand in certain countries. He also warmly advocated that the compulsory working in this country of inventions made abroad, as distinguished from those made in England, was impracticable, and in direct contravention of international convention, and that manufacture for the mere purpose of complying with the requirements of a working clause had no practical effect in promoting native industry, but it had a great effect in discouraging inventors from taking patents and subsequently in destroying their patent rights if acquired. He contended that compulsory working would be ruin to any industry, and asked the Board to place themselves in Austria and assume that the Austrian law had no compulsory working clause, and take their patent to this country and have a compulsory working clause, and then consider the great hardship it would be upon the Austrian inventor. To this Mr. Balfour remarked that the British inventor at present was exposed to those injustices which the foreigner did not have to contend with in this country. In reply to some further remarks from the President of the Board of Trade, Mr. Justice admitted that the compulsory license clause fairly met the case where a foreign patentee imported his goods into this country while refusing to allow his patent to be worked here. Sir W. Houldsworth, who headed the deputation from the Manchester Chamber of Commerce, supplemented the above remarks, dealing with the question from the point of view of chambers of commerce. Mr. Balfour's reply was couched in the official language customary on such occasions. He would give the views expressed his most careful consideration, and would see how far it would be possible to meet the wishes of the deputations. He could not say what the intentions of the Government were respecting the change advocated above, and he was not prepared to express any opinion regarding the compulsory working of a foreign patent in this country. He felt bound to say, however, that there were considerable difficulties in the way of such a course. If a compromise on this point were possible, however, so much the better. If not, he was in favour of a suggestion made that the Government should pass a Bill providing for examination of previous specifications on application for patents. The other matters might be left over for discussion, but he gave a half promise that they might be embodied in a second Bill next year.

Electric Shock.—Major-General C. E. Webber made a short reply to the discussion of his paper on "Electric Shock" at the meeting of the Institution of Electrical Engineers last week, previous to the paper on "Problems of Electric Railways" by Messrs. J. Swinburne and W. R. Cooper being taken. Dealing first with the criticisms of Dr. Hedley and Dr. Lewis Jones on the question of the heart acting as a pump, of which he had expressed some doubt in his paper, General Webber remarked that if the suggestion he had made was rather startling, he was quite content to leave it to those better informed than he to work it out. He mentioned, however, that a French institution was at the present time engaged in investigating the subject of how electric shock affected the human system, and so far they had pursued the course indicated by him in his paper. On this point, also, he recommended a careful study of Dr. Margaret Cleave's articles, which had been published in this country by the *Electrical Review*, and which went to show that the heart was the most vulnerable part of the human sytem. He next referred to the importance attaching to the presence of the factory inspectors at the last meeting, and called attention to the appointment of Mr. Gilbert S. Ram, a member of the Institution, to be electrical inspector of factories and workshops, which was announced a day or two ago. He thought they might take some credit to themselves for that appointment, as it would probably never have been made but for the prominence which their Institution had given to the subject of factory legislation as applied to electrical works. With regard to Dr. Lewis Jones's remarks on the question of pain from electric shock, it was a matter well worth anyone's time in thinking it out, and trying to arrive at some good explanation of what were the feelings of pain from electric shock. He mentioned, in conclusion, that the Council had permitted him to add to the report of these few remarks in the *Journal* a communication as to how the legislation on this subject had been brought about. Mr. Langdon, in proposing a vote of thanks to the three authors for their respective papers, said he had no doubt that the attention which had been drawn to this subject would result in considerable benefit as regards the mode of treatment it was desirable to apply to victims of electric shock. General Webber had given prominence to the set of regulations prepared apparently with the object of forming official rules under the new Factory Act. In so doing General Webber had done yeoman service for the Institution, but at the same time it must be remembered that these regulations had not been adopted, and it was to be hoped that before any official regulations were approved grave consideration would be given as to the effect they might have on the industry at large. He also hoped that their Institution would be consulted in the matter, so that the regulations might be drafted under the joint guidance of members of their Institution and members of the Government department whose duty it was to deal with the subject. A vote of thanks to Major-General Webber, Mr. Aspinall, and Mr. Trotter for their interesting and instructive papers was then passed with acclamation.

Wolverhampton Corporation Tramways.—The report of Mr. Henry Lea, the electrical expert called in by the Corporation of Wolverhampton to give his opinion on the working of the Lorain surface-contact system in that town, contains many points of interest hitherto unpublished. His general conclusion, as briefly mentioned in our last issue, is favourable to the system, although with only 30 days' trial he is not able to vouch for its ultimate success. Even 12 months he regards as being all too short for a complete investigation into the practicability of any surface-contact system. Time alone can show whether the system is all that it appears to be. Many details are given in the report with regard to the carbon contact armatures. The weight of the armature is 2·75oz., from which it is deduced that the actual lifting effort is 169 per cent. in excess of what is required to just support the armature. This excess effort ensures the armature rising with the rapidity necessary for making the stud active by the time the collecting skate arrives at the stud. From observations made, Mr. Lea has found that there is absolutely no friction between the moving and stationary parts to cause wear and tear, and he feels justified in

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saying that there is not even a remote possibility of the bottom carbon remaining in contact with the top carbon after the car has gone by. As regards the effect of street traffic on the boxes, for the purposes of experiment a 15-ton steam-roller was driven over a portion of the track, and subsequent examination failed to reveal any disturbance or cracking. The mean leakage of current to earth is given at about 0·01 ampere for the length of seven-eighths of a mile of the experimental track; *pro rata*, the leakage on 11·375 miles, the length of the Wolverhampton system, would be about 0·13 ampere, which at 500 volts represents a constant loss of only 0·87 e.h.p. over the whole system. The report of Mr. C. E. C. Shawfield, the borough electrical engineer, on the 30 days' trial is also in favour of the Lorain system being extended to the whole of the tramways in Wolverhampton. It appears from this report that during that period no less than 49,392 passengers were carried on the short length of line in operation, the receipts being £205. 16s. The car miles run were 4,298, the receipts per car mile 11·49d., number of double journeys run 2,364, number of journeys lost 110, and percentage of journeys lost 4½ per cent. As many as 42 of these lost journeys were due to the necessity of taking the cars into the depôt for repairs and adjustments of collecting skates, gearing, brakes, etc.; 51 journeys were lost owing to the rails being blocked by snow, salt not being used; and 17 were lost from various causes, such as defective paving. During the 30 days each box was tested daily to see whether there was any trace of electrical pressure on the top plate after the cars had passed over it, but in every case the boxes were found to be perfectly "dead" except in two instances, where a very slight pressure of rather less than one volt was discovered. In consequence of the wet weather experienced just before Christmas some of the boxes were flooded before they were sealed up, and, as a result, when current was first switched on the system seven boxes were found to be alive at pressures varying from 1 to 100 volts. The chief trouble which has arisen in connection with the operation of the line has been that the cars have frequently lost the current at certain places, this being attributable mainly to the collecting skates on the cars becoming bent and failing to make proper contact. Under present conditions the life of a skate is given as only between 300 and 400 car miles, and consequently the cost of renewals is rather a serious matter, being something like ½d. per car mile. Mr. Shawfield concludes his report with the statement that the Corporation are quite justified in instructing the contractors to proceed with the equipment of the remainder of the 11 375 miles of single track.

Liverpool Overhead Railway Fire.—The report of Colonel H. A. Yorke, R.E., to the Board of Trade on the fatal fire which occurred at Dingle Station on the Liverpool Overhead Railway on Dec. 23 last, shows conclusively that it was not so much due to the faulty motor, as to the imprudence of the driver, Ashbee, although, of course, that was the initial cause of the trouble. In the words of Colonel Yorke himself, "the fire would have been productive of no serious danger if driver Ashbee had only acted with a moderate degree of prudence. When this man discovered that his rear motor had failed, his duty was to disconnect the rear motor by means of the plug provided for the purpose in his compartment. He should then have run into the station with one motor, as is often done." Herein then lies the root of the whole trouble. "For some reason or other, which," continues Colonel Yorke, "cannot be conjectured, Ashbee, instead of disconnecting the defective motor, and in disregard of the warning of the guard, made repeated efforts to bring it into use, the result being that before long the woodwork of the rear carriage was ignited by the flashes produced by the electric arc when the current was switched on to the defective motor. While Ashbee was so employed, both he and the guard appear to have told the passengers to keep their seats, as there was no danger. Both these men and station foreman Rendell seem to have exhibited a lamentable lack of judgment in this respect. It is impossible not to feel that the sacrifice of life on this occasion was unnecessary and might have been easily avoided. If the passengers had been hurried out of the train as soon as it became evident that it had broken down, and if none of them had been permitted to loiter about the station, their safety would have been secured. And if the train men and station foreman, who deserve credit for their efforts to prevent the fire from spreading, had only realised sooner that the train was doomed, they, too, had ample time to escape." The practical conclusion which Colonel Yorke draws from the circumstances connected with the fire is of great importance. They show, he says, the advisability of removing all woodwork as far as possible from the neighbourhood of the electric machinery upon railway carriages, and of adopting for the purposes of insulation some material which is uninflammable and smokeless. Also, stations situated in tunnels on electric railways should have as little woodwork about them as possible, although Colonel Yorke does not find the company guilty of any blame for storing in the tunnel some sleepers intended for repairing the permanent way, which caught fire and added considerably to the conflagration. As was announced a few weeks ago, Dingle Station has been reconstructed, and Colonel Yorke commends the company for having used stone and concrete in the new station as far as possible; there is now practically no woodwork at all about the place. Mr. A. P. Trotter's report on the origin of the fire is appended, and goes to show that the failure of the motor was due to defective insulation. An electric arc was started, and was repeated each time the driver attempted to go on ahead. From the fact that the lights "went low," Mr. Trotter concludes that a very heavy current was being taken. The arc due to this heavy current, or perhaps the earlier flashes, set fire to the woodwork of the coach, and the strong wind caused the fire gradually to spread. Eight years' experience on this railway has shown that such failures, even when resulting in a "burn-out" of a motor, have never before set fire to any part of the train, and Mr. Trotter asserts that the risk of fire involved in the present railway, on which there is but one short terminal tunnel, was less than on ordinary steam railways. His concluding remarks with regard to insulation are of importance, and contain some sound advice. They are to the effect that "flexible cables covered with indiarubber or other combustible material are used unnecessarily in many cases in electrical work. This mode of construction does not commend itself to mechanical engineers. Combustible insulating materials should not be used on the main current conductors of electric trains, particularly in tunnel railways. These conductors should be rigid, and might be bare, or enamelled, or protected by incombustible ferrules in iron pipes. Flexibility should be restricted to necessary points, and not used for convenience in arranging the conductors. Flexibility should be provided by pinned hinge or knuckle joints shunted by bare flexible links of wire gauze, or cable braided with wire, or by some other sound mechanical mode of construction. Little or no woodwork should be used in the construction of electric locomotives, or of the driver's cabs of motor coaches, and in the latter the resistances and the controlled switches should be placed, if possible, in front of and outside the cab."

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THE RHYL ELECTRICITY WORKS.

We all know that humans are gregarious animals, and no doubt a final spur was given to the electricity undertaking at Rhyl because the neighbouring towns had already taken up the work of electric lighting. In the summer of 1899, after preliminary enquiries, Mr. Trentham, in conjunction with Mr. Peers, of Manchester, was employed to draw up a scheme in which the public lighting was to form a prominent feature. In the fulness of time contracts were entrusted to Messrs. Thornton, of Liverpool, for buildings; Messrs. Manlove and Alliott, dust destructor; Messrs. Babcock and Wilcox, boilers; the Lancashire Dynamo Company, with Alley-Maclellan engines, steam dynamos; Messrs. Clayton and Co., of Huddersfield, switchboard; the Western Electric Company, mains, arc lamps, etc.; Messrs. Dutihl Smith, McMillan, and Co., for Hart accumulators; and Messrs. Marshall, Fleming, and Jack, travelling crane. The buildings and dust destructor have been carried out under the superintendence of the surveyor, Mr. A. A. Goodall.

Dynamos.

As will have been seen from the contract, the combined sets were entrusted to the Lancashire Dynamo and Motor Company. The main generators (Fig. 4) consist of three 150-kw. six-pole machines coupled direct to three compound single-acting three-crank engines by Messrs. Alley and Maclellan, of Glasgow. These generators are shunt-wound machines of the company's standard design, having each an output of 300 amperes at 500 volts. The magnets are of steel, elliptical in section, and securely bolted to the yokes, which are split on the horizontal diameter. The yokes are provided with brackets lined with white metal to support the brush ring. The field coils are former-wound, each being provided with its own terminals. The bearings are of the spherical-seated self-oiling type of liberal dimensions, each having two brass oil rings which dip into the well below. The armature is built upon a cast-iron sleeve which extends to the bearing on one side, and is formed into a coupling on the other, thus strengthening the shaft, and eliminating the strain on keys and shaft incidental to changes of load—an important point in traction work. The commutator is also carried on this sleeve, and consists of hard-drawn copper bars of liberal depth built up under hydraulic pressure and insulated with specially selected mica. The end rings are divided into segments, which are drawn together by special steel rings of wedge-shaped section. In this way the bars are held down with great pressure, but are left free to expand longitudinally. The brush-holders are the company's patent type made of light brass stampings, so that the inertia is small. They are pressed against the commutator by means of springs giving a long range of pressure, the same springs serving to hold them off the commutator when they are drawn back. The brushes are of carbon, and the current density does not exceed 30 amperes per square inch. The brush-holders are carried by a special carrier which supports both ends of the steel spindle. These carriers being clamped in the arms of a brush ring supported from the magnet yokes, the brushes are not subjected to vibration, and interference with the ready removal of the bearing caps is avoided. The plant supplied by this contractor also includes a balancing and boosting set (Fig. 5) for battery charging, and a motor-driven tramway booster. The former set consists of two of their standard No. 10 machines coupled to two of their standard No. 6 machines. The No. 10 machines are the balancers, each wound for 250 volts and capable of dealing with an out of-balance current of 125 amperes. The No. 6 boosters are each wound for an output of 110 volts 50 amperes. The shunt winding of the balancer magnets is supplemented by a few series turns on each machine, the current flowing through the series turns being the current in the middle wire, the direction of these series turns being such that they oppose the shunt turns in the motor and assist them in the generator, with the effect of automatically

MR. W. H. TRENTHAM, CONSULTING ELECTRICAL ENGINEER RHYL.

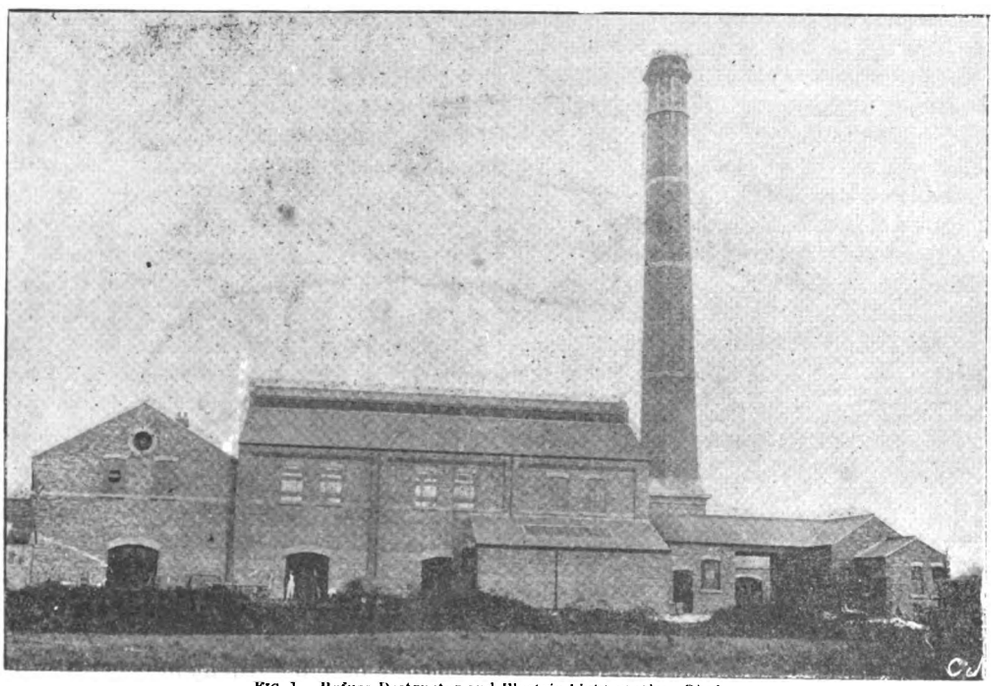

FIG. 1.—Refuse Destructor and Electric Light Station, Rhyl.

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reversing as the current in the middle wire reverses, an arrangement capable of effecting a great nicety of balance. The motor-driven tramway booster consists of a 500-volt motor direct-coupled to a generator to deal with a current

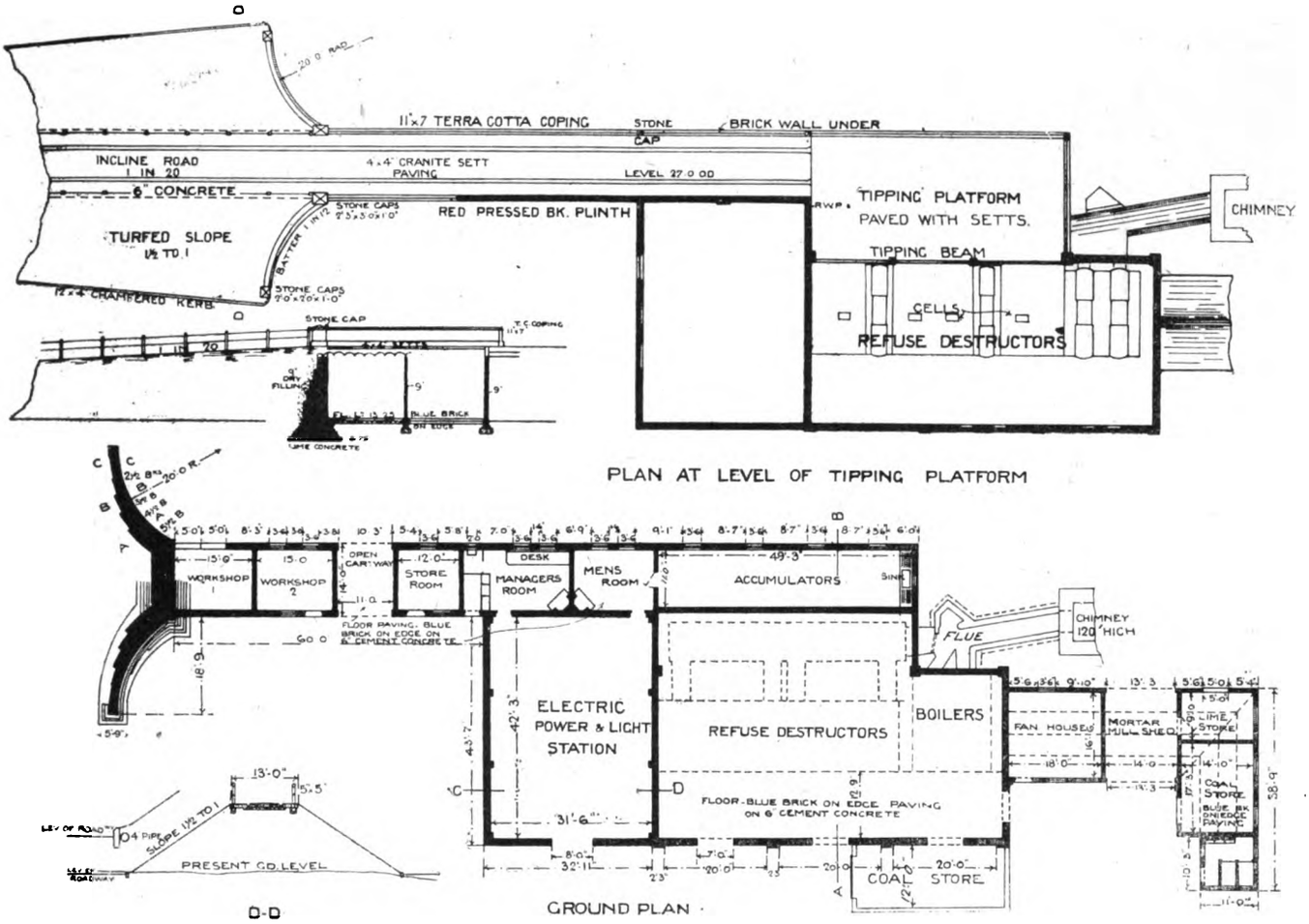

FIG. 2.—Details of Road to Tipping Platform and Plan of Electric Light and Power Station, Rhyl.

of 25 amperes, and capable of boosting to the extent of 100 volts. The design is circular and exceedingly compact, without any parts being unduly cramped. The brushes are very accessible, and the design is such that the brush-holders when drawn back project through the doorways, self-oiling type of large dimensions, each being provided with two brass oil rings, which dip into the well below. The bearing supports fit into circular recesses in the cast-steel yoke, bored at the same time as the magnets, thereby ensuring absolute alignment. The armatures are well

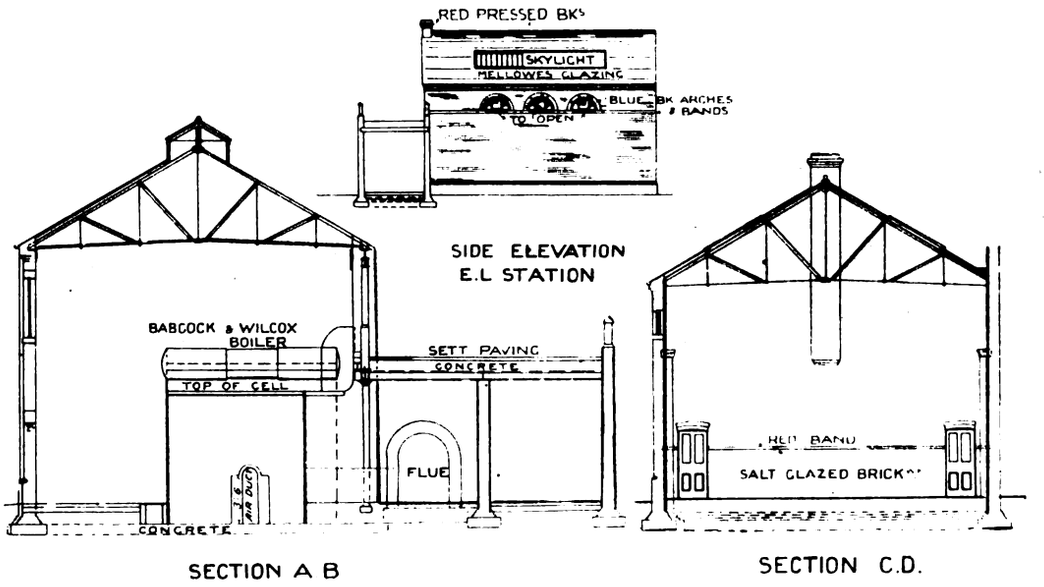

FIG. 3.—Sections and Side Elevation.

enabling the carbons to be easily changed whilst the machine is running without any danger of shock, even if the frame of the machine is connected to earth. Absolute interchangeability of parts is guaranteed by the use of high-class gauges and jigs. The pole-pieces are laminated, and of special form to prevent sparking and to eliminate eddy currents. The pole-pieces can be easily removed and the field coils withdrawn. The field coils are former wound, and a very high insulation is obtained between them and the frame. The bearings are of the swivel ventilated and the plates built up on a cast-iron sleeve, which extends from bearing to bearing. The brush-holders are in all essentials similar to those on the larger machines.

ENGINES.

The three engines, by Messrs. Alley and Maclellan,

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coupled direct to the generators, are of the makers' standard pattern "Sentinel" high-speed engine of the vertical tandem, compound, single-acting, self-lubricating type. Each engine develops 190 b.h.p. at 400 revolutions with 135lb. steam pressure, non-condensing, and is designed to stand an overload of 30 per cent. so as to be suitable for electric traction. They may be run either condensing or non-condensing, and have exceptionally large bearing surfaces, the advantages of which are well known to our readers. The governors are situated at the rear end of the crankshaft, and act on the steam throttle valve, and by means of a spring the opening of the valve can be altered while the engine is running, giving a variation of speed of some 15 per cent. Once set, however, the speed remains constant at any load within 2 per cent. of the mean.

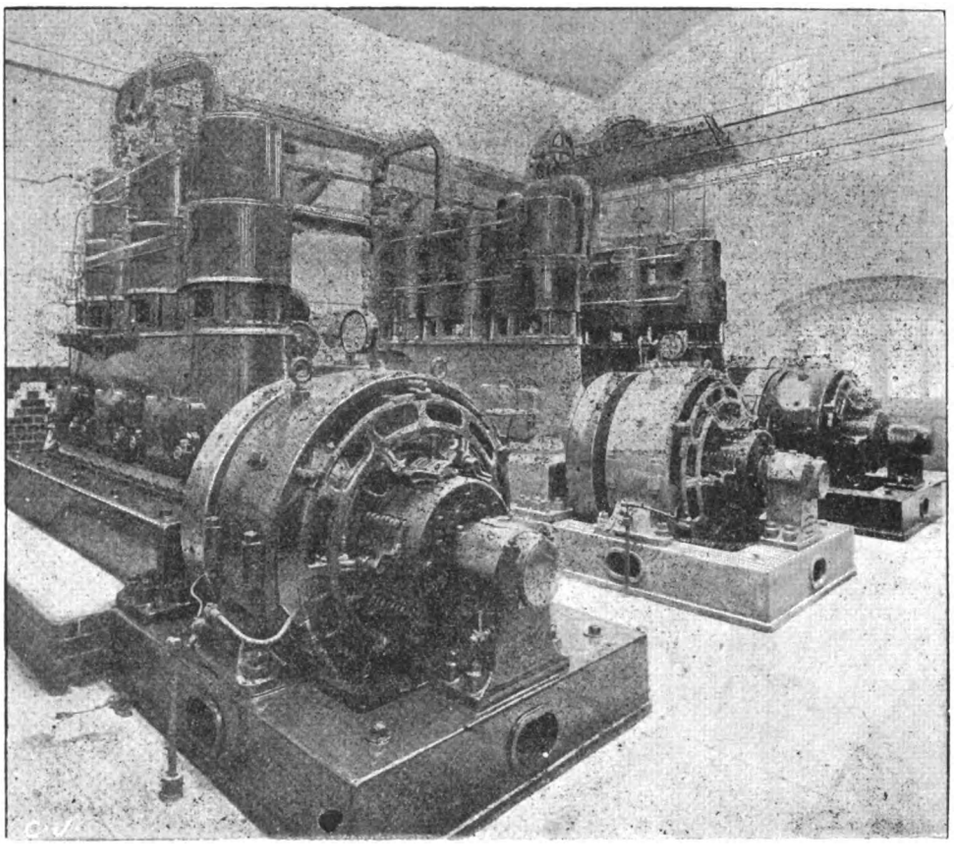

FIG. 4.—Combined Sets, Rhyl Electric Light and Power Station.

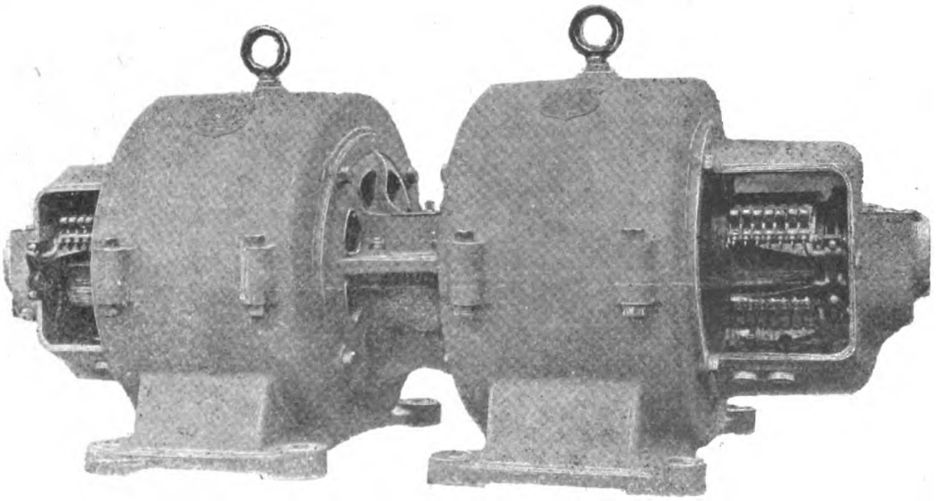

FIG. 5.—One Half of Balancer Booster Set, Rhyl.

BOILERS.

The steam-raising plant consists of two Babcock and Wilcox water-tube boilers of 250 h.p. each, fitted with Babcock's patent superheaters, and constructed for hand stoking. Each of these boilers is capable of evaporating 5,000lb. of steam per hour at a pressure of 160lb. per square inch. In addition to these boilers, two smaller ones, each having an evaporative capacity of 2,000lb. of water per hour at the same pressure, are fired either by coal in the usual way or by the hot gases from the Manlove and Alliott refuse destructors, which are so designed that by means of dampers the products of combustion can be passed from the cells on either side of each boiler into the boiler furnaces, or instead direct to the main flue. It will thus be seen that there are four cells, each of which is capable of burning 10 tons per day. The refuse is brought in carts over the weighing machine at the entrance of the works up the inclined roadway, and thence tipped on the platform above the destructor furnaces, where it is dried and finally charged by hand into the cells as required. Combustion is kept up by means of a fan or blower driven by a small auxiliary engine.

STEAM-PIPES.

The steam-pipes, which are of lap-welded steel, run on both sides of the boiler-house and connect by branches from each side to alternate boilers, being coupled along the

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engine-house wall by a main carrying the leads to the generators. The exhaust pipe runs in a trench below the engines, and passing a pit left for the introduction of condensers at a later date, the pipe leads to the atmosphere through a feed-water heater or by-pass at will. In addition to the main steam ring is an auxiliary pipe running the full length of the boiler-house, and supplying the injectors, pumps, auxiliary engines, etc. Feed-water pipes run from the pump, which is of the compound double-acting type, by Messrs. Hall and Co., of Peterborough, and capable of delivering 2,000 gallons per hour, against 160lb. boiler pressure, to the feed-water heater of Royle's patent type, in passing through which the water is heated to some 200deg. F., and from thence to the boilers, which are also fitted with injectors as stand-by. All steam-pipes are coated with asbestos lagging to prevent condensation and radiation of heat; suitable traps are provided to ensure the non-accumulation of water. In the engine-house, beneath the steam-main referred to, is fixed a gauge which gives a continuous record of the steam pressure.

SWITCHBOARD.

From the generators mains are carried through a trench to the switchboard (Fig. 6), which runs nearly the whole length of the building in front of the generators, and is fixed at a height of some 4ft. from the floor-level. The switchboard is made up of enamelled slate panels, 1½in. thick, secured in an angle-iron frame, and supported by wrought-iron stays. The whole board is surrounded by a massive teak frame, well polished; the clock is supported in a carved ornamental teak frame. There are 15 panels, as follows—viz.: three dynamo panels, one tramway panel, one accumulator panel, two battery booster panels, one balancer panel, one station panel, two arc lighting panels, three feeder panels, and one spare panel for extension purposes.

The dynamo panels contain double-pole quick-break switches arranged to make contact on another set of 'bus bars when required for tramway work. All main switches are of the chopper type. The charge and discharge switches are of the vertical type, with 20 contacts.

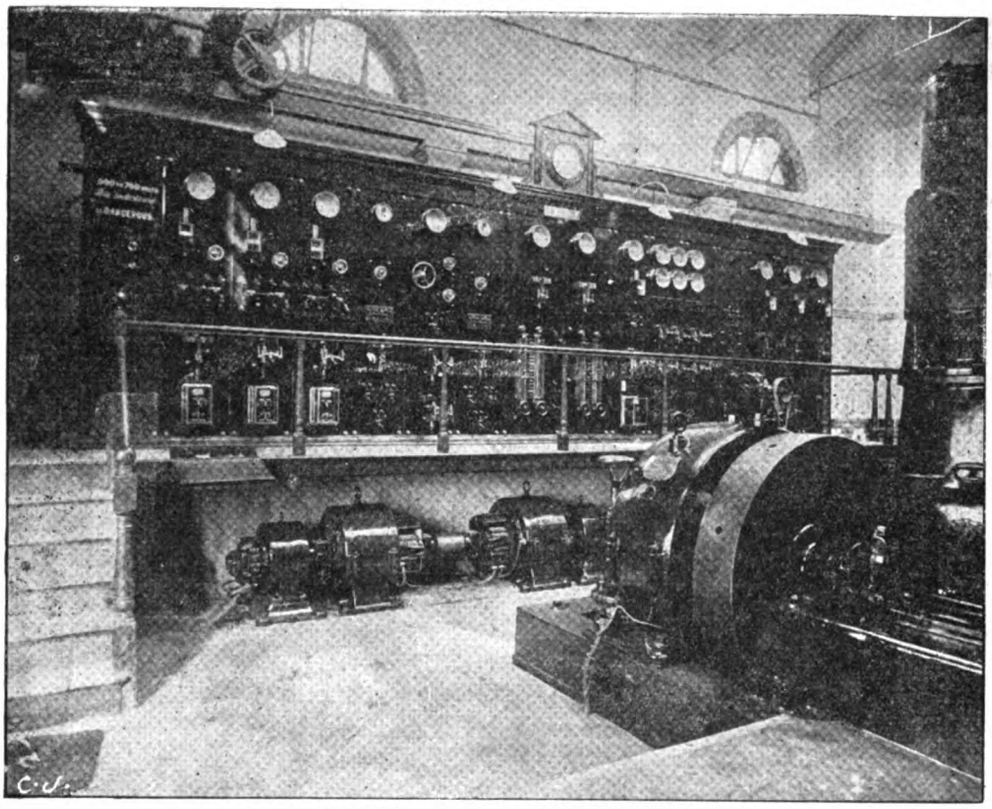

FIG. 6.—Switchboard and Balancing Machines, Rhyl.

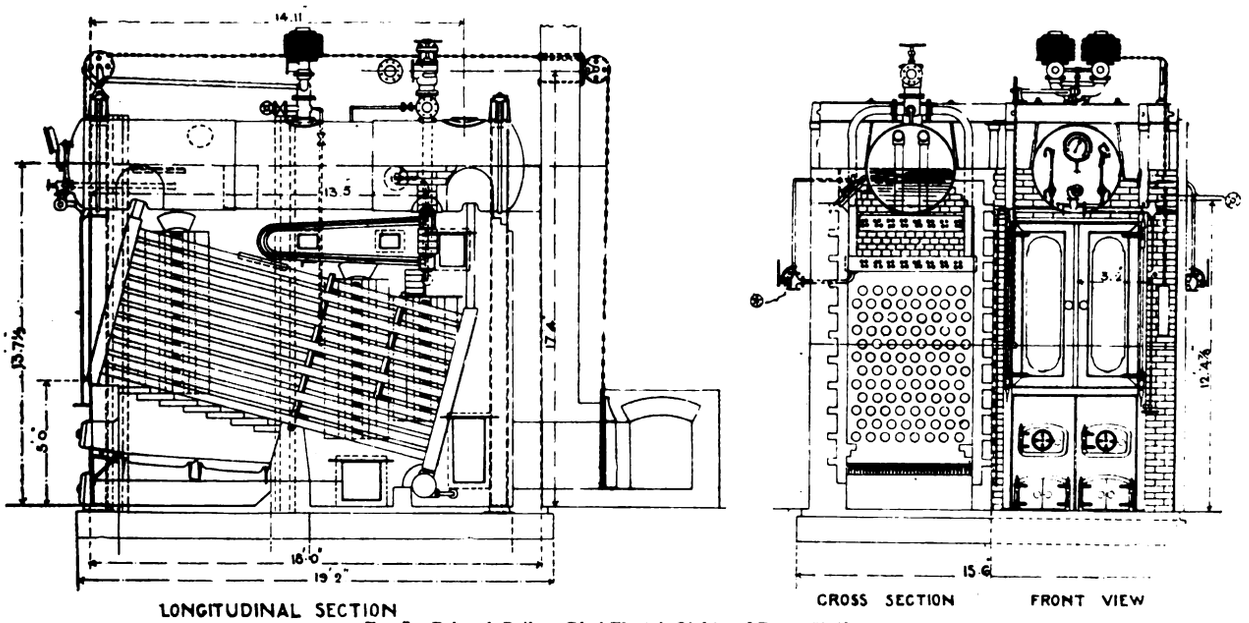

FIG. 7.—Babcock Boilers, Rhyl Electric Light and Power Station.

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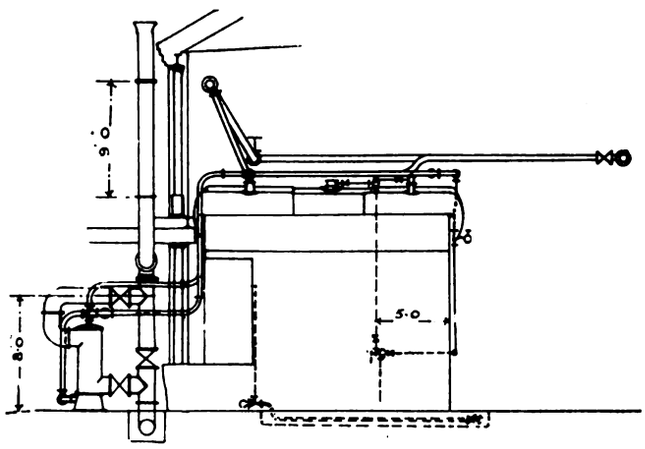
Storage Battery.

This was supplied by the Hart Accumulator Company, and consists of 274 of their standard 19-plate lighting type cells, having capacity of 49 amperes for nine hours, or 72 amperes for five hours, and capable of being discharged at the rate of 180 amperes for a period of one hour, the E.M.F. not falling below 1·80 volts per cell at end of discharge. The cells are their ordinary lighting type, the plates being supported on glass slabs in the usual way, the containing boxes being of glass, thus enabling the sections to be easily and carefully examined. The battery is divided into two halves, positive and negative, for use on the three-wire system of distribution, and erected on pitch-pine stands, well varnished and capable of withstanding the action of the sulphuric acid. All cells are fitted with patent non-corrosive terminals, which are supposed to give no trouble whatever.

Reference may be made to the overhead crane, which was supplied by Messrs. Marshall, Fleming, and Jack. It is an ordinary hand crane, capable of dealing with a load of four tons. The crane is of 30½ft. span. All the motions are controlled by means of hand ropes from the floor level.

Cables.

The cables were manufactured and laid by the Western Electric Company. They run along Victoria-road, Sisson-



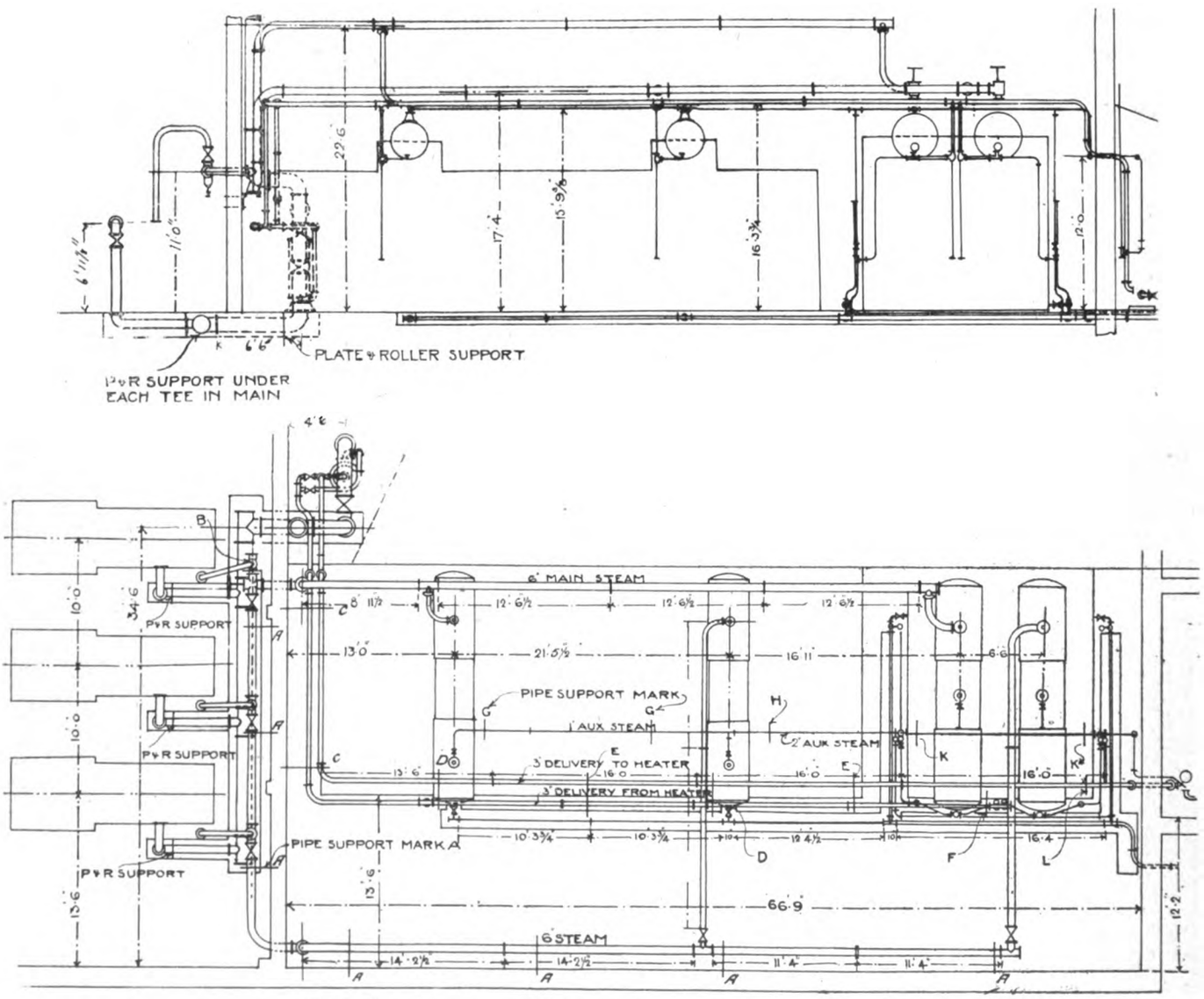


Fig. 8.—General Arrangement of Piping.—Rhyl Electric Light and Power Station

street, Ernest-street, Vale-road, over the railway bridge, and along High-street. Two of the three feeders, which are ·1 × ·1 × ·05 square inch cross section, branching to the left along Wellington-road to Abbey-street, and to the right through Russell-road to Conway-street, the remaining feeder joining the distributing system at the top of High-street. From each feeder box pilot wires return along the same routes to the works in order to ensure correct pressure being maintained at the feeding points. Together with the feeders and pilot wires run six $^{7}/_{16}$'s arc lamp cables, and one ·08 tramway cable, the former supplying the six arc lamp circuits, and the latter being laid on to the parade near the top of High-street to supply the light railway or tramway authorised in Rhyl and between Rhyl and Prestatyn. Distributing cables, which are of ·125 × ·125 × ·062 square inch cross-section, are laid along the full length of the parade, High-street, Wellington-road, Russell-road, Bath-street, Church-streets, Queen-street, Bodfor-street, Water-street, and Abbey-street. In all some 16 miles of cables have been laid, the system being paper and jute insulated, lead covered, and laid solid with bitumen in creosoted wooden troughs. Up to date some 50 con-

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sumers have been connected, representing about 2,000 8-c.p. lamps.

ARC LAMPS.

The parade and main streets of the town are lighted by 56 12-ampere 16-hour arc lamps, each being fitted with automatic cut-out and substitutional resistance, the latter contained in a cast-iron box near the base of the ornamental columns carrying the lamp. The arcs burn nine or ten in series across 500 volts pressure, and the effect of the 36 lamps along the sea-front on a dark night is very striking, while the remainder give very adequate lighting in the principal streets of the town.

Our thanks are due especially to Mr. Goodall for the great trouble he has taken to show us the works at Rhyl and to compile the information largely used in this article; and Mr. McInnes for personal explanations and information. We would also mention the courtesy and kindness of Alderman Mostyn Williams in assisting us. May Rhyl continue to prosper!

REMINISCENCES OF WORKSHOP LIFE.

BY A CENTRAL-STATION ENGINEER.

(Continued from Supplement, February 14.)

The machine to which I was next moved was a small lathe, and as its chief use was confined to facing nuts, or turning studs, I soon got into the way of finishing off these small deer with neatness and despatch. While I was working on this machine I furtively turned up several small washers, the stolen waters, so to speak, of lathedom, that came in very handy for calipers later on. A brass shirt-stud with a fancy head—caused inadvertently by the "chattering" of the diamond point tool—was also one of my products during times of laxity of work.

My professional career with this lathe suffered, however, a sudden check, as I was ordered by the foreman to exert my abilities at the bench in a region of the works devoted to the fitting up of the connecting rods for the locomotives. The fitter to whom I looked for guidance was an artist in his way. He was most particular as to the finish of his work, and I used to spend hours at first, trying to get the right curve and chamfer of the cottar ends, before I could satisfy his love of beauty and of the eternal fitness of things. He used no template; he had no gauge but his eye; but he taught me at last to file with a grim precision; no switchbacking with the file, no tremors, but a straight drive from the elbow level. A man of the old school, he took his time about his work, but his satisfaction was that it always left his bench well done and true. With his flowing beard and his thoughtful eye he made an impressive appearance when leaning against his vice. He had his rules of life, his code of ethics, moral and social. He used to affirm that the proper attitude for walking was the chest and beard thrown forward, the head erect and slightly held back, and the feet arranged at an angle of 60deg. to each other. Then each foot was to be planted in succession freely and firmly on the ground, and a man might face the world with a free heart and walk his five miles to the hour or his 45 miles to the day in comfort and happiness.

I regret to say one of the apprentices very irreverently used to call his style of walking "spread-eagle" fashion, and I fear that he had some reason for this opinion, as the angle of 60deg. between the feet used generally to widen out to 120deg. in defiance of all rules of pedestrianism. A son of Adam, my instructor used to say, should wear his hair short and his beard long, and I remember one day that I had considerable difficulty in controlling my laughter when he told me with stern feeling how he went on a certain occasion to have his hair cut, and the barber snipped tentatively around his throat a few turns before he relinquished his scissors. On arriving home he was horrified to find that as soon as he brushed his beard vigorously a quantity of long, luxuriant hair fell to the ground and was lost to him for ever. The barber's scissors had ruthlessly severed it from its origin, but the surrounding growth had held it till the application of energy had disturbed its insecure tenure.

I made a lot of calipers, squares, etc., while working at this bench, and I also made a template for use when filing nuts, as I was fired at that time with thoughts of trying for a Whitworth scholarship, and I heard somewhere that one of the tests for proficiency with the file was to make an inch bolt and nut to within ·001 of an inch to a standard pattern. This is not quite so easy a thing as it appears to be. You may make one side face of the nut beautifully square, but the angle its neighbour makes with it may be very doubtful. A false stroke with the file and there is gnashing of teeth; a lack of delicacy with the calipers will cause inward groans. However, with a little practice the idea will grow upon you.

Again there was a general move, and I was a second time put in charge of a lathe, this time an automatic feeder. Turning motion pins and various kinds of bolts seemed to be the staple industry here, though occasionally a brisk time with wagon brake hangers set in. I say brisk, because these had to be done piecework, and the price was somewhat low, so that as soon as the rough forgings were dumped down near the lathe it was necessary to lay on hard—to be up and turning. The centering was done in a primitive manner with "jinny wallopers," and the centres themselves punched with an old 1in. centre punch, the head of which, with continual assault, had become swaged over in a sort of metallic fringe. A dozen round-nosed and side tools were always prepared beforehand for this piecework, and it was worth while to give a tip to the tool smith to ensure the quality of the tempering. As soon as the clerk had noted the time of day when you were ready to begin, you centered for dear life, and then started turning operations with a heroic depth of cut, digging deep into the vitals of the hanger, while the soapsuds fizzled on the shavings and splashed around the nose of the tool. The old lathe used to groan horribly and to utter strong protests, and sometimes in a fit of anguish would chuck the work off its centres or throw the belt off the pulley, and its row could be heard all over the machine shop. I got into bother with my first batch of brake hangers, for I earned 2d. too much—we were only allowed time and a quarter, and I slightly exceeded the limit.

Immediately opposite this lathe was to be constantly seen a very remarkable personage. He was an aged labourer, and wore a countryman's smock frock and gaiters. His duty it was to keep certain shop tools, taps, stocks and dies, etc., in a cupboard, and give them out on loan to any authorised person who desired to use them. His other occupation was to sort with a large horseshoe magnet the iron from the brass amongst a heap of filings swept up from the workshop floor and deposited in a trough at his elbow. Seated on a stool and slowly drawing his magnet along the trough, he would impart to the "horseshoe" a regular motion, lifting it, bristling with its prey, and causing it to sweep through the air, and, descending, to be drawn across a dusty brush which relieved it of its burden, and then he would lift it to fish in the trough again. At times this monotonous task would be too soporific; he would begin to nod! His hobnail boots must have been portentously heavy, because he used to lean back, when in his drowsy moods, at a seemingly impossible angle to the vertical, yet he usually kept his balance. Occasionally he was, literally, caught napping, for some mischievous imp would hurl a bolt at the cupboard door adjacent just as the old gentleman was on his farthest stretch; the sudden shock to his auditory nerves would rudely awaken him, would snap the last link of equilibrium, and down he would come. Arising with muttered curses on his lips he would endeavour to read the suspiciously innocent faces of the boys near, but without success. I used to feel rather sorry for him, for he got so excessively angry at every small prank that was played him, and his annoyance only made more fun for the "young devils." He got a kind of affection for me as I used to forbear to worry him, and go and chat with him occasionally. He must have got up before four in the morning, as he had to walk three miles to the works, and he came earlier than the others, by an hour or so, to sweep out the foreman's office. One day he struck a keen note of pathos, for I heard him singing in a harsh bass, "When shall my labours have an end!" He, too, was a great thinker, had studied much, as he would say, and his

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conclusions were quite decided, his convictions unalterable. His axiom was that "Them as works hardest all'us gets worst paid," and it was founded, so he said, on his own experience in particular. In his happier moods he would tell with infinite gusto of the many quarts of cider he used to drink in the hayfield or on the railway embankment, for he had been both a farm labourer and a navvy in his time. His accounts of his having two shirts when at work, one always hung up to dry while the other girt his body, were coarse but instructive. I used to wonder how he managed to know what amount of waste to give out when receiving a requisition order from one of the mechanics, but he had a very good idea of what should be given to each man, and could not easily be bamboozled. As he told me one day, it was true he could not read, but he could distinguish a "hell" and a "harr."

A certain man who worked at a bench near often used to disappear mysteriously; for some time this puzzled me, till one day I noticed him crawl out of a cupboard under his bench: rather a risky proceeding one would think, but his mate kept watch for him faithfully.

The machine shop was extremely cold in winter, and as it was impossible to keep warm, the misery of shivering all day was intense. One by one you would see the men take their tools to the smiths' shop, ostensibly to get them tempered, but in reality to serve as an excuse for getting a warm. Often when the dim form of the foreman was descried in the semi-darkness of the shop numerous figures would emerge from various warm corners each with a lathe tool or chisel in hand. Feeling the cold very much, I found it necessary to put an occasional half hour in some place where the temperature was more genial than the machine shop, and this little relaxation helped to get through what was a very trying time when frost was about. I often thought that a decent system of warming the place, such as one finds in all well-appointed shops, would have soon paid for itself by lessening the amount of wasted time. Before the wheels were set in motion at 6 a.m. a certain few used to be allowed to congregate around the shop boiler—an old loco. type. As soon as the bell stopped these men were turned out by the stoker-driver, and I always noticed one man who seemed to emerge from the lowest deep, from the ash-pit probably. For myself, I used to stand against the side of the smoke-box, between the box and the wall—for the boiler was stowed away in a corner—and I could hear the man's voice rising thickly from some dark, murky recess. Black appeared he, as he came out to our view, but warm, warm to the heart's core.

The summons came at last to go into the erecting shop, and accordingly I shifted my traps, and was installed as one of a gang (it is not so dreadful as it sounds) who took charge of the repairs of the engines on three or four of the pits. The leader of our worthy band was an old North country-man, quite a character in his way.

(To be concluded.)

THE CONSTRUCTION OF HIGH-TENSION CENTRAL-STATION SWITCHGEARS, WITH A COMPARISON OF BRITISH AND FOREIGN METHODS.*

BY HENRY W. CLOTHIER, A.M.I.C.E. A.M.I.E.E.

In the earlier years of our industry the switchgear at a central station was regarded as a comparatively unimportant item. Electrical engineers gave prominence to the steam-raising department, to the generating plant, and to the distributing system. As time went on, however, the necessity of paying greater attention to the controlling arrangements became more evident. There are many instances on record where faulty switchboards and connections thereon have introduced unforeseen disasters, which have included the loss of life, destruction by fire, and very frequently the discontinuance of the supply to the works and to the consumers. Such experiences as these are not only costly in themselves, but they have a tendency to check the growth of our industry by fostering a lack of confidence on the part of the general public in electricity as applied to power and lighting purposes.

The manufacture of switchgear is now considered a distinct branch of electrical engineering, and the user recognises it as the centre of the whole system. He desires it to be an ornament to the station, on which special care is taken in the design, erection, and upkeep, so

* Paper read before the Manchester Local Section of the Institution of Electrical Engineers.

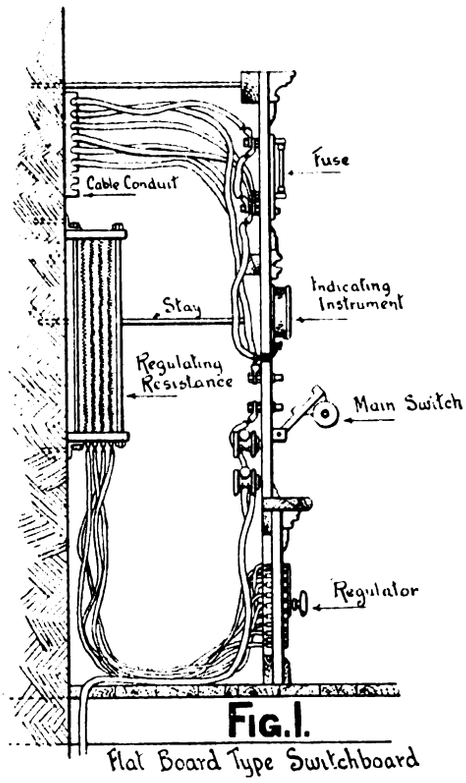

FIG. 1.

Flat Board Type Switchboard

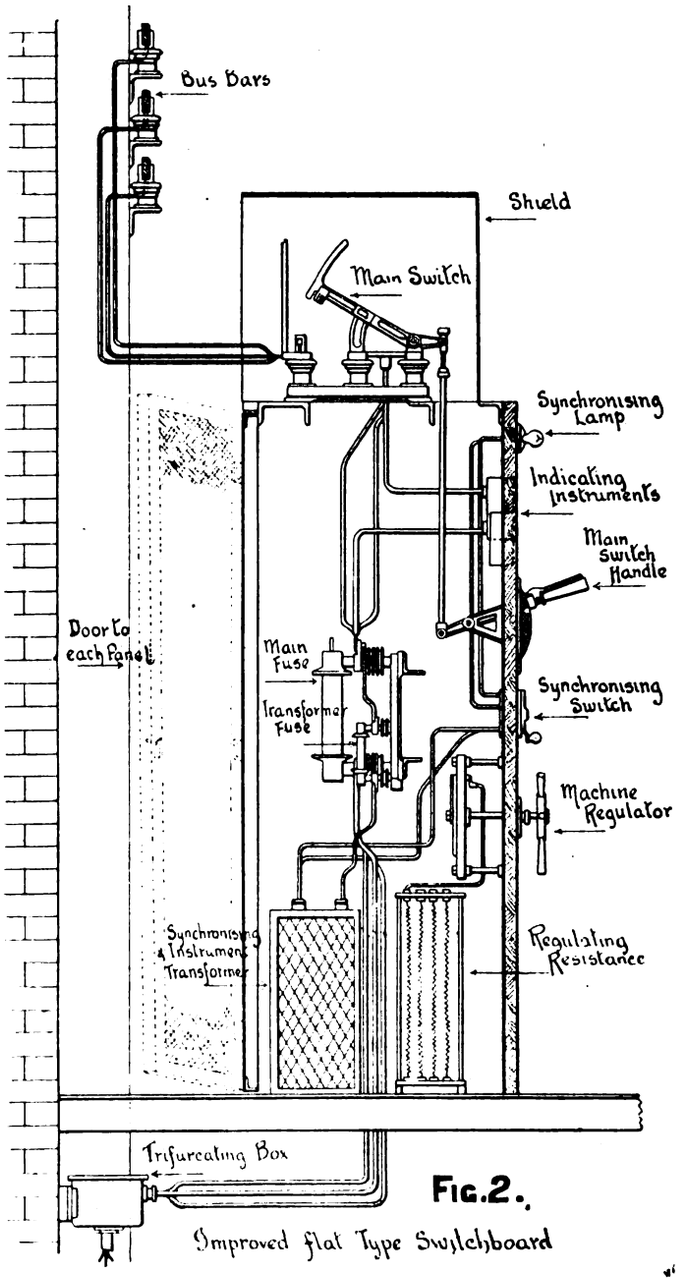

FIG. 2.

Improved Flat Type Switchboard

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that it will be an example of utility, security, cleanliness, and general order to the rest of the equipment. Engineering firms have established separate switch departments, and they now compete with another for contracts, the extent of which was unthought of but a few years ago in this country. The introduction of high-tension multiphase power transmission schemes, with generating stations and numerous outlying sub-stations equipped with converters, rotary or static, have created a demand for extensive controlling devices, which at the present time attain a value of from £30,000 to £70,000, according to the methods adopted by the several contractors.

It is the object of this paper to deal briefly with the broad outline of central-station switchgear practice for alternating currents, and at the same time to meet the request of the Council of the Institution, to illustrate the main features in design of the apparatus produced in Germany as compared with our home productions. The scope of this paper will be limited to a discussion on the broad principles rather than matters of detail, the way in which the components are assembled rather than the individual parts themselves; also since the limit of pressure in this country is about 11,000 volts, it will be of sufficient interest for the present to consider only those equipments which are in general use for that or lower voltages.

The functions of the switchgear are, of course, familiar to you; but before proceeding it will, perhaps, be well to recapitulate the chief considerations to be borne in mind by the designer: (1 The entire energy of the electric supply system is concentrated on the switchgear and controlled therefrom, much as the heart controls the circulation of blood in the human body. It receives cable connections from the generating plant, and distributes the energy transmitted by them into the outgoing main feeders, which in their turn supply the districts covered by the system. (2) It must embody arrangements for coupling or disconnecting any of the various members of the system, whether on the generating or distributing side. (3) It must be provided with devices which will isolate any part of the system on which a fault may arise that would disturb the supply and cause damage to the affected part, or to any other part of the system. (4 The apparatus must be capable of cutting off any machine or feeder, whether automatically or by hand, in such a way that no destructive arc will occur to damage the apparatus itself. It is also essential that the operation should not cause rises in potential sufficient to break down the insulation of the cables, or to injure any of the equipment on the system. (5) It must be furnished with measuring instruments for indicating the pressure and current of the energy generated and distributed. (6) Devices must be included for synchronising the generators, and for regulating them to keep up the supply at a constant potential to the consumers. (7) The above parts must be assembled and constructed in a way that will afford the greatest security to the operator, and also to any other person who may be engaged on or near the gear for repairs, adjustments, additions, for cleaning, or any other purpose. At the same time it should be so designed that it is only necessary to rely upon a minimum amount of skill and caution on the part of the persons so engaged.

Part I.—Notes on General Construction.

The apparatus used, although of so many different designs, can be broadly classified under two very simple headings—viz., switchgears with backs and switchgears without backs. There are, of course exceptions, but these headings serve the further purpose of generalising a distinction between the popular modern designs produced abroad and at home respectively. The word "back" is used in its widest sense, to define the space occupied behind a board, or in a basement, cellar, or any place out of sight of the station operators. Constructions with backs can be sub-divided into the following types for the purposes of this description—*i.e.*, flat-board, multiple-frame, cubicle, basement, and keyboard types. Those without backs will be described as wall surface, hinged panel, pillar, and cellular types.

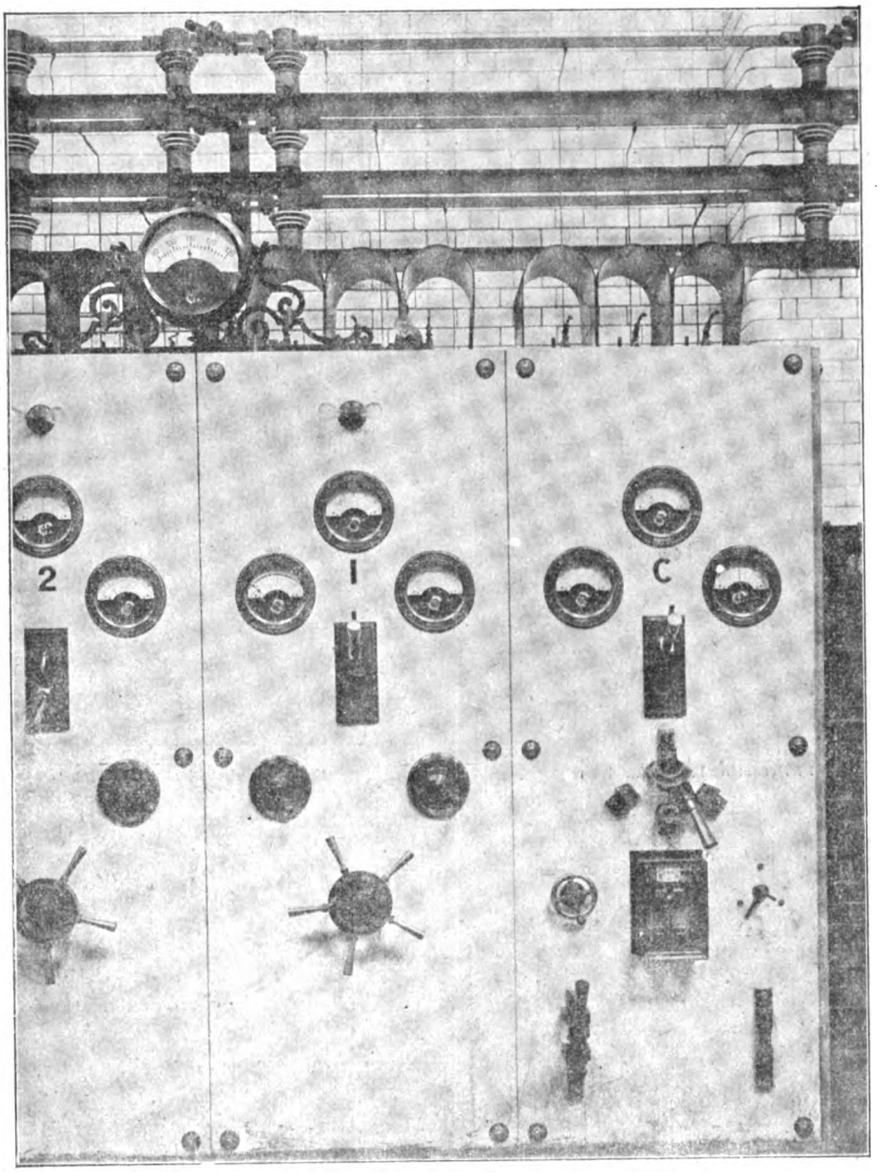

Fig. 3.—Front View of Alternating Panel, Flat Board Type.

Flat-Board Type.—This very common construction consists of panels of marble or slate fixed in vertical positions by bolts or screws to a metal or wooden framework, which is tied to the wall and bolted to the floor. The board formed by these vertical slates divides a space off from the engine-room, the space or "back" affording room and facilities for storing away and connecting up the several apparatus required. This type was used almost exclusively in early stations in this country for the small units which were then generally installed. Fig. 1 serves to illustrate the arrangement of a machine panel constructed on this principle. It will be seen that the switches, fuses, etc., were dangerously mounted on the front, with terminals

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projecting through to the back, joined up by cable connections. It is unnecessary to state that the risk to the operators of this type of board was recognised many years ago, and switchboards were made (notably the well-known Siemens and Lowrie-Hall type) on which all high-tension parts projecting through the front were covered by cups of porcelain or other insulating material, so that it was difficult to make accidental contact with them. But although the front of the board was then comparatively safe, the "backs" were always a source of anxiety. They were usually complicated by a chaos of inflammable cable connections, particularly where the board was designed for "independent" running on a double-pole system, in which each circuit panel was provided, in duplicate, with cable connections from each pole of each generator. The cable connections naturally increased the chances of fire, and also the extent of the damage in the event of a fire starting. Many improvements have been made, such as covering up prominent parts of the frame with insulating material, by allowing very liberal space at the back and by replacing the rubber cable connections between the terminals of the various appliances with carefully braided copper strips; but in regard to English practice it can be truly said that the type in question has caused so much trouble that it is now practically extinct among our home productions for high-tension alternating-

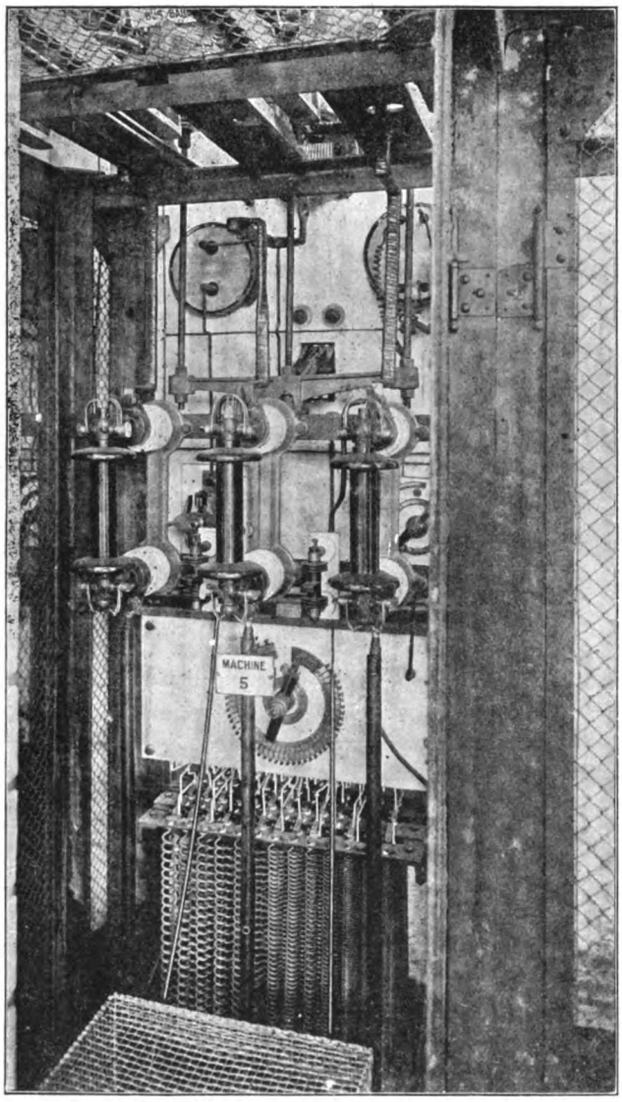

FIG. 4.—Back View of Alternating Panel, Flat Board Type.

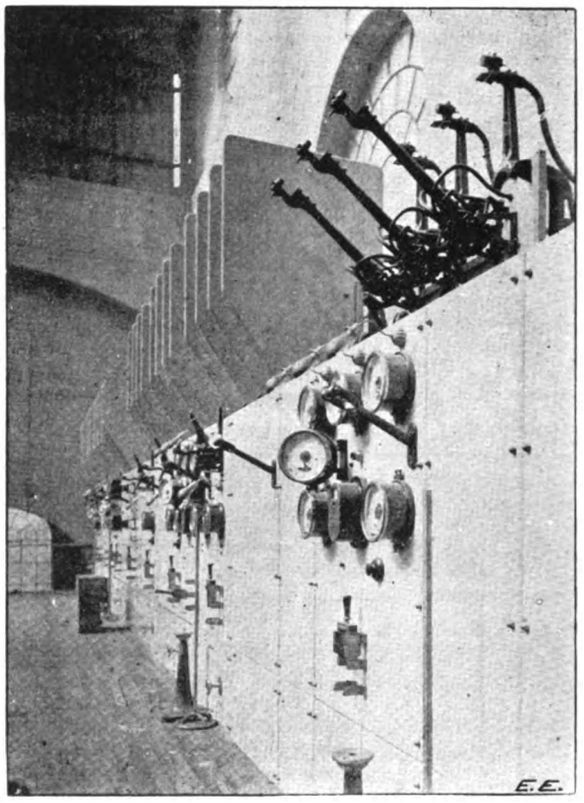

FIG. 5.—Main Switchboard, Pinkston Power Station, Glasgow.

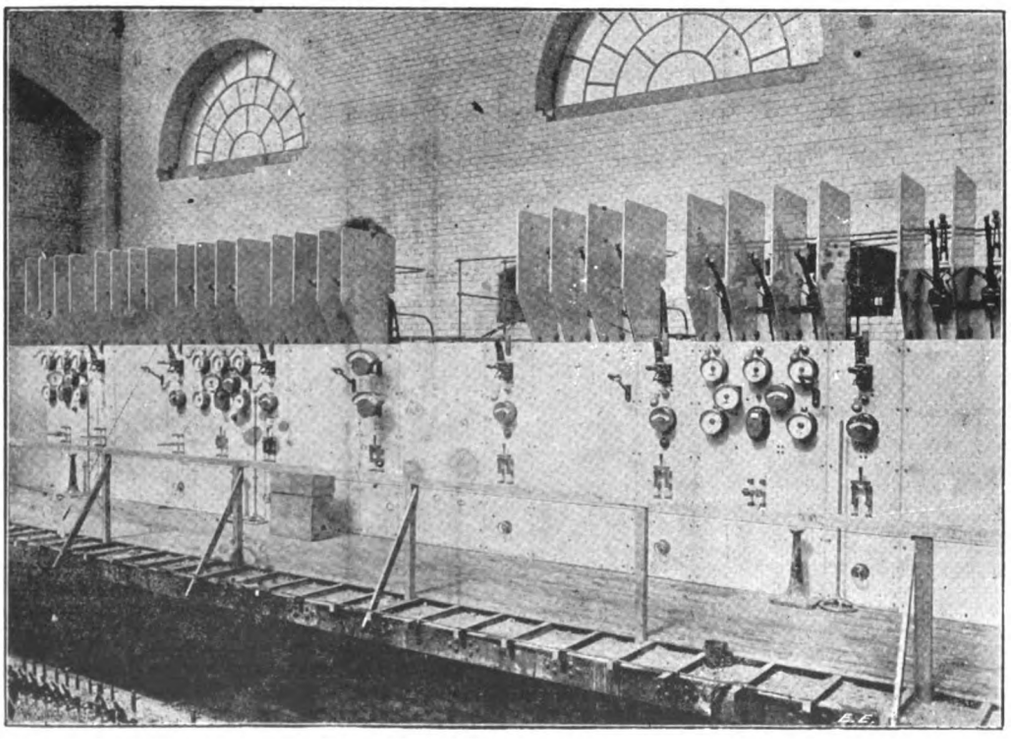

FIG. 6.—Main Switchboard, Pinkston Power Station, Glasgow.

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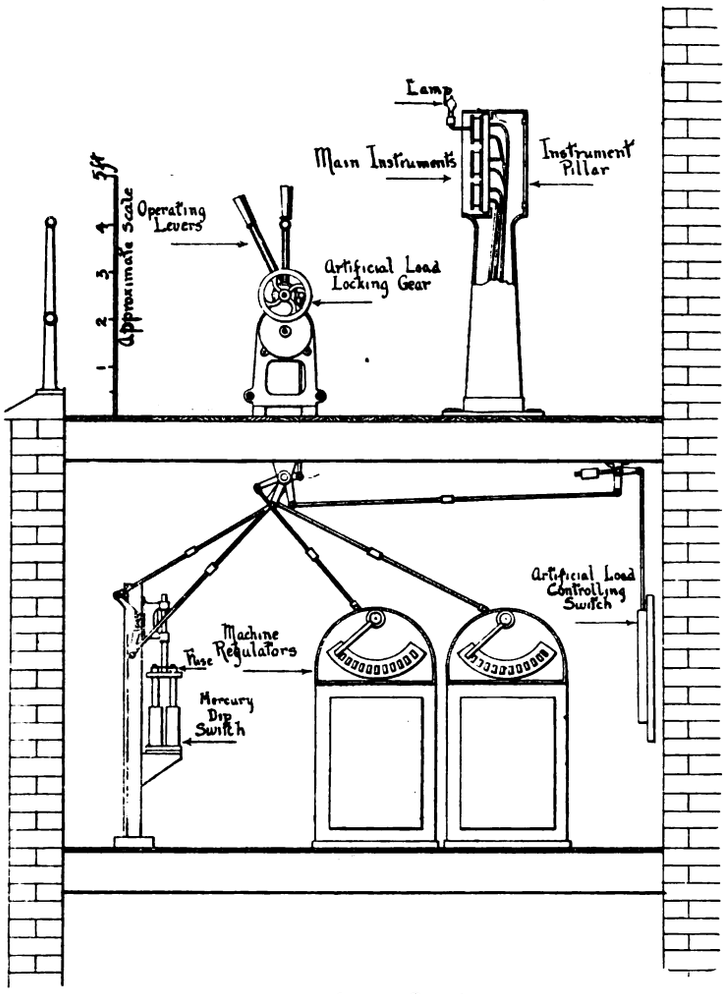
current stations. No recent examples have been installed by home manufacturers, but, on the other hand, a large majority of the type originally installed in early supply systems have, at no small expense, been changed for switchgears without backs, which will be described later. Considering these experiences at stations generating about 2,000 volts pressure, which has been a very usual voltage for lighting systems, one would not expect the larger power transmission schemes now becoming universal, generating at voltages from 5,000 to 7,000, to accept this type of board. Consequently, it is interesting to observe, as an example of Continental practice, the method adopted at the Kensington and Notting Hill Supply Company's station at Wood-lane, which reintroduced the type into this country. Fig. 2 represents a section through a 500-kw. 5,000-volt three-phase generator panel. Here live fittings are exposed only at the back and top, the front being quite free from any high-tension metal work. With the exception of the main switches and the 'bus bars, the connections are contained in a cage of iron meshing, and it is needless to add that the main switch coupling the panel to the 'bus bars must be locked off before anyone is allowed to open the cage door, shown on the drawing. Figs. 3 and 4 clearly show the disposition of the instruments as seen from the front through a hole in the marble slab, the main fuses, of a tubular pattern, mounted on insulators fixed to a metal frame, the levers operating the main switch, the regulating resistance at the base, and the cable connections, which, though numerous, have been neatly arranged. An American example of three-phase extra high tension switchboard in use at the Glasgow

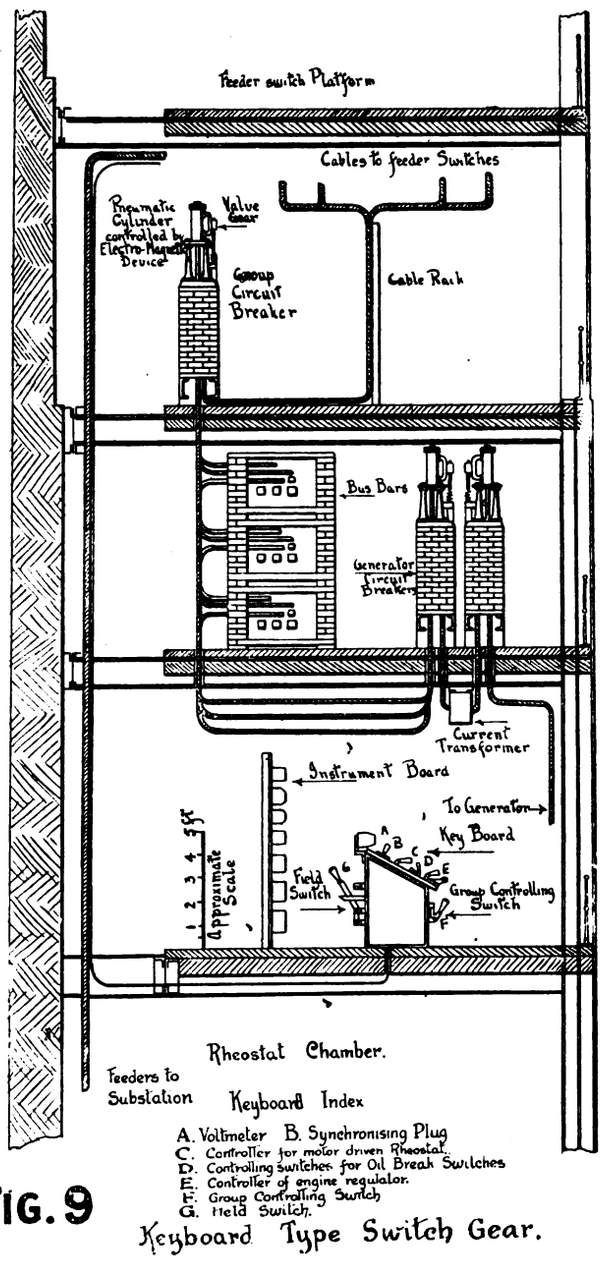


Basement Type Switch gear

FIG. 8

The Multi-Frame Type.—This construction, shown in Fig. 16, consists of a marble front mounted in a metal frame carrying switch handles and instruments similar to the flat-board type, but the back of these panels is used only for the exciter connections and low-tension instruments. A separate and distinct skeleton framework, with a clear space around it and a passage between it and the front frame, carries all high-tension conductors, including fuses, switches, 'bus bars, instruments, transformers, etc. A somewhat similar type, constructed by the Allgemeine Company, is in use at Berlin for their three-phase system. Although this construction covers a greater floor space than usually convenient, it has its advantages when compared with the previous type, in that the high-tension conductors are spread over a larger surface, and there is room enough to get at them from all sides.

Cubicle Type.—For feeder switchgear, the Westinghouse cubicle type, as applied at Glasgow, should be mentioned. The construction consists of sets of four complete three-phase panels placed back to back in two pairs, each set of four panels enclosing a space, forming as it



Keyboard Type Switch Gear.

FIG. 9

electric tramways generating station, may be termed a modification of the flat-board type. Figs. 5 and 6 represent views of this 6,500-volt dynamo board. No attempt at covering high-tension fittings has been made, but as a precaution in design all high-tension conductors are placed at the top above the heavy cross girders behind the board, at a height not less than 10ft. from the floor level. All measuring instruments mounted on the front are of the transformer type, the transformers being also mounted out of reach from the floor level. The main switches seen in Fig. 6 are a carbon break type, and are arranged in compartments between marble slabs. It is unnecessary to cite the many Continental and American switchboard constructions, and the numerous methods of arranging details to show that abroad the "flat-board" type is very commonly used for high and extra high voltages. The main idea in the design of these boards has been to make them safe to the operators from the front, and presumably to expect a high degree of skill and caution from those who may be engaged on any other part of the gear.

were a chamber, on the walls of which are mounted the main cable junction boxes and the low-tension instrument connections, etc. Like the dynamo board at the same station, no exposed high-tension connections are within reach from the floor level. This useful method splits up the usual back into a number of chambers, which can be readily inspected by the attendant in passing from one section to another.

Basement Type.—There are several types of supply station apparatus on which the dynamo or circuit high-tension gear (sometimes both) is mounted in compartments below and above (generally below) the attendant's platform. The switches are controlled either by chain gear or by a mechanical arrangement of levers and links. The Helios switchgear at Dresden is a notable instance of the latter. Fig. 8 represents a section through a dynamo panel showing a plug type mercury contact main switch controlled by a system of railway signalling levers from the platform. Each machine is furnished with other similar levers for regulating, synchronising, etc. Directly behind

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these levers is a metal column containing all instruments and connections thereto.

The Keyboard Type.—Fig. 9 represents a section through the platforms and galleries showing the relative positions of the main parts of the construction, an example of which is to be seen in the generating station of the Metropolitan Street Railway Company at New York, where switchgear is at present installed for controlling eight 3,500-kw. units at 6,600 volts, three-phase. On the first gallery will be seen a keyboard, with small switch handles arranged, in order, to represent a diagram of connections. An instrument panel is supported on a metal framework behind the keyboard. The main dynamo switches, in duplicate (as a precaution against one failing to operate), are supported on a second gallery, which also carries the main 'bus bars covered by a brickwork erection. The switches are controlled by a pneumatic cylinder, the valves being operated by electric relays from the keyboard on the gallery below. Later designs replace the pneumatic cylinders by a system of electric motors. Whether they find it is satisfactory to have such important work dependent on the delicate pneumatic and electric auxiliary gear, irrespective of the initial cost

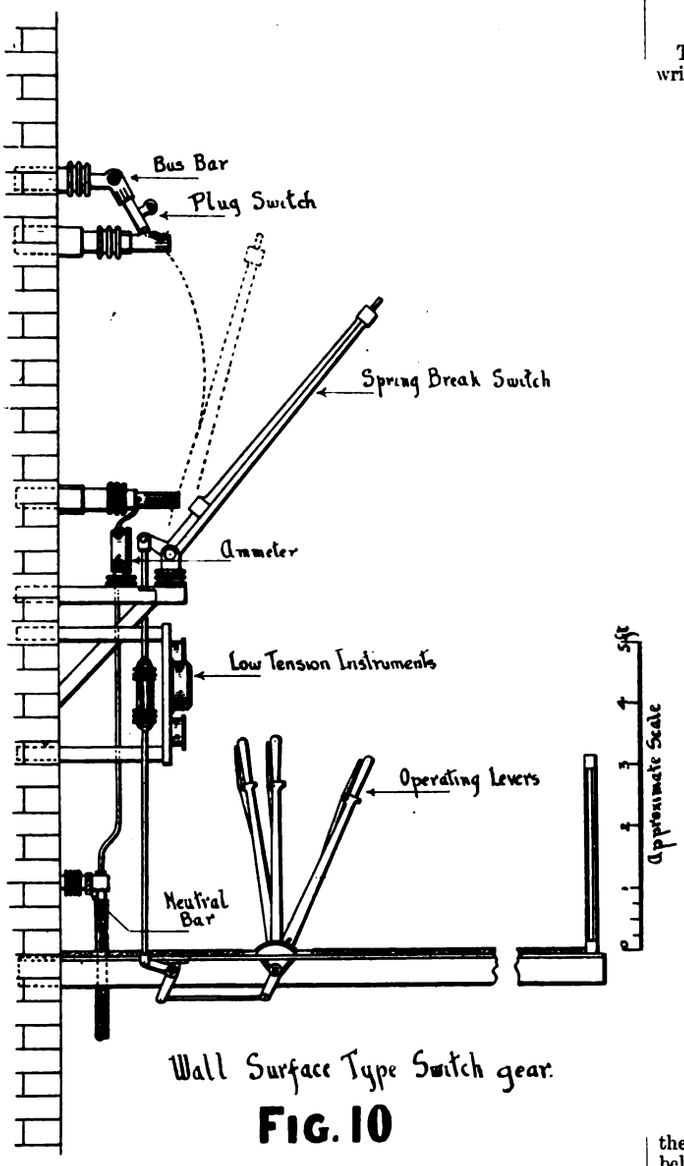

FIG. 10

of this design, I am not able to say. But obviously this objection is met by duplicating the switches in series with each machine.

SWITCHGEAR WITHOUT BACKS.

Wall Surface.—Fig. 10 illustrates the type of switchgear constructed at Deptford in 1888, the first station in this country where power transmission on a commercial scale was attempted. Although in designing this station for 10,000 volts Mr. Ferranti was at least 10 years before the times, yet the switchgear then installed has certain advantages not to be found in many of the modern designs. It will be seen from the drawing that the general idea was to support the extra high tension conductors on porcelain or ebonite insulators mounted directly on to the surface of one of the walls of the station. Thus all connections were visible and easily traced by a person standing on the platform. To prevent arcing between adjacent conductors a liberal area of wall was occupied, and slate or marble partitions were set here and there in the wall at places where the clearances dividing parts of different potential were limited. Each panel can be isolated from the main inner 'bus bar by the removal of a plug with the aid of a long insulated hook. The main switches are of a long spring-break type, the machines being entirely controlled levers mounted on the platform. Thus, although the operator has always a clear view of all his connections, yet they are so far out of his reach that he cannot make accidental contact with them in the ordinary course of his duties.

Pillar Type.—This type also deserves a place in the front rank of English designs, the best known being that designed by Mr. Raworth many years ago and constructed by the Brush Company. There was one complete unit of switches, instruments, etc., for each generating plant, enclosed in a pillar as shown in Fig. 11. The illustration in question represents a view of a dynamo pillar with water-break switch at the top controlled by a handle protruding from the front at a lower level. The merits of the design, however, have not been confirmed in actual practice; in fact, as stations grew in size the system appears to have been found inconvenient and costly, with the result that the pillar type has become almost obsolete in England.

(To be continued.)

TRADE NOTICES AND NOVELTIES.

Steljes Telegraph Recording Instrument.

This instrument, which is being put on the market by the Typewriting Telegraph Corporation, Limited has this week been on view at

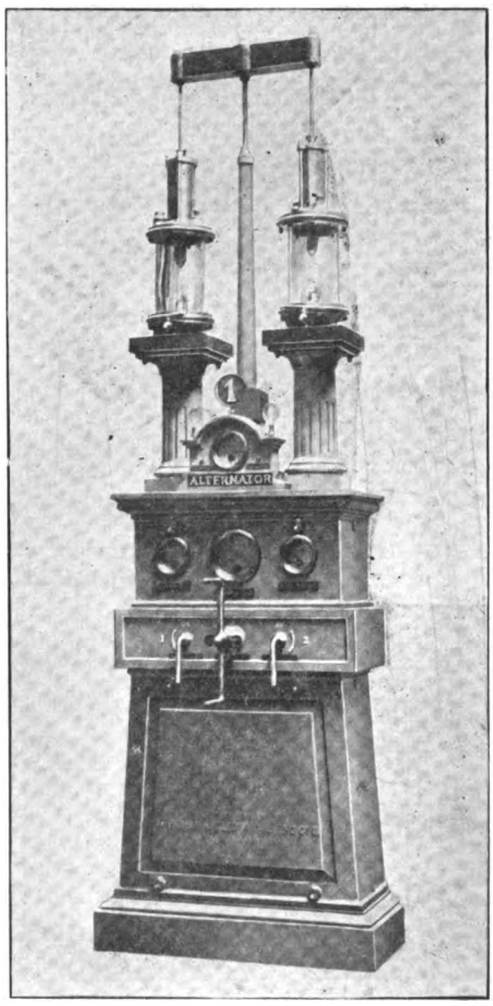

FIG. 11.—Pillar Type Switch Gear.

the offices of the company, Dashwood House, New Broad-street. We believe that the company has recently been reconstructed as far as the directorate is concerned, and that the instruments are to be pushed commercially. They consist practically of A B C instruments, which print the message at both sending and receiving stations. The motive power is obtained from the armature of a magneto, which also synchronises by means of alternate currents the sending and receiving instruments. The design of the apparatus is such that small currents of not more than 10 milliamperes are required to work them. The speed of sending is, of course, limited to the speed of the ordinary A B C instrument, but the great advantage is that they can be worked with small currents and give an absolutely similar record at either end of the line. Also the receiving instrument will work quite without attention from an operator in the same way that the tape machines do at present. The system would seem to have a good prospect of success in the commercial world.

The Flame Arc Lamp.

On Friday last this lamp was on view at the showroom of the Union Electric Company, at 151, Queen Victoria-street. The feature of the lamp is the use of carbons with impregnated cores containing salts which give an orange tinge to the light. The arc also is longer than is usual, the normal distance between positive and negative carbon being ½in. Fig. 1 shows a complete lamp, and Fig. 2 is a larger view of the cup used to partially enclose the arc. This

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inverted cup is made of fireclay, and the positive carbon is only slightly smaller than the hole in the cup through which it passes. The result is that the heated vapours round the arc accumulate in the inverted cup and prevent any oxygen reaching the positive carbon. For this reason the positive carbon can be of

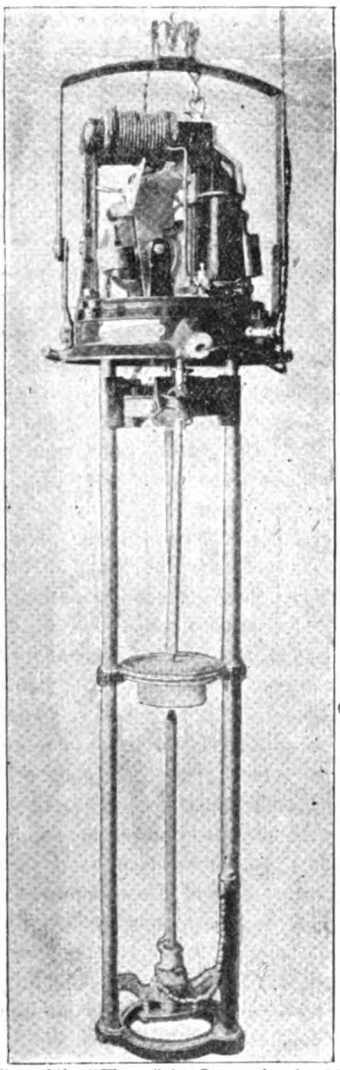

FIG. 1.—View of the "Flame" Arc Lamp, showing Mechanism.

smaller diameter than the negative, which is not so protected, which reverses the usual state of affairs. The arrangement of the cup round the arc also acts as a reflector, which gives a larger proportion of the light in the downward direction. The cores of both positive and negative carbons are impregnated with salts, and these, as the carbons burn away, are deposited in a brilliant white powder on the cup, which

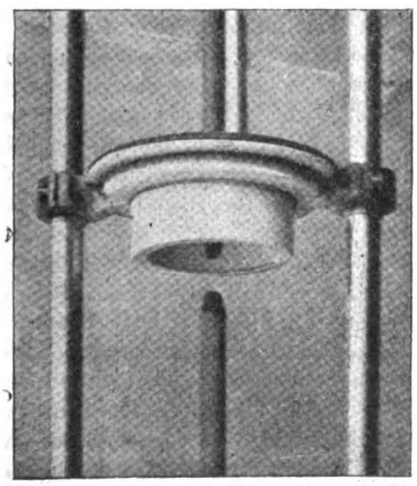

FIG. 2.—View of the Inverted Cup of the "Flame" Arc Lamp.

increases the reflecting and diffusing properties of the same. This arc, although ½in. long, only requires 43 volts with a current of nine amperes. We saw four of these lamps working well in series off a 200-volt circuit. The mechanism of the lamp is practically the same as is used in the ordinary lamps of the same firm, except that the arc-striking apparatus is modified to give a longer arc. The present type of flame lamp is being supplied at practically the price of an ordinary lamp, but the carbons are some 50 per cent. dearer than the common unimpregnated type. Also, the life of the carbon is somewhat less than usual, as the lamp will only burn some eight hours without retrimming. Against this, as will be seen from the figures given in our last issue, must be put the greatly increased light obtained, which is about 100 per cent. more than the ordinary arc when using direct current and 130 per cent. more with alternating current. These figures are for mean hemispherical candle-power, and are those obtained by the makers. The colour of the light is much more pleasant than that of the ordinary arc. It is very interesting to see these lamps at work, and it is noteworthy that many of the effects obtained with an enclosed arc are obtained by means of the inverted cup, which does not interpose any light-absorbing medium between the arc and the area over which the light is usually required to be distributed.

Hartmann and Braun's Measuring Instruments.

We have received from Messrs. O. Behrend and Co., Limited, Dunedin House, Basinghall-avenue, London, E.C., copies of Sections 1 and 2 of their new price-list No. 26. The first of these sections deals with electromagnetic instruments of the Hartmann and Braun switchboard pattern. Very good descriptions of the instruments are given. To take for example the firm's type F brass-cased, dead-beat electromagnetic volt and ammeters, we are told that the working parts consist of a solenoid in which a soft-iron cylindrical segment is concentrically pivoted, and a soft-iron core of cylindrical section partially surrounding the segment. The core and the segment are magnetised in the same direction by the current through the coil; the segment is consequently repelled from the core, the movement being controlled by gravitational force. Two fixed cores can be used instead of one, and with three a repelling and attracting reaction on the movable segment is obtained. Jewels are employed for supporting the spindle of the moving segment. As the type of scale varies according to the arrangement of cores adopted, scales can be obtained with approximately equal divisions, or with open readings at the end of the scale, eliminating entirely or in part the lower readings, for voltmeters on constant-pressure circuits. By these means, instruments with scales suitable for use on both the charge and discharge sides of a battery can be obtained. The damper consists of a Z-shaped disc, moving in the opposite direction to the pointer, in a chamber enclosed on all sides. The effects of residual magnetism, due to the soft-iron core, are reduced to a minimum by the relatively small magnetic axis of the core; the instruments do not therefore show a great difference between the readings for increasing and decreasing current. It is claimed that this type of instrument, with the damping arrangement, is frequently more suitable for alternating-current work than the hot-wire type, especially where excessive overloading (arising, for instance, from lightning discharge) is possible. The ammeters are stated to have an accuracy of about ±1 per cent. throughout the entire scale, which commences at approximately 10 per cent. of the maximum reading. The voltmeters have an accuracy of ±1 per cent. at their normal working pressure. The power consumption is only about 1·5 watts owing to the large resistance of the coil employed. Iron-cased instruments of the same pattern and internal finish are listed at very much lower prices. Full directions for fixing are given, also numerous illustrations. Several patterns of brass-cased solenoid ammeters (Kohlrausch system) are illustrated. Section 2 of the list deals with moving-coil switchboard-type instruments manufactured by Messrs. Hartmann and Braun. These instruments are constructed on the principle of Deprez and D'Arsonval—a moving coil rotating in a powerful magnetic field of constant strength. Damping is effected by means of a Foucault brake, rendering the instruments almost instantaneous in their readings

Single-Phase and Two-Phase Motors.

From the Langdon-Davies Electric Motor Company, Limited, 101, Southwark-street, London, S.E., we have received copies of their reduced price-lists of single and two phase motors. The latter are listed for outputs of from ½ b.h.p. to 35 b.h.p., while the single-phase motors of the firm's standard pattern cover the same range. Special low-speed pattern single-phase motors are also listed for outputs of from ½ b.h.p. to 6 b.h.p.

NEW COMPANIES REGISTERED.

Kalgoorlie Electric Tramways, Limited.—Capital, £250,000. Objects: to acquire any concessions, rights, and privileges for the construction of tramways and railways in Australia and elsewhere; as carriers, electrical engineers, electricians, engineers, and contractors, manufacturers of and dealers in railway, tramway, electric, and other apparatus; as producers and suppliers of gas and electricity for the purposes of light, heat, or power, etc.

Comyn Ching and Co., Limited.—Capital, £30,000. Objects: to enter into agreements with S. Chity, B. G. Williams, R. C. Ching, W. Thwaites, and E. F. Johnson; to acquire the business hitherto carried on by Comyn Ching and Co. at Castle-street and elsewhere in London, and generally to carry on business as ironmongers, electrical engineers, etc.

Iroquois Machine Company.—This Company has just been incorporated at 150, Nassau-street, New York, having been organised by Mr. W. W. Gibbs, who is also vice-president of the Kidder Press Company, and a member of Gibbs-Brewer Company, of New York City. Objects: to manufacture new and improved wire-drawing machinery, automatic and plain drop hammers, swaging machines, rolling-mills, roller bearings, and grinding machines, etc.

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TO CORRESPONDENTS.

All Rights Reserved. *Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

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BARS TO PROGRESS.

The happy medium between municipal trading and private enterprise is exceedingly hard to fix. We have frequently asked the strongest opponents to municipal trading to state clearly what in their opinion is the limit to which municipal trading may be carried, and in practically every case have found that they see little objection to municipal action in any direction except that in which it affects their own business. In the same way in conversation with the Socialistic members of town councils who hold with the direct employment of labour and with the municipalisation of undertakings which cannot be efficiently controlled except by an autocratic personality, we have found a universal condemnation of private enterprise in undertakings connected with municipal authorities. These gentlemen refuse entirely to recognise pioneering risks, or to give due praise for the carrying out of undertakings which, while unprofitable for many years, have at last reaped their due reward for supplying public necessities. It is also to be remembered that the municipalisation of gas and water undertakings has been attended with the payment of large sums for goodwill, which have often handicapped the undertaking in after years. That this shall not be the case in the future, at least as far as electric lighting and electric traction is concerned, has been ensured by Acts of Parliament, under which the tramways of London, for instance, have been acquired by the London County Council at under cost price. In spite of this, the municipal authorities in this country, or, speaking more correctly, the members of a large number of town councillors still look upon an electric lighting company or an electric traction company as their natural enemy. They endeavour in making terms with such companies to obtain even more favourable conditions for repurchase than those required by Parliament, and in this way hamper, in certain instances, the growth of prosperity of their towns. Our remarks particularly apply to smaller towns, as the larger corporations, as a rule, are carrying out their own tramway schemes, and are already suppliers of their own electric light. These town councils are naturally not so assured of making profits, owing to the limited size of their undertakings. They also, in too many instances, have the idea that they will not be acting wisely if they allow private enterprise to assist in the development of their town. A case has recently been brought to our notice in which a small electric lighting company undertook a few years ago to supply electrical energy for light and power. Before being allowed to do so they were obliged to enter into an agreement by which the Corporation could repurchase the undertaking at stated intervals, which were of course much less than the forty-two years provided in the provisional order. Early in 1900, and again at the present time, this company is seeking the permission of the Town Council to lay down a system of electric tramways, which are much needed in the town. The consent was refused in 1900, and from information before us is likely to be refused again now, because the Town Council think that the purchase money for both the lighting and traction undertakings would come to more than they could afford to pay when the next opportunity of repurchase occurs. The town has recently acquired municipal waterworks at a great cost, and the Council is afraid of increasing in the future its capital obligations. In fact, the whole circumstances of the case would point to the advantage of allowing private enterprise to do what the Corporation is afraid to undertake, and which, if undertaken, would be likely to starve for want of enterprise. The opposition to improvements, which from the local Press we gather are urgently needed, is hard to reconcile with

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the idea that the town councillors are intelligent beings with the interests of the town at heart. A reasonable course for them to pursue would be to go in a body to Huddersfield and to bury themselves at once in the municipal cemetery there, as it is quite likely that they will otherwise have to rely on private enterprise for their final resting-places in their native town.

EASTER-TIDE.

A PRAYER FOR FREEDOM FROM BREAKDOWNS.

The simple needs of simple man that, once upon a time, good Lord,
Did not require to plot nor plan to compass those he could afford;
By time so amplified have been: we die if stops a mere machine.

The tinkered parts of iron and brass, of steel and copper, hemp and hide,
Are such that it hath come to pass: by these machines we must abide.
So to those prayers for rain and sun, we plead to add another one.

That, as by aid of brain and thew, machines are made to help mankind,
O, wilt thou, Lord, these things endue that we may not be always blind
To those perplexing subtle laws, that work without apparent cause.

For miracles we do not ask, we would not nature's code revise,
We would not shirk our daily task, we do not ape the overwise.
We only pray thou wilt protect us from breakdowns we least expect.

From boiler-tube's all sudden burst; from engine flywheel heavenward fly;
From dynamos that do their worst when none the switching gear is nigh;
But, most of all, wilt thou ordain *fair play* unto the buried main.

For these there duplicates are none; an inch's tenth part but divides
Those strands which, two or three in one, seek e'er the fate of suicides.
Where man's eye cannot penetrate they lie and court undĕrfoot fate.

And therefore, Lord, grant this desire: that we in happiness may live:
Before the dreaded arc of fire thy servants ample warning give
('Twould also stay discourse profane, which must recording angels pain).

B. C. H. J.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the ordinary general meeting on March 20, 1902, the following were the candidates balloted for:

Members.—C. H. Merz, 28, Victoria-street, Westminster, S.W.; H. Rowley, 277, St. George's-terrace, Perth, Western Australia; L. P. Stark, King's-court, Broadway, Westminster, S.W.

Associate Members.—A. E. Barber, 2, Lancaster-road, East Ham; C. E. Douglas, Salford Ironworks, Manchester; T. P. K. Hammarskjold, 155, Temple-chambers, Temple-avenue, E.C.; H. Jackson, Engineer's Department, Wallasey, Cheshire; G. Lauchlan, New Zealand Electrical Syndicate Wellington, N.Z.; T. C. Parsons, Corporation Electricity Works, Salford; J. A. Robertson, 1, Chapelton-gardens, Dumbarton; R. J. Rosser, 17, Wilkinson-street-gardens, Cape Town; C. F. Trippe, 69, Beresford-road, Highbury, N.; W. J. R. Wray, British Schuckert Electric Company, Limited, Clun House, Surrey-street, Strand.

Associates.—S. E. Barnes, 4, Poplar-villas, Poplar-road, Cleethorpes; A. Bernstein, 5, Barry-street, Bradford, Yorks; C. D. C. Cummins, Tramway Power Station, Osborne-street, Hull; W. Drysdale, Electric Light Station, East Bridge-street, Belfast; H. R. Edmonds, 1, Gresham-street, E.C.; J. H. Edwards, Cabo Submarino, 56 Caixa, 56, Santos, Brazil; J. H. Holder, The Oaks, West Town, Bristol; H. H. Lindon, Prospect-street, Kogarah, Sydney, N.S.W.; T. McIlwraith Mackay, 63, Dalblair-road, Ayr; A. Marston, 24, Nether-green-road, Ranmoor, Sheffield; E. M. Martin, 27, Park-place, Greenwich; J. H. Stephens, Eastern Telegraph Company, 33, Charterhouse-square, E.C.; H. I. Van Straubenzee, 13, Peacock's-buildings, Park-row, Leeds; C. R. Walker, Transylaw, Dunfermline, N.B.; J. H. Woolliscroft, Oak Bank, Hawarden, near Chester.

Students.—M. Alisan, R.I.E. College, Englefield Green, Surrey; R. Amberton, 7, Sotheby-road, Highbury Park, N.; D. H. Bishop, care of Miss Baird, 4, Garland-place, Dundee; H. C. Carter, Electric Power Station, Heckmondwike; L. S. Challis, 98, Philbeach-gardens, Earl's Court, S.W.; P. J. Clears and O. B. R. Collins, Faraday House, Charing Cross-road, W.C.; J. S. Crone, jun., Kensal Lodge, London, N.W.; A. E. Davy, 11, Belfast-terrace, N.C.R., Dublin; J. R. Gillman, 218, High-road, Balham, S.W.; H. M. Lyons, 2, Ovington-gardens, S.W.; A. N. McIntyre, 102, Clive-street, Calcutta; R. B. Perring, St. Cuthbert's, Park-road, Buxton; G. Rackstraw, 68, High-street, Chelmsford.

FORTHCOMING EVENTS.

THURSDAY, APRIL 3.

Rontgen Society.—At 8.30 p.m., ordinary meeting. Paper: "X-Ray Diagnosis of Renal Calculus," by Dr. Ch. Leonard.

FRIDAY, APRIL 4.

Institution of Mechanical Engineers.—At 8 p.m., extra meeting for further discussion of the four papers on "The Fencing of Machinery," read at previous meeting.

Electro-Harmonic Society.—The next and final smoking concert of the season will be held on Friday evening, April 11, instead of on March 28, as previously arranged.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

467. With E.M.F. recorded on a chart, describe fully the best method to obtain the percentage of variations and to ensure that this percentage is independent of errors in the instrument.—ELECTRO.

468. To alter the direction of rotation of a three-phase motor, the rule is to change any two of the leads connected to the stator terminals. This rule implies that the motor may be connected up in six different ways, three of which will cause it to run in one direction and three in the opposite direction. Supposing there are a number of motors run off the same mains, and that the generator supplying those mains be relieved by another, is it possible that while some motors continue to run in the same direction as before, others might change their direction of rotation?—F. E. H.

ANSWERS.

Question No. 461.—Is it possible to ring a bell between a house and works a distance of 200 yards without wires? The reason I require the above is this: The property in between is not ours, and the owners will not let me cross it with wires. The bell is needed to call me in case of the dynamos or any part of the installation going wrong during the night. The distance to walk round to my house is about a mile. Describe how it can be done.

Answer to No. 461 (*awarded 7s. 6d.*).—The requirements of the question are somewhat unusual, but it is quite feasible to ring a bell over the distance there stated without joining a point by means of a wire, as has been shown by Hertz, and later by Marconi. A modification of Marconi's system may be used in this case. To transmit the signals a coil capable of producing a 1in. spark would be required having oscillators fixed to the spark terminals, as used by Lodge, and shown in Fig. 1. For receiving the impulse a coherer, as used by Lodge, may be employed (Fig. 2) in

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series with which a continuous ringing bell and battery are connected. A continuous ringing bell is best, so that when contact is once made the bell will continue to ring until it

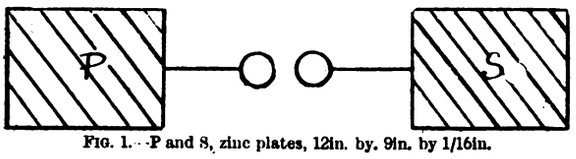

FIG. 1.—P and S, zinc plates, 12in. by. 9in. by 1/16in.

is reset. This arrangement will avoid any trouble due to intermittent contact in the coherer.

A cheaper and, perhaps, more simple method is to erect two wires parallel to each other, one at each building. It

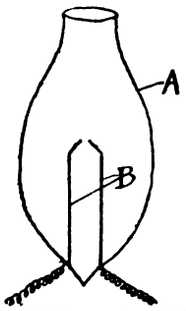

FIG. 2.—A, glass bulb; B, platinum wires 1/16in. apart at tips and surrounded with nickel filings.

is essential that these wires should be parallel. A few yards—say 10—will be long enough, but the longer the better the results. The wires should be stretched between insulators on the roofs of the buildings, or as high as pos-

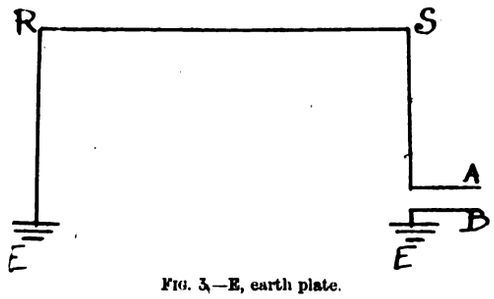

FIG. 3.—E, earth plate.

sible. Care must be taken in placing the connections to the overhead wires, or these connections may partly neutralise the E.M.F. set up in the wires. The connections

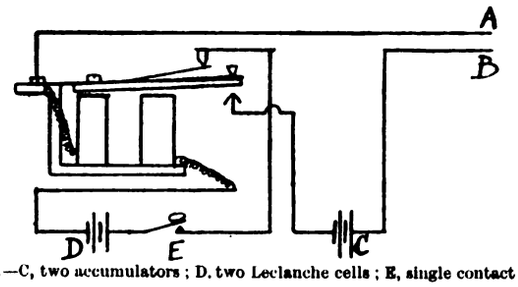

FIG. 4.—C, two accumulators; D. two Leclanche cells; E, single contact key.

should be arranged as shown in Fig. 3, where R S is the overhead wire. At the transmitting end would be placed in series with the overhead wire a vibrating contact breaker

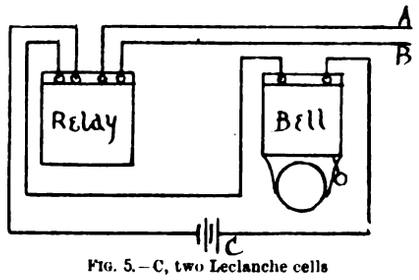

FIG. 5.—C, two Leclanche cells

and a battery (two accumulators). A current of about ·25 ampere would be sent through the overhead wire, the current being rendered intermittent by means of the contact breaker. The current through the line wire should not pass through the coils of the contact breaker, or the contacts will soon be burnt up by the spark due to self-induction, but connections should be made as in Fig. 4; at the receiving end connections as shown in Fig. 5, the relay being wound with 36 S.W.G. wire to a resistance of 80 ohms. This relay must be well made and carefully adjusted. If it is required to answer the call signals, each end must be fitted with transmitting and receiving apparates, a double-contact instead of single-contact key being used, as in Fig. 4. It would probably be convenient to have the two points connected by means of telephones, and thus be able to communicate after a call has been sent. This may be done by sinking earth-plates two at each end, the lines joining the two sets of plates being parallel, as in the case of the overhead wires, the two plates of each pair being put in about 20 yards apart or more if possible, then connect a telephone and battery between each pair of plates. It will then be possible to communicate between the two points by means of the telephones, but attention cannot be called by means of the telephone bells, so that each telephone need only consist of a microphone, receiver, induction coil, battery, and a hook for the receiver; the latter being arranged to break contact when telephone is not in use.—H. J. G.

Answer to No. 461 (*awarded* 7*s.* 6*d.*).—The form of this question instantly suggests the (so-called) wireless telegraphy of which we are hearing so much, and conjures up visions of oscillators and coherers and ætheric vibrations. But before considering that method, it would be as well to give some attention to a simpler plan. Although it is impossible to run wires straight across, yet perhaps two wires may be laid parallel to each other, and of a length of 200 yards or over—the longer the better—one having in it a source of E.M.F. and a contact maker in the power-house, and the other having a small relay to close a local

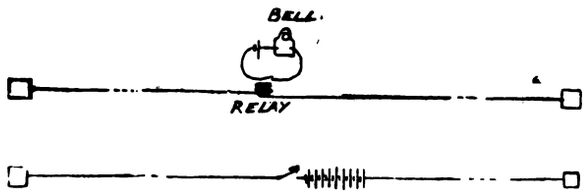

FIG. I.

circuit consisting of a bell and a small battery. The ends of the two wires should be well earthed by means of zinc plates buried (see Fig. I.). When there is set up a difference of pressure between two points in a large conducting surface, the current does not flow straight from one point to the other, but spreads out in all directions.

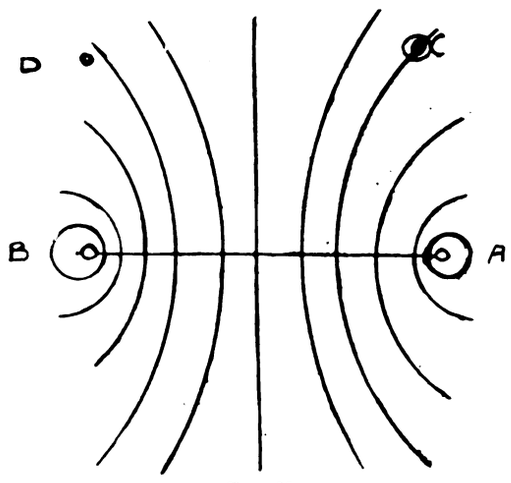

FIG. II.

The fall of potential also is not confined to the area between the points, but is represented by a series of circles arranged as shown in the sketch (Fig. II.). Thus, supposing the potential difference between A and B to be 10 volts, then we might have between C and D five volts, which would be sufficient to work a relay, even when the arrangement of lines of equal potential was altered by

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the presence of the conductor. But supposing that it is impossible to run wires out on either side, then the only thing left is to make use of Hertzian waves. For the transmitter a small induction coil capable of giving, say, a 2in. spark, and an oscillator are necessary. The latter consists of two polished brass balls in a tube of oil separated by a small distance, say $\frac{1}{10}$in. These are connected up as shown to an insulated wire hanging vertically, and about 20ft. or 30ft. high. On the spark passing between the spheres, the waves are sent out into space. To receive

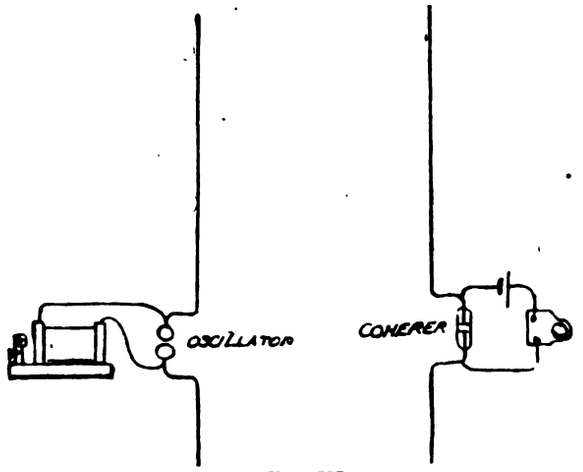
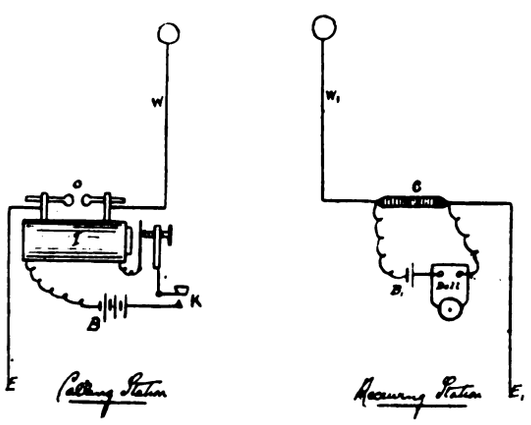


FIG. III.

them, a similar insulated wire is erected, and in place of the oscillator a coherer is placed. This is a small glass tube with two discs in at about $\frac{1}{20}$in. apart and filled with silver filings between the silver discs. The local circuit, consisting of the bell and battery, is completed across the coherer, which is in the ordinary way not conducting. On the waves from the oscillator reaching it, however, it becomes a conductor, and remains so until shaken. During this time the bell will be ringing. The lower ends of the wires need not be earthed, but they need not be insulated, only the upper end.—T. P. S.

Answer to No. 461 (*awarded* 5*s.*).—To establish a bell service without connecting wires across a distance of 200 yards is quite practicable by the medium of the Hertzian waves. It is well known that the effect of electrical waves set up by an induction coil causes iron filings to adhere in a manner sufficient to conduct a current from a local battery. This system can certainly be utilised to meet the requirements of the question. At the calling point—in this case the dynamo-house—about 30ft. of insulated wire must be depended from a mast or suitable support on the building. It will be found advantageous to place at the top of the wire length, and in connection with it, a metal plate about 1ft. in diameter to act as radiator.



The lower end of the wire is connected to one terminal of the secondary of a $\frac{1}{2}$in. spark coil (which is sufficient for this distance), while the other terminal is joined to earth. At the point to be rung up, a similarly insulated wire of the same length must be erected at the same height as that at the calling point, the lower end in this case being attached to one terminal of a "coherer"; the other terminal of the latter must be joined to earth. In circuit with the coherer join a local battery and trembler bell. A study of the diagram will, perhaps, make the connections plain. W and W_1 are the aerial wires, E and E_1 the earth connections, which may be attached to a water-pipe in order to make good earth. The induction coil, I, should work with three or four dry cells, B, the primary circuit being completed by key K. The oscillators, O (brass balls), forming the terminals of the secondary, between which the spark passes, should be adjusted to less than $\frac{1}{2}$in. in order to obtain as "thick" a spark as possible. The coherer, C, is a small hermetically sealed glass tube, having two pieces of metal passed through each end, leaving a small vacuous space at the centre, in which the filings are placed. B is a single cell in circuit with the coherer and bell. On depression of K, electrical waves set up by the spark cause the distant coherer to complete the bell circuit; a permanent ring is thus started, which will only cease on reducing the filings to a non-conductive state, by tapping the coherer smartly with the finger.—H. T.

Answer to No. 461 (*awarded* 5*s.*).—It is, of course, quite possible to ring a bell by means of etheric vibrations over a distance of 200 yards; but the apparatus for this would cost about £250. This is, evidently, too expensive; and either of the following methods may be suggested to bridge over acoustically the narrow space in question: (1) a church bell, of tin-tabernacle calibre; (2) fog signals; (3) steam syren; (4) exploding rockets fired across the 200 yards. Should this intervening property be residential, and the foregoing apparatus in frequent and vigorous use, it is likely that in due time the owner of the property would consider it a favour to be allowed to run wires across at his own cost, to facilitate communication between the house and the works in question.—B. C. H. J.

Question No. 462.—A winch motor of 2 h.p., shunt wound, is situated on the top floor of a five-storey warehouse. Describe and illustrate a cheap electrical or mechanical arrangement for starting and controlling the motor from any floor.

Best Answer to No. 462 (*awarded* 10*s.*).—As a rule the controller of a winch motor is operated by a handle which carries the lever for making circuit and for reversing. After current is switched on by means of this lever the automatic starting gear of controller is brought into action. This being the case, we have only to consider the best means of controlling this lever from the five flats of warehouse. A very good electrical arrangement is as follows: operate the handle of controller by two solenoids (one for each direction of rotation); the solenoids will be controlled by means of a two-way and off single-pole switch on each flat, and the circuit for solenoids will be entirely independent of winch motor circuit. These solenoids will have a suction core, which will give the motion to a special turning drum, which in turn will operate the handle of controller. Fig. 1 shows the arrangement proposed. A and A′ are the two solenoids controlled by the two-way and off switches on the several flats, B and B′ the special turning drums. These drums will be of cast iron, 2in. diameter,

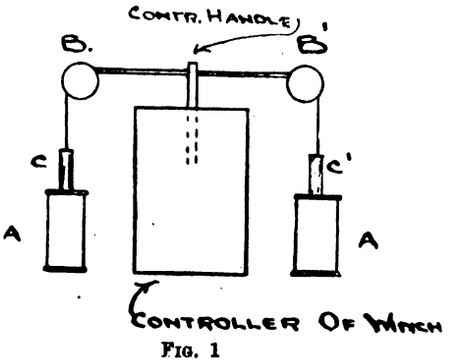


FIG. 1

and broad enough to take (1) a small rope $\frac{1}{2}$in. diameter, this rope being securely fixed to drum, the other end of rope being fixed to plunger of solenoid; and (2) a steel strip spring, say, $\frac{3}{4}$in. broad, this spring to be secured to drum, the other end of spring being attached to handle of controller. The turning drums will be carried on a spindle secured to controller case by suitable brackets. The solenoids

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will be fixed on a level to suit travel required for putting controller switch on. From Fig. 1 it will be seen that when solenoid A is switched into circuit by any of the two-way switches, that plunger of A solenoid gives motion to turning drum, B, which winds up the steel spring attached to it, and so puts controller switch into contact. At the same time it will be seen that the spring attached to the turning drum of the A′ solenoid is put in tension, consequently when A solenoid is switched out of circuit the tension of spring on turning drum, B′, together with weight of plunger of A′ solenoid, will bring the lever of controller back to its mid position, and it will be seen that A solenoid will do this same work when A′ solenoid is in circuit. To avoid any tendency of bringing the lever of controller over its mid position, the springs and plungers of the solenoids must be made exactly alike, so that they counterbalance each other at mid or off position of switch.

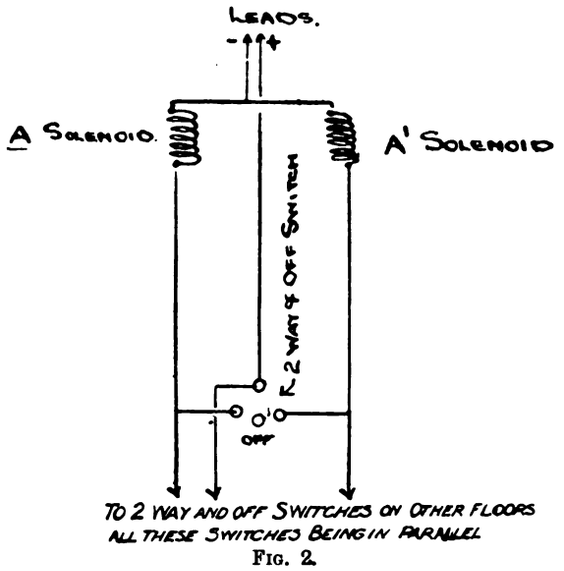
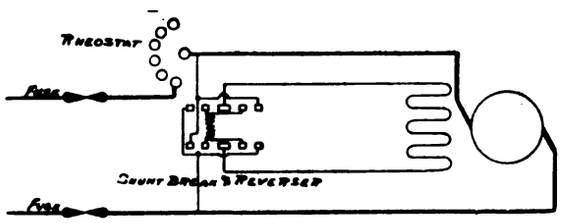


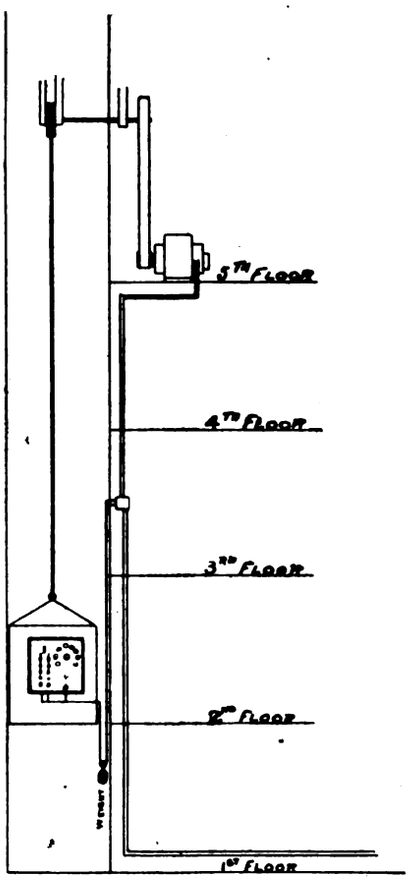
FIG. 2.

Fig. 2 gives a diagram showing the wiring and switches required for controlling the solenoids from the various floors. There will be a two-way and off single-pole switch on each flat. Switches to be of the five-ampere size. $^{3}/_{22}$ wire will be large enough to wire the switches with, as current required by solenoids (only one of which is in use at a time) will be very small, the actual current, of course, depending on voltage of circuit.—G. R.

Answer to No. 462 (*awarded* 5*s.*).—To control the motor from the various floors would at times be found to be rather an unhandy method, and I would suggest that a better plan would be to have the controlling gear on the hoist itself. This could easily be arranged by having a length of good flexible fixed in such a way that a weight would take in all the slack due to the movement of the hoist. By this arrangement the hoist could be started, stopped, or regulated in any part of its travel. To reverse the motor would necessitate the leading of the shunt wires also from the hoist. A glance at the sketch and diagram



will show more clearly the proposal. By the use of the shunt break and reversing switch, the reversal of the motor could be accomplished. This switch, as shown in the diagram, would require to be a special one, having a resistance between the contacts shown to protect the field winding when the shunt circuit is being broken. The regulation shown in the diagram is done by the armature current. This could be done more economically by the introduction of a field regulator, and only using the rheostat as a means of starting. The rheostat should have a magnetic release, so that when the current failed the circuit breaks. In the above it is always assumed, of course, that a man will be on the hoist. To control the motors from the various floors would be an expensive arrangement if separate rheostats, etc., were to be used



for each floor, and to work with one set of controlling gear by means of chains or ropes is, to say the least of it, a most unreliable method. The ropes are a constant source of trouble, as the attendant does not see the position of the rheostat, the contacts are liable to be burned, and, besides, the various ropes or chains are often being pulled at the wrong time, which might cause serious trouble at one time or another.—ELEVATOR.

Answer to No. 462 (*awarded* 5*s.*).—As it is required to not only start the motor in either direction, but also regulate its speed, undoubtedly the cheaper arrangement would be that in which the apparatus necessary to perform these operations is actuated mechanically. A system that would provide for regulating the speed of the motor by electrical means from each of the five floors would be a complicated one and an expensive one, and as such it will not be dealt with here. The arrangement suggested here is simple and cheap. It consists of a controller that combines the starting, regulating, and reversing movements, and a light double rope passing through the four floors for operating it. Fig. 1 shows a front elevation and section of the controller; Fig. 2 is the connection diagram. These sketches, intended to show, as they do, only the principle, are self-explanatory. It will be noticed that the sprocket wheel is not shown in the front elevation (Fig. 1). This omission is for the sake of clearness. The controller is to be placed some 6ft. or more above the level of the top floor. A short length of chain is required to work over the sprocket wheel of the controller. To the ends of the chain are secured the ends of a light rope. The double length of rope thus formed passes through the four intervening floors and runs round a loosely-running pulley situated in the basement. The coil marked "brake magnet" belongs, as its name implies, to the electrical brake. This brake is of the band type, and is applied to a pulley on the motor shaft. An iron weight—that is, the keeper of an electromagnet keeps the brake constantly applied except when current flows through the coils of the magnet. The incandescent lamp

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shown on the diagram is to take the effects of the self-induction of the brake magnet and the shunt

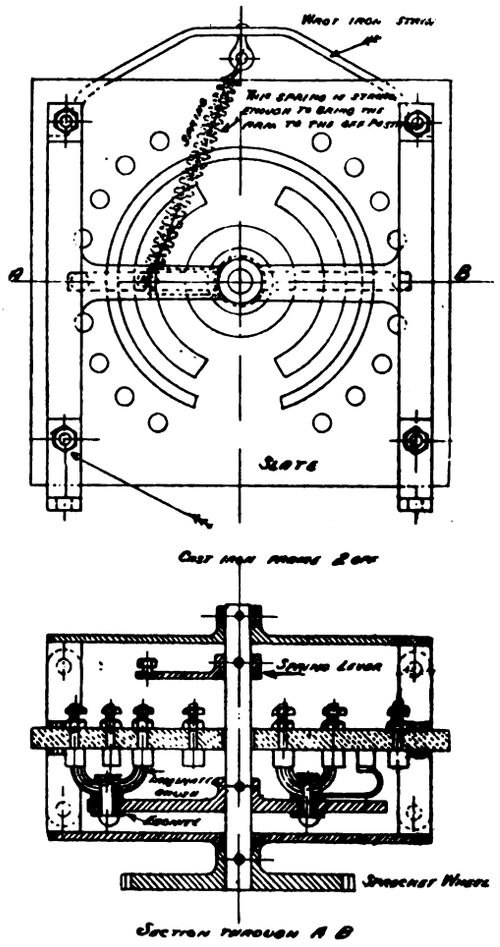

FIG. 1.

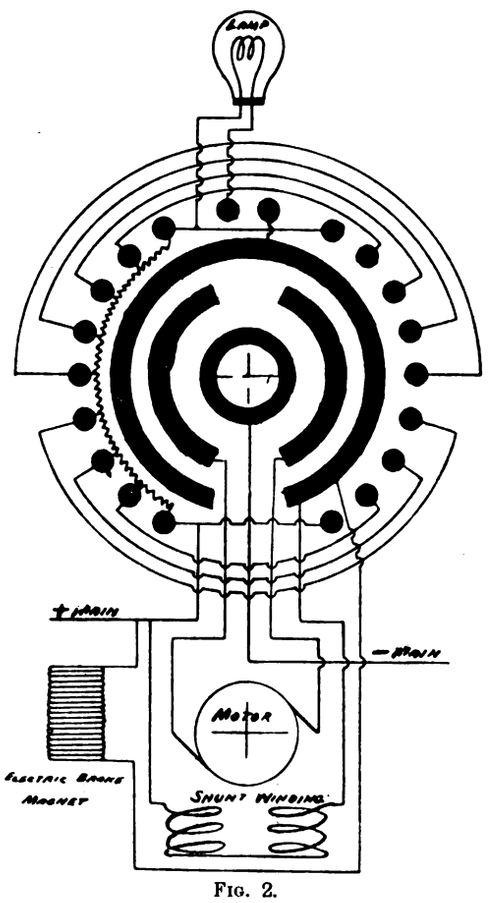

FIG. 2.

winding of the motor when the circuit is interrupted. The spiral spring on the controller is to keep the switch arm in the "off position," excepting, of course, when the controller is being operated. To start the motor, all that is required to be done is to pull one of the ropes. Preferably this should be done slowly, but a motor of the size of the one under consideration would not be damaged no matter how quickly the resistance might be cut out by this apparatus. By referring to the diagram it will be seen that, firstly, the shunt circuit and the brake magnet circuit (which releases the brake) are simultaneously made, and, secondly, the armature circuit is made. If the switch arm is drawn into the first stud only, the speed of the motor is very slow. The farther the rope is pulled the more resistance is cut out, and the faster is the speed of the motor, until when the rope is pulled to its limit the motor runs at its maximum speed. Upon releasing the rope, the spring on the controller draws the switch arm back to the "off position," thereby cutting off the power and applying the brake.

As a careless operator may put a superfluous amount of energy into his "pull," and occasionally may not be satisfied that the motor is running at its highest speed until he has tried his weight on the rope, it is essential that the controllers should be of strong construction, securely fastened down, and provided with suitably strong stops to limit the movement of the switch arm. With due regard to strength and convenience, the best position for these stops is on the sprocket wheel, and the stops with which they engage cast on the iron frame. The resistance box should be placed near the controller, to reduce to as short a length as possible the nine wires that lead from it, to the studs on the slate of the controller. The resistance is of sufficient value to allow about 1·3 times the full-load current of the motor to flow through it when the switch arm is on the first stud. The different values of the resistance taken successively from the first to the ninth stud are, as is now well known, in geometrical progression.—S. F. B.

LEGAL INTELLIGENCE.

ELECTRIC SIGNS.

In the Westminster County Court on March 22 the case of Charles *v.* "My Valet," Limited, was tried before the deputy judge, Mr. Lush Wilson. It raised a question of some importance to electrical engineers. The plaintiff, an electrical engineer, sought to recover from the defendants, who carry on business at Regent-street, W., and elsewhere, the sum of £16 for work done to their order in the erection and wiring of an electric trade sign. The defence was that the plaintiff had charged more than the contract, and that, moreover, he had erected the sign without first obtaining the consent of the Borough Council, in consequence of which the surveyor to the city of Westminster had given orders for its removal, and the work was, therefore, quite useless.

The **Surveyor** to the city of Westminster was called, and said that under the Act of Parliament the sign in question was regarded as a structure, and ought not to have been erected without the consent of the Council.

His Honour said he thought the plaintiff had erected the sign at his own risk in not having first obtained the consent of the local authorities, and judgment would, therefore, be for the defendants, with costs.

APPOINTMENTS VACANT.

Prime Cost and Third Assistant Clerk, St. Pancras Borough Council, electricity and public lighting department, £100, increasing £5 annually to a maximum of £120 per annum, April 4. Full particulars in our advertisement columns.

Junior Clerk, St. Pancras Borough Council, electricity and public lighting department, £50, increasing £5 annually to a maximum of £80 per annum, April 4. Full particulars in our advertisement columns.

Charge Engineer, Stepney Borough Council, 37s. 6d. per week, April 1. Full particulars in our advertisement columns.

Electrical Engineer, Wakefield Corporation, £300 per annum, April 8. Full particulars in our advertisement columns.

Specification Clerk, in large patent agency. Full particulars in our advertisement columns.

K. M. S. Syndicate, Limited.—This company has been registered with a capital of £5,000, its object being to acquire any patents, patent rights, etc., and to develop and turn to account the same; as producers and suppliers of gas and electricity for the purposes of light, heat, or power, etc.

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COMPANIES' MEETINGS AND REPORTS

CITY AND SOUTH LONDON RAILWAY.

At a special general meeting of this Company, held at the offices, Finsbury-pavement, E.C., on Tuesday (Mr. C. G. Mott in the chair), resolutions were adopted as follows: (1) approving the Bill now pending in Parliament for incorporating the Islington and Euston Railway Company; (2) authorising the insertion of an additional provision in the Bill on petition substituting the Company for the proposed Islington and Euston Railway Company, and authorising the City and South London Company to carry out the works and exercise the powers contained the Bill; and (3) approving the provisions of a working agreement proposed to be entered into between the two companies.

DIRECT SPANISH TELEGRAPH.

The **Marquis of Tweeddale** presided over the ordinary general meeting of the shareholders in this Company at Winchester House on Monday, and in moving the adoption of the report (which appeared in our last issue) referred to the heavy expenditure which had been caused by the interruptions to their Bilbao and Barcelona-Marseilles cables. The Bilbao cable was interrupted for about a month, and cost £4,074 for repair; while the Barcelona-Marseilles cable was interrupted twice, on the first occasion for the unprecedentedly long time of three months. This repair cost £8,179. The cable was again interrupted in the latter part of last year, but the break was only for 14 days. This repair, however, cost £2,976. Altogether about £15,230 was paid by the Company during last year for repairs. Fortunately, they were able without any difficulty to meet this outlay, as they had a handsome reserve or renewal fund, at the credit of which there was still £46,948. The interruptions naturally affected the Company's traffic receipts, which were £699 less than in the previous year. The directors believed that had it not been for these long interruptions the receipts would have been considerably in excess of those of 1900, and therefore much above the average. Business between Great Britain and Spain showed evident signs of increase, and they had every reason to hope that the traffic returns would increase. They now possessed an automatic apparatus of the best quality, and capable of doing any amount of work which it was at all likely to be called upon to do. Their experience of this apparatus was entirely favourable, both as regarded speed and accuracy.

Sir J. Denison-Pender seconded the motion, which was unanimously adopted, and a dividend of 4 per cent. per annum was afterwards declared.

LIVERPOOL DISTRICT LIGHTING.

The annual meeting of the shareholders in this Company took place on the 19th inst. at the offices in Liverpool, Mr. Arthur Hill Holme presiding.

The **Chairman**, in moving the adoption of the report, said they met under more favourable circumstances than ever before, for they were now in the position of being a dividend-paying company, and he hoped they would continue to pay a dividend as long as they existed. The increase in the number of lamps connected last year was from 6,234 to 8,904, while since January last the figure had further increased to 9,638, or 734 lights in the last few months. Referring to the Garston order, which they had transferred to the local authority, he said they had not got the electric light there yet, and now the district had been taken over by Liverpool, and arrangements made to supply electric lighting in Aigburth and Garston. The Company were doing well at Waterloo and Crosby, but were in the somewhat unfortunate position of having customers who paid 4d. per unit in Liverpool and 6d. per unit in Waterloo and Crosby. He had received many letters complaining of this charge when they only paid 4d. in Liverpool. The directors were considering the matter, and wondering whether if they had the courage to reduce the price they would get an increased number of consumers. At the same time there were very few places which supplied electric light as cheaply as, or more cheaply than, Liverpool, while hundreds of places charged 6d. per unit. The item in the report of £1,440. 13s. was the profit on the Gateacre sale, after they had paid all the preliminary expenses. The profit on the year's working was £2,207, and the balance from last year £551, a total of £2,758. They had written off £628 for depreciation, leaving £2,129. 19s. 7d. available. From this they must deduct the interim dividend at the rate of 4 per cent., leaving £1,420 to be carried forward.

Mr. Naylor seconded, and the motion was approved.

WINCHESTER ELECTRIC LIGHT.

The annual meeting of the shareholders in the Company was held at the offices in Winchester last week, Mr. T. F. Kirby presiding.

The report of the directors stated that the progress which the Company has made is very satisfactory, 5,690 8-c.p. lamps having been added during the year, making the total connection at the end of the year 20,815 lamps. Including the balance brought forward from last year's account, £125. 19s. 1d., the account shows a net profit of £2,839. 16s. 2d., which, after payment of debenture interest, leaves a balance of £1,839. 16s. 2d. available for dividend. The directors recommend that a dividend be declared at the rate of 5 per cent. per annum, which will absorb £730. 1s. 9d., and that £750 be placed to reserve for the renewal of plant, leaving a balance of £359. 14s. 5d. to be carried to the next account. The whole of the works have been maintained in perfect working order, and during the year large additions have been made both to buildings and plant. The whole of the share capital has been issued and fully paid up. For the purpose of providing the further capital required for extensions an extraordinary general meeting had been called to authorise the increase of the capital by the issue of 5,000 new shares of £5 each, to be issued as the directors may from time to time determine. The directors regret to record the death of one of their number, Major-General Montgomery. It is not proposed that the vacancy thus created should at present be filled up.

The **Chairman**, in moving the adoption of the report, remarked that at their first meeting, four years ago, they had scarcely begun business and they paid no dividend; at the second annual meeting they paid 2½ per cent., at the third 3 per cent., and at the present meeting they were in a position to pay 5 per cent. He thought they would agree with the directors in thinking that that was a satisfactory state of things. During the year they had been obliged to put in a fourth engine and a fourth boiler, and to add considerably to their plant at the works, as well as to their cables and extensions.

Alderman Stopher seconded, and the report was approved.

At an extraordinary general meeting held afterwards resolutions were adopted to increase the capital of the Company to £50,000 by the creation of 5,000 new shares of £5 each.

GATESHEAD AND DISTRICT TRAMWAYS.

The report of the directors for the year ended Dec. 31, 1901, shows a profit during that period of £6,429. 6s. 10d., to which has to be added a balance of £129. 3s. 3d. brought forward, making a total of £6,558. 10s. 1d. Interest on mortgages amounting to £810 has been paid, leaving £5,748. 10s. 1d. to be dealt with. The directors recommend a dividend of 6 per cent. on preference shares and 2½ per cent. on the ordinary shares leaving £3,316. 14s. 4d. to be carried forward to the next account. The total expenditure on capital account amounts to £194,717. 19s. 9d., which sum includes a balance of £176,471. 11s. due to the British Electric Traction Company, Limited. It is proposed to allot to that company 5,528 ordinary shares and 12,000 5 per cent. preference shares of £10 each in part payment of the amount due to them.

ENGLISH ELECTRIC MANUFACTURING.

Mr. R. H. Prestwich presided over the ordinary general meeting of the shareholders of this Company, held at Preston on Tuesday, and, in moving the adoption of the report, said the gross profits amounted to no less than £69,407. After liberal provision had been made for depreciation, and deductions made for debenture interest, dividend on preference shares, and preliminary expenses, etc., there was a balance left of £27,479. This balance was sufficient to pay 13 per cent. on the ordinary shares, but the directors wished to make the concern as sound as possible, and decided to carry it over. The amount of profit covered a period of 18 months, but the first six months' operations naturally did not result in any profit to the concern. The works were now fully equipped, and the productions were sent to almost every country.

Sir Mitchell Mitchell-Thomson seconded, and the motion was carried.

LONDON ELECTRIC SUPPLY.

The ordinary general meeting of the shareholders in this Corporation was held at Winchester House on the 20th inst., Mr. Robert H. Benson presiding.

The **Chairman**, after referring to the loss which the Company had sustained by the death of Lord Wantage, proceeded to deal with the accounts. With regard to the gross revenue account, he stated that it would have been misleading to give last year's figures only, because for seven months of the year 1900 the station at Deptford was closed for a complete overhaul of the machinery, and to enable new plant, long overdue, to be put in to meet the normal and legitimate growth of the business. In 1900, therefore, the Company had to buy current from other producers, leaving to the latter the profit. The closing of the station at Deptford also involved a temporary loss of customers. This was now all changed. The machinery was running perfectly, and the quality of their product was of the highest; and by Dec. 31 last they had practically regained all lost ground, and almost overtaken their record year of gross revenue—1899. In consequence of the improvement in their generating machinery the tendency still continued for expenses to decrease, while their customers steadily increased. Referring to the fact that the directors only recommended a dividend of 3 per cent. this year, he remarked that it was the duty of every well-managed company to pile up reserves, if not against depreciation, at least against emergencies. He expected that out of the larger net revenue which was already in sight in the current year the Board would be able next year to increase both the reserve and the preference dividend. The shareholders would shortly receive particulars of the proposed issue of £100,000 of 4 per cent. debenture stock at 94. The proceeds would pay off the temporary debt to their bankers of £82,500 and leave the Company in a sound financial condition. He concluded by moving the adoption of the report.

Sir W. H. Preece, in seconding the motion, stated that last year he was accused by some of being too sanguine, but every hope which he expressed on that occasion had been fulfilled. Their cost per unit generated was 10 per cent. less than it was when he addressed them last year, although coal was 17 per cent. dearer. The result was that the absolute present cost per unit was 20 per cent. less than it was a year ago, but this was owing to the way in which the work had been carried out, the weight of coal consumed being 32 per cent. less than it was last year. There was still further room for economy. There was the prospect of economising their fuel by the use of oil instead of coal, and if oil were not in the hands of a very strong syndicate or ring it would prove a very awkward competitor with coal. There was, however, a competitor coming on which would sooner or later require serious consideration—*i.e.*, gas for motive purposes. The Mond process of producing gas had caused considerable excitement in the engineering world, and powers had been obtained in the Midland districts to supply it It was to be hoped that the result would lead to still

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further economy in the generation of the Company's power, although the cost was now very low.

After some discussion, in the course of which the **Chairman** stated that to meet the increased demand the directors had placed an order for a new 1,000-kw. plant, which was due for delivery in August next, the resolution was passed unanimously.

NATIONAL ELECTRIC WIRING.

Report of directors (with abstract of accounts) to Dec. 31, 1901:

The gross profits for the period under review is £12,664. 14s. 7d., from which has to be deducted expenses of administration, allowances on contracts, etc., amounting to £6,060. 10s. 8d., leaving a balance of £6,604. 3s. 11d. To this has to be added the balance carried forward at Dec. 31, 1900—viz., £384. 5s. 9d.—making a total of £6,988. 9s. 8d. The directors recommend that this amount be dealt with as follows: to pay a dividend at the rate of 5 per cent. on the paid-up capital for the year, £4,093. 12s 1d.; provision for further allowances, depreciation, etc., £2,522. 7s. 8d.; to carry forward, £372. 9s. 11d. The directors have pleasure in stating that the increase in the business during the year has again been satisfactory. The orders taken from Jan. 1 of the current year to date of this report show that the increase has been maintained. During the year 2,741 installations with an aggregate of 79,843 lamps of 8 c.p. have been completed, of which 805 installations with an aggregate of 25,080 lamps of 8 c.p. were free wiring, and 1,936 installations with an aggregate of 54,763 lamps of 8 c.p. were contract, while the orders in hand at the close of the year were 315 installations with an aggregate of 29,342 8-c.p. lamps. Free wiring contracts have been entered into with the metropolitan borough of Hackney and the Hornsey District Council. The directors regret to state that, for business reasons, Mr. J. W. Swan resigned his seat on the Board during the year. Mr. J. T. Jervis and Mr. W. R. Davies, in accordance with the articles of association, retire at this meeting, but are eligible, and offer themselves for re-election.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Management expenditure at head office, etc.	4,545	16	7
Directors' fees	800	0	0
Auditors' fees	52	10	0
Allowances on contracts, bad debts, etc.	662	4	1
Balance carried down	6,604	3	11
	£12,664	14	7
Depreciation provisions	2,522	7	8
Balance, as per balance-sheet	4,081	16	3
	£6,604	3	11
Cr.	£	s.	d.
Revenue from free-wired installations	3,366	9	4
Profit on contracts completed and in progress	8,359	16	7
Interest, discount, and commission	814	4	10
Sundry receipts	118	4	4
Transfer fees	5	19	6
	£12,664	14	7
Balance brought down	£6,604	3	11
	£6,604	3	11

Mr. R. Stewart Bain presided over the ordinary general meeting of this Company, held at Westminster Palace Hotel on Tuesday.

The **Chairman**, in the course of his remarks, congratulated the shareholders on the success of the year's working, and upon the steady progress that had been made since the incorporation of the Company. They were slowly but thoroughly building up a good business, and they were known as one of the largest wiring companies in the kingdom. During the year they completed 2,741 installations, with an aggregate of 79,843 lamps, as compared with 2,240 installations, with an aggregate of 57,519 lamps during the previous year. The free-wiring portion of the business showed a satisfactory improvement on that of last year, and what was of more importance, in nearly every case the revenue of all new free-wiring contracts which the Company entered into was guaranteed by the lighting authority. If the business continued to increase in the same ratio as it had hitherto done, the necessity of additional capital might soon have to be considered, more especially if the Company were successful with some of the negotiations now in progress for installations running into considerable amounts. Should it be necessary to increase the capital, the shareholders would have the first consideration in any new capital issued, whatever form it might take. He then formally moved that the report and accounts be adopted.

Mr. W. R. Davies seconded the motion, which was carried unanimously.

WILLANS AND ROBINSON.

Directors: Mark Robinson, Esq., M.I.C.E., chairman; Sir Gilbert A. Clayton East, Bart., deputy-chairman; Captain H. Riall Sankey, R.E. (ret.), M.I.C.E.; Thomas O. Lazenby, Esq., J.P.; Arthur Lazenby, Esq., A.M.I.C.E.

Report of the directors (with abstract of accounts) for the half-year ended Dec. 31, 1901:

After writing off as depreciation from plant, etc., the sum of £6,114. 5s. 2d., and paying interest upon debenture stock, the balance to the credit of profit and loss account at the end of the half-year (including £6,457. 1s. 1d. brought forward) is £39,804. 9s. 4d. Out of this the directors propose that dividends be paid at the rate of 6 per cent. per annum upon the preference shares, and 10 per cent. per annum upon the ordinary shares, amounting in all to £22,531. 15s. 10d. The amount payable to directors in accordance with the articles of association, and with the resolution passed by the shareholders on Oct. 2, 1901, is £4,737. 2s. 4d., leaving an available balance of £12,535. 11s. 2d. From this the directors propose to carry £2,000 to the debenture redemption fund, and £3,500 to the reserve fund, leaving a balance of £7,305. 11s. 2d. to be carried forward. A further sum of £20,000 has been transferred from the premiums on shares account to the reserve fund, raising the latter (if the above proposal to transfer £3,500 from the last half-year's profits be also taken into account) to £111,146. 9s. 11d. The boiler works at Queen's Ferry have made satisfactory progress, and one section, the steelmaking department, is at work. The quality of the steel produced has been excellent, and the directors looked forward with confience to the development of the steel manufacture, and to the financial results of the boiler work generally. The trials of the Niclausse boilers of H.M.S. "Fantome" are understood to have given very satisfactory results, and the Admiralty has recently ordered another similar vessel to be built and fitted with Niclausse boilers. They have also called for tenders for Niclausse boilers for several larger vessels, but it is understood that no decision with regard to these has yet been arrived at. Whatever may be the judgment of the Admiralty, the directors, as they have stated before, are entirely satisfied as to the amount of boiler work to be done for land service, and to complete the equipment of the works on the scale which is desirable, and to provide working capital for the future, as well for the engine as for the boiler business, they ask authority to make an issue of £250,000 of debenture stock (which as regards £100,000 will merely take the place of the existing issue) in such amounts and at such times and at such rate of interest as they may deem best. A resolution to this effect will be submitted to the shareholders at the meeting. It is hoped that an arrangement will be effected with the present debenture stockholders for the exchange of their present stock for stock of the new issue. Mr. Robinson and Sir Gilbert A. Clayton-East retire from the Board, in accordance with the provisions of the articles of association, but are eligible, and offer themselves for re-election.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Rent, rates, and taxes	715	7	6
Interest on debenture stock	2,125	0	0
Salaries, including directors' remuneration	7,472	11	6
Contingent salaries to employés	1,780	4	5
Fire insurance	296	6	8
Fire insurance fund	400	0	0
Legal and professional charges	19	14	0
Advertising	573	4	5
Books, stationery, and printing	807	18	5
Postage and telegrams	317	6	10
Travelling, hotel, and general expenses	532	8	10
Auditors' fee and expenses	125	9	10
Company's subscription to sick club, etc.	355	10	1
Depreciation of property and plant and machinery	6,114	5	2
Allowances to reservists' families	33	13	8
Balance carried down	33,347	8	3
	£55,016	9	7
Contingent share of profits to directors	4,737	2	4
Balance available for dividend or reserve	28,610	5	11
	£33,347	8	3
Cr.	£	s.	d.
Gross profit for the half-year	52,679	5	1
Royalties	501	4	9
Interest on investments, etc.	1,791	5	3
Transfer and registration fees	44	14	6
	£55,016	9	7
Balance, profit (half-year), brought down	£33,347	8	3
	£33,347	8	3

POTTERIES ELECTRIC TRACTION.

The report of the directors for the year ended Dec. 31, 1901, states that the gross receipts for the year amount to £86,386. 4s. 1d. After deducting all expenses chargeable to revenue, including repairs and maintenance and interest on loans and debentures, there remains a net profit of £19,650. 14s. 6d. To this has to be added £205. 15s. 9d. brought forward from the previous account, making an available balance of £19,856. 10s. 3d., which the directors recommend should be applied as follows—viz.: to provide for dividend for the year on the cumulative preference shares, £10,054. 3s. 4d.; to pay a dividend on the ordinary shares of the Company at the rate of 4 per cent. for the year, £8,043. 16s. 9d.; to transfer to the credit of depreciation and reserve fund, £1,500; to carry forward to next account, £258. 10s. 2d. During the year traffic receipts have increased and administration and other expenses have been reduced, but the Company's business has suffered considerably from the general stagnation in the trade of the district, and loss has been sustained through the reduction of the service between Hanley and Longton, pending the reconstruction of part of the old line in Fenton of the North Staffordshire Tramways Company In April last the British Electric Traction Company, Limited exercised the option to subscribe for £75,000 debenture stock referred to in the last report. The directors have considered it desirable for the Company to acquire the outstanding £20,000 5 per cent. debentures of the North Staffordshire Tramways Company, and in order to

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carry this into effect 2,000 ordinary and 2,000 5 per cent. preference shares of £10 each were issued to the shareholders on which £1 per share has been called up. This has enabled the directors to offer £20,000 4½ per cent. debenture stock to the holders of the 5 per cent. debentures of the North Staffordshire Company in payment for their debentures, and this Company now holds all the issued debentures of the North Staffordshire Company except £150. The total capital expenditure to Dec. 31, 1901, was £415,496. 17s. 3d., in addition to £205,333. 10s., the cost of the debentures and shares held by the Company in the North Staffordshire Tramways Company, Limited. The light railways order applied for in 1900 has now been granted, and the lines authorised by this order are coloured red on the accompanying map. The directors propose to commence the construction of some of these lines forthwith. In order to cope with the increased demand for services, additional plant has been installed, and the system of electrical feeders has been extended. The rolling stock has been augmented, and the Company has now a total of 105 cars. The express parcels delivery service was commenced towards the end of the year, and has dealt successfully with a large amount of business. Receiving offices have been opened in Stoke, Hanley, Burslem, Newcastle, Longton, etc., and agents have been appointed throughout the district. The directors have appointed Crouch's Universal Parcels Express Company for business in London and the provinces, in connection with this service. Some capital expenditure has been necessary for the purchase of vans and other apparatus. The directors have received applications from various local authorities for extensions of the system into parts of the district not yet served by the tramways, and these suggestions are receiving the careful consideration of the directors. The negotiations with some of the local authorities for the transfer to the Company of their electric lighting orders have been postponed. The directors have considered it desirable to join with the North Staffordshire Tramways Company in applying to Parliament in the present session for a Bill to confirm certain agreements with the local authorities for power to appoint an arbitrator in certain eventualities and for other purposes. The Bill has passed second reading. During the year Mr. J. S. Raworth has retired owing to other engagements, and the directors have elected Mr. George F. M. Cornwallis-West to fill the vacancy thus caused on the Board. The directors retiring this year are Mr. Stephen Sellon, Mr Stephen Mear, and Mr. George Cornwallis-West, who are eligible for re-election.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Power and running expenses	34,462	11	2
Repairs and maintenance	6,597	7	11
Administration and general expenses	5,009	11	7
Debenture trustees' fees	100	0	0
Auditors' fees	73	10	0
British Electrical Superannuation Fund	3	4	7
Amount payable under working agreements	11,401	5	0
Interest on loans and debenture interest	9,087	19	4
Balance carried to balance sheet	19,650	14	6
	£86,386	4	1

Cr.	£	s.	d.
Traffic receipts	73,592	11	8
Advertising receipts	553	15	6
Sundry receipts	1,970	16	8
Interest on debentures and dividends on shares of the North Staffordshire Tramways Company, Limited	10,269	0	3
	£86,386	4	1

The ordinary general meeting of the shareholders was held on Tuesday at Hamilton House, Victoria-embankment, Mr. Emile Garcke in the chair.

The **Chairman**, in moving the adoption of the report, remarked that it indicated progress and improvement in almost every direction. Wherever it had been possible to show improvements by energy, he was glad to say that progress had been made, and it was only in matters quite beyond the control of the Board that they had not been able to make an improvement. The Company was now running 29 miles, as compared with 23 miles in the previous year, and had carried 13,250,000 passengers, compared with under 10,000,000 in the previous year. The gross receipts for traffic had gone up from £52,000 to £73,000. The expenses showed a considerable reduction in the items under the control of the Board, but unfortunately, owing to abnormal increases in other items, the aggregate did not show the considerable reduction which it ought to do. Rates and insurance alone showed an advance of £900, which, of course, neutralised the whole of the economies which had been made in other directions. During the period under review the Potteries district had suffered from extreme depression in many of its trades. The coal, iron, and steel industries had been very severely depressed, and the total exports showed a decrease of 40 to 50 per cent. as compared with the previous year. Still, against those depressing circumstances they could count the fact that the electrical tramway industry was a progressive one, and one that they might expect to steadily advance. The Board had every reason to feel satisfied with the results which had been achieved, and they hoped that next time they met they would have still better results to lay before the shareholders. On the new lines, which the Board of Trade had now sanctioned under the Light Railways Act, double-decked cars would be run. During the year 2,000 additional ordinary and the same number of additional preference shares had been issued. Additional debentures to the amount of £20,000 had also been issued in order to exchange the remainder of the debentures of the North Staffordshire Tramways Company. The running of the steam omnibuses to the outlying districts had not proved successful. The Company had introduced what he believed to be a thoroughly efficient and satisfactory system of conveying parcels over the whole of the Potteries district. This business seemed likely to prove a complete success. He mentioned, in conclusion, that the Board of Trade had not yet given permission for the attachment of trailer cars behind the passenger cars for the parcels.

Mr. G. F. M. Cornwallis West seconded the motion, which was adopted *nem. con.*

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING.

Directors: J. B. Braithwaite, jun. (chairman); Frederick W. Reynolds; Aymor H. Sanderson; Francis E. Savory; Joseph Shaw; R. Percy Sellon, M.I.E.E. Chief engineer: Charles P. Sparks, M.I.C.E. Secretary: H. B. Renwick.

Report of the directors (with abstracts of accounts) for the year ending Dec. 31, 1901:

The capital expended during the year in respect of the Company's London districts amounted to £129,781. 11s. 9d., making the total expenditure on account of those districts up to Dec. 31 last £1,022,458. 14s., particulars of which are given in the various capital accounts and in the balance-sheet. This expenditure has been met by the sale of the balance of the unissued 4½ per cent. debenture stock in February, 1901, at the price of £103 per cent. net, and by the issue of a further £100,000 6 per cent. preference shares, allotted *pro rata* to the shareholders in October last at a premium of £2 per share. The premium received on the abovementioned issues has been applied in the following manner: reduction of preliminary expenses, £1,538. 3s. 11d.; reduction of costs of pending applications for provisional orders, £500; amount carried to reserve for depreciation, repairs, and renewals, etc., £9,159. 5s. 11d.; amount carried to reserve, £8,265. 0s. 2d. The balance from last account, after payment of the final dividends on the preference shares and the ordinary shares of the Company for the half-year ended Dec. 31, 1900, less income tax, amounted to £3,638. 14s. 1d.; and the balance from revenue account, after payment of directors' fees, rent, taxes, general establishment, and other charges, wages, and proportion of salaries, to £43,944. 19s.; making a total available revenue for the year 1901 of £47,583. 13s. 1d. From which must be deducted the following items: (*a*) interest on debenture stock, including interest on instalments paid in advance, less income tax, £16,987. 10s.; (*b*) interim dividend on 20,000 6 per cent. preference shares for half-year ended June 30, 1901, less income tax, £5,675; (*c*) interim dividend on 40,000 ordinary shares at 4 per cent. per annum for half-year ended June 30, 1901, less income tax, £7,566. 13s. 4d.; leaving for further distribution, £17,354. 9s. 9d. The directors recommend (*a*) that payment of the interim dividend on the 20,000 6 per cent. preference shares for the half-year ended June 30, 1901, less income tax, be confirmed; (*b*) that payment of the interim dividend on the 40,000 ordinary shares at the rate of 4 per cent. per annum for the half-year ended June 30, 1901, less income tax, be confirmed; (*c*) that a further dividend on the 20,000 6 per cent. preference shares for the half-year ended Dec. 31, 1901, less income tax, be declared; and (*d*) that a further dividend on the 40,000 ordinary shares for the half-year ended Dec. 31, 1901, at the rate of 4 per cent. per annum, less income tax, be declared, and that the same be paid to all proprietors registered at March 14, 1902. This will absorb £13,318. 0s. 1d., and leave a balance of £4,036. 9s. 8d. to be carried forward. The profits derived from the Company's London stations have arisen from £32,863. 8s. 8d. in 1900, to £50,503. 19s. 4d. in 1901, being an increase of 53·6 per cent. for the year. The total applications received at Dec. 31 last amounted to the equivalent of 325,978 8-c.p. lamps, being an increase of 36 per cent. for the year, and the total units sold were 4,351,105, as against 2,990,138 for the previous year, being an increase of 45 per cent. The retiring directors are Mr. Frederick W. Reynolds and Mr. R. P. Sellon, who are eligible for re-election. The auditor, Mr. R. H. Marsh, also retires, and is eligible for re-election.

LONDON STATIONS.

St. Luke and Clerkenwell, Eastern Holborn, Western Holborn, and St. Giles.—The balance to credit of revenue for the 12 months ended Dec. 31, 1901, amounted to £26,885. 17s. 4d., details of which are given in revenue accounts. In these districts the total applications to Dec. 31 last, including power, represented the equivalent of 196,499 8-c.p. lamps, of which 173,704 were then connected to the mains. The applications for the year represented an increase of 53,304, and the connections an increase of 54,628. Included in above are 256 users of motors, aggregating 2,278 h.p. supplied from the Company's mains, showing an increase of 1,107 h.p. for the year, and further applications have since been received, raising the total to 309 applications, representing 2,843 h.p. Additional generating plant for both lighting and power purposes has been erected during the year at the Company's City-road station.

Wandsworth District (including the parishes of Putney, Wandsworth, Clapham, Streatham, and Tooting), Camberwell, St. Olave, Bermondsey, and St. George-the-Martyr, Southwark.—The balance to credit of revenue for the 12 months ended Dec. 31 last amounted to £23,618. 2s., details of which are given in revenue account. In these districts the total applications to Dec. 31 last represented the equivalent of 129,479 8-c.p. lamps, of which 120,130 were then connected to the mains. The applications for the year represented an increase of 32,872, and the connections an increase of 29,658. The work of laying mains in St. Olave, Bermondsey, is now completed, and current is available in the principal thoroughfares of that district. The additional plant erected at the Company's station on the Wandle is now in working order.

INVESTMENTS IN PROVINCIAL ELECTRICITY SUPPLY COMPANIES.

Bournemouth and Poole Electricity Supply Company, Limited.—The directors of this Company have recommended the payment of a dividend on the ordinary shares of the Company at the rate of 7 per cent.

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for the year ended Dec. 31, 1901, less income tax, as against 6 per cent. for the previous year. The progress made by this Company is very satisfactory.

Dover Electricity Supply Company, Limited.—The directors of the Dover Company have recommended the payment of a dividend on the ordinary shares of the company at the rate of 5 per cent. for the year ended Dec. 31, 1901, less income tax, as against 3½ per cent. for the year 1900. Since the close of the year the Dover Corporation have, subject to their obtaining the necessary borrowing powers, entered into an agreement for the purchase of this company's undertaking at Dover.

Scottish House-to-House Electricity Company, Limited.—The provisional order for electric tramways at Coatbridge, granted to the company by the Board of Trade, was duly confirmed in the last session of Parliament. The work of remodelling the Coatbridge station from alternating to continuous current, which was commenced last year in order to supply lighting power and traction from one set of machinery, is now approaching completion. A supply of current will be available in Airdrie by the autumn.

Dr. General Revenue Account.	£	s.	d.
Directors' fees, rents, taxes, insurance, wages, and proportion of salaries	6,248	16	9
Printing, stationery, and postage	823	18	11
General charges and travelling	828	7	11
Legal expenses	223	5	6
Trustees' fee	105	0	0
Auditors' fee	157	10	0
Reserve for bad debts	50	0	0
Depreciation of office furniture	197	4	3
Interest paid on temporary loans	3,810	18	6
Amount written off legal expense suspense account	223	12	1
	12,668	13	11
Balance carried to net revenue account	43,944	19	0
	£56,613	12	11

Cr.	£	s.	d.
Gross profits derived from rents, discounts, and administration of associated companies	1,334	10	10
Transfer fees	39	16	0
Interest and dividends receivable, less income tax	4,735	6	9
Balance from revenue account	50,503	19	4
	£56,613	12	11

County of London (Northern Extensions) Electric Lighting Order, 1897.

Dr. *Revenue Account.*	£	s.	d.
Generation—Engineers' salaries and wages	516	10	6
Coal and other fuel	1,730	0	6
Oil, waste, water, etc.	230	3	6
Stores and works expenses	24	4	6
Repairs to buildings and plant	419	7	0
Distribution—Engineers' salaries and wages	164	7	6
Repairs	11	15	5
Rents payable	183	16	10
Rates and taxes	416	5	4
Insurance	41	18	6
Stationery and printing	45	18	0
Auditor's fee—Board of Trade	13	10	0
	3,797	17	7
Less repairs and renewals	431	2	5
	3,366	15	2
Balance carried to general revenue account	4,754	11	2
	£8,121	6	4

Cr.	£	s.	d.
Receipts from sale of current, less abatements	7,911	11	6
Rental of meters	209	14	10
	£8,121	6	4

County of London (North) Electric Lighting Order, 1892.

Dr. *Revenue Account.*	£	s.	d.
Generation—Engineers' salaries and wages	2,071	16	3
Coal and other fuel	6,920	8	10
Oil, waste, water, etc.	920	19	8
Stores and works expenses	97	2	1
Repairs to buildings and plant	1,674	17	0
Distribution—Engineers' salaries and wages	1,092	2	10
Repairs and maintenance	392	1	10
Rents payable	736	4	0
Rates and taxes	1,400	11	9
Insurance	171	3	10
Stationery and printing	183	15	9
Auditor's fee—Board of Trade	54	0	0
General charges and travelling	247	17	1
Legal expenses	16	2	8
	15,979	3	7
Less repairs and renewals	2,066	18	10
	13,912	4	9
Balance carried to general revenue account	18,998	15	6
	£32,911	0	3

Cr.	£	s.	d.
Receipts from sale of current, less abatements	31,730	9	1
Rental of meters	838	14	11
Rents receivable	339	3	9
Testing fees	2	12	6
	£32,911	0	3

Holborn and St. Giles Electric Lighting Order (No. 1), 1898.

Dr. *Revenue Account.*	£	s.	d.
Generation—Engineers' salaries and wages	287	10	10
Coal and other fuel	961	3	4
Oil, waste, water, etc.	127	17	6
Stores and works expenses	13	9	2
Repairs to buildings and plant	230	17	0
Distribution—Engineers' salaries and wages	273	0	0
Repairs	29	8	0
Rents payable	102	4	2
Rates and taxes	222	16	6
Insurance	23	5	10
Stationery and printing	25	13	0
General charges	21	9	3
Auditor's fee—Board of Trade	7	10	0
Legal expenses	10	13	7
	2,336	18	2
Less repairs and renewals	260	5	0
	2,076	13	2
Balance carried to general revenue account	3,132	10	8
	£5,209	3	10

Cr.	£	s.	d.
Receipts from sale of current, less abatements	5,022	15	3
Rental of meters	186	8	7
	£5,209	3	10

Wandsworth Electric Lighting Order, 1892.

Dr. *Revenue Account.*	£	s.	d.
Generation—Engineers' salaries and wages	1,704	11	11
Coal and other fuel	5,110	14	4
Oil, waste, water, etc.	825	3	8
Repairs to buildings and plant	1,376	2	10
Distribution—Engineers' salaries and wages	1,267	9	3
Repairs and maintenance	427	10	6
Rents payable	105	6	3
Rates and taxes	733	14	10
Insurance	137	18	4
Stationery and printing	209	0	3
Auditor's fee—Board of Trade	60	0	0
Legal expenses	52	11	7
General charges and travelling	340	14	4
	12,351	3	1
Less repairs and renewals	1,803	18	4
	10,547	4	9
Balance carried to general revenue account	17,602	9	6
	£28,149	14	3

Cr.	£	s.	d.
Receipts from sale of current, less abatements	26,918	16	1
Rental of meters	1,155	11	8
Rents receivable	74	16	6
Testing fees		10	0
	£28,149	14	3

Camberwell Electric Lighting Order, 1896.

Dr. *Revenue Account.*	£	s.	d.
Generation—Engineers' salaries and wages	440	4	4
Coal and other fuel	1,320	3	8
Oil, waste, water, etc.	215	5	4
Repairs to buildings and plant	370	5	4
Distribution—Engineers' salaries and wages	534	3	10
Repairs and maintenance	164	5	5
Rents payable	29	0	4
Rates and taxes	216	12	0
Insurance	34	0	2
Stationery and printing	55	1	6
Auditor's fee—Board of Trade	16	0	0
Legal charges	5	2	7
General charges	38	11	9
	3,438	16	3
Less repairs and renewals	534	10	9
	2,904	5	6
Balance carried to general revenue account	4,985	13	11
	£7,889	19	5

Cr.	£	s.	d.
Receipts from sale of current, less abatements	7,625	2	1
Rental of meters	264	17	4
	£7,889	19	5

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SOUTHWARK ELECTRIC LIGHTING ORDER, 1892.

Dr. *Revenue Account.*	£	s.	d.
Generation—Engineers' salaries and wages	127	1	1
Coal and other fuel	330	11	8
Oil, waste, water, etc.	55	3	0
Repairs to buildings and plant	93	8	0
Distribution—Engineers' salaries and wages	205	10	6
Repairs and maintenance	68	16	2
Rents payable	8	1	10
Rates and taxes	69	15	2
Insurance	8	2	2
Stationery and printing	13	1	10
Auditor's fee—Board of Trade	4	0	0
	983	11	5
Less renewals and repairs	162	4	2
	821	7	3
Balance carried to general revenue account	1,029	18	7
	£1,851	5	10

Cr.	£	s.	d.
Receipts from sale of current, less abatements	1,812	11	4
Rental of meters	38	14	6
	£1,851	5	10

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

County of London (Northern Districts).	
Quantity generated in Board of Trade units	3,781,079
Quantity sold	2,839.713
Quantity used on works	177,906
Total quantity accounted for	3,017,619
Quantity not accounted for	763,460
Total maximum supply demanded (kilowatts)	1,898

County of London (Southern Districts).	
Quantity generated in Board of Trade units	2,103,626
Quantity sold	1,511,392
Quantity used on works	51,947
Total quantity accounted for	1,563,339
Quantity not accounted for	540,287
Total maximum supply demanded (kilowatts)	1,777

The ordinary general meeting of the shareholders in this Company was held on Monday at Winchester House, Old Broad-street, E.C., Mr. J. B. Braithwaite, jun., presiding.

The **Chairman**, in moving the adoption of the report and accounts, observed that the Company had made satisfactory progress in every department in the past year. In view of the very large areas in which the Company had electric lighting rights, it was not probable that the capital account could be closed for a considerable time, although the outlay in the present year would probably not be so large as it was last year. Interest and dividends receivable amounted last year to £4,735, as compared with £3,896 for 1900. This was owing to the improving prospects of the provincial companies in which they were interested at Bournemouth, Dover, and Coatbridge. The Dover Company had come to an agreement with the Corporation there for the sale of their undertaking at a price which, it was said, was calculated to work out at about £8. 10s. for each £5 share. The backbone of the Company's business was in London. The result of the past year's working at the London stations was that on the north side of the river they had earned £12,000 more at an increased outlay of £3,570, and on the south side, curiously enough, the amount earned had also been £12,000 more, but the increased cost had been £4,750. The gross revenue for the year from all sources had been, as he had said, £56,613, representing an advance of 47 per cent. on that for 1900; but the net profit had increased by 54 per cent., showing that the previous outlay of capital on mains, etc., was gradually becoming remunerative. Last year the directors had not been able to provide out of revenue the sum which ought to be placed to repair and renewal fund, but the directors had no doubt that in the current year they would be able to do this, as well as easily to maintain the present dividend on the ordinary shares. With reference to their charge per unit, it was based on the sliding scale. If a person were a good customer he got the benefit of this, but if he were a bad customer he paid a higher price. Their maximum charge was 7d., but in some cases their customers received their current at considerably under 4d., while some of them had it at 3d. per unit. The total average price received by the Company for the whole of their current on both sides of the river had been almost exactly 4½d. Alluding to the increasing tendency of municipalities and local bodies to harass private investors, he maintained that the tendency was a dangerous one to the public, not only as shareholders in any industry, but also as ratepayers. He also condemned the action of the Corporation of London towards the City of London Electric Lighting Company, and further complained that the borough of Camberwell had been endeavouring to take a leaf out of the same book as regarded the County of London Company.

Mr. Frederick W. Reynolds seconded the motion, which was **adopted**.

BRITISH COLUMBIA ELECTRIC RAILWAY.

A report has been issued by Mr. R. M. Horne-Payne, the chairman of this Company, to the shareholders, giving the results of the visit he has made to British Columbia by desire of his co-directors and in response to the repeated request of the general manager. He has inspected the whole of the Company's property and plant. As a result of his visit he recommends at the conclusion of his report: (1) that the directors should be authorised to create £175,000 (part of £220,000) special 4½ per cent. 50-year debenture bonds, or to guarantee a similar amount of similar bonds of the Vancouver Power Company, in order to enable the Vancouver Power Company to construct and instal the Coquitlam water-power plant; (2) that power be granted to the directors to increase the capital by £300,000 from time to time, as occasion may require, for the general expansion of the business; (3) that the shares of the Company be converted into stock; (4) that the present preference shares be converted into preferred (5 per cent. minimum) ordinary stock, and the present ordinary shares into deferred ordinary stock, and that £250,000 of the new capital be created as 5 per cent. perpetual cumulative preference stock and £50,000 as additional preferred (5 per cent. minimum) ordinary stock, and that provision shall be made in the articles providing that there shall at no one time be outstanding more preference than there is of preferred ordinary stock and also of deferred ordinary stock already outstanding, and that at no one time shall there be more preferred ordinary stock outstanding than there is already of deferred ordinary stock outstanding. The effect of this is that there will be £250,000 in each of the three issues of capital and £250,000 of debentures, and that ample provision will be made for the growth of the Company. He adds: "The shareholders will, of course, understand from this report that I have no idea or intention of recommending any large present increase in the capital, but that I am suggesting a convenient means of increase as business necessitates and justifies the expenditure in the future, and I think there can be no doubt that when the time comes for the increase the shareholders will secure very materially increased dividends both on the present preference and ordinary shares."

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bedford.—The Corporation invite tenders for 28 30-kw. alternating transformers. Tenders by April 3.

Edinburgh.—The Corporation invite tenders for annual supplies from May 15 for the electric supply department.

Brisbane (Queensland).—The Postmaster-General invites tenders for a number of telephones. Tenders by April 14.

Madrid.—The date for receiving tenders for the lighting of the model prison has been postponed from March 7 to March 29.

Barcelona.—The Harbour Board invite tenders for an installation to supply electric light, power, and cranes. Tenders by April 7.

Rockhampton (Queensland).—The contract for the municipal tramways, full particulars of which appeared in a former issue, will remain open until March 31.

Maidenhead.—Tenders are required for an electric light installation. Particulars may be obtained from Messrs. Burstall and Monkhouse, Westminster. Tenders by April 4.

Madrid.—The Postal Telegraph Department invite tenders for 12 tons 3mm. and 3 tons 1½mm. bronze wire. Price per ton not to exceed 2,280 pesetas. Tenders by April 5.

Devonport.—The Corporation invite tenders for materials and work for about three miles of double tramway track. Specification, etc., may be obtained from Mr. C. Chadwell, 20, Victoria-street, Westminster. Tenders by April 16.

Hackney.—The Electric Lighting Committee invite tenders for the construction and erection of three water-tube boilers and accessories, and water-softening plant. Tenders by April 9. Details in our advertisement columns.

Rathmines.—The District Council invites tenders for supply and erection of engine-house plant, extension of switchboard and electricity supply mains. Tenders by April 24. Full particulars in our advertisement columns.

Warrington.—The Corporation invite tenders for a complete overhead tramway equipment. Specifications, etc., can be obtained from Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W. Tenders by April 9.

Southend-on-Sea.—The Corporation invite tenders for the installation of electric wiring, lamps, and other fittings on the premises of private consumers in the borough. Tenders by April 2. Details in our advertisement columns.

Madrid.—The Public Works Department invite tenders for extensions to the San Sebastian tramways and working the same for not more than 60 years. Particulars may be obtained from the Department. Tenders by April 5.

Burgess Hill.—We are informed that no tenders have been received for the construction of electricity supply works in the district which the Urban District Council had invited last month, and the time of which expired on March 12.

Southend-on-Sea.—The Corporation invite tenders for supply and delivery of 50 arc lamp columns. Further particulars may be obtained from Mr. W. E. J. Heenan, M.I.E.E., borough electrical engineer, Southend. Tenders by April 3.

Shipley (Yorks).—The Shipley School Board invite tenders for the work of installation of electric light at the Central School. Specification and other particulars may be obtained from Mr. W. Popplestone, clerk, School Board Offices, Shipley. Tenders by April 2.

Sydney.—The Municipal Council invite tenders for supply and erection of plant and machinery required for the complete equipment of their proposed electricity supply stations and sub-stations. Par-

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ticulars may be obtained from Messrs. Preece and Cardew, Westminster. Tenders by May 7 at noon.

Madrid.—Tenders are invited by the Spanish Government for the supply of 141 tons of iron wire for the Government telegraph service. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m. Tenders by April 2.

George Town (Penang).—The Municipal Commissioners invite tenders for the supply and delivery, f.o.b., of boilers, etc., ejector condenser, pumps, tanks, etc., pipes, steam dynamos and balancer boosters, switchboards, batteries, cables, junction boxes, &c., and arc and glow lamps, posts, and accessories. Tenders by April 28. Details in our advertisement columns.

Trowbridge.—The Trowbridge Urban District Council having obtained a provisional order for the supply of electricity in their district, are prepared to receive applications for a lease of their powers under the said order. A plan of the district can be seen at the offices of the Council. Applications to be sent to Mr. T. S. Hill, clerk, Council Offices, Town Hall, Trowbridge, by April 30.

Edinburgh.—The Corporation invite tenders for the supply of the following materials for the electricity supply department for the year from May 15, 1902: (1) arc lamp carbons; (2) cast-iron pipes, pavement and road box frames and covers, etc. Specifications, etc., can be obtained at the Resident Engineer's Office, 5, Dewar-place, Edinburgh. Tenders, for carbons by March 31, for ironwork by April 12.

Bermondsey.—The Council invite tenders for the supply of the undermentioned articles up to March 31, 1903: arc lamp columns, electricity meters, demand indicators, and main fuses, engine oils, incandescent lamps, indiarubber cables and jointing material, ironmongery and engine-room stores, lead-covered cables, and meter boards. Tenders by April 14. Details in our advertisement columns.

Falkirk.—The Corporation invite tenders for the supply and erection of the following: three 100-kw. steam dynamos (vertical enclosed high-speed engines); two dry-back marine-type boilers, with fittings; economiser, with dampers. Specifications, etc., can be inspected and all information obtained at the offices of Messrs. Burstall and Monkhouse, consulting engineers to the Corporation, 14, Old Queen-street, Westminster, S.W. Tenders by April 12.

Oldham.—The Surveyor's and Tramways Committee invite tenders for the complete electrical equipment of new car depot at Wallshaw, within the borough boundary. The car depot is constructed to accommodate 70 cars, and contains eight tracks, laid the full length of the building. The work required to be done is approximately as follows: overhead equipment, lighting feeder and conduit from generating station to car depot, switchboards, car-shed lighting, motors, and telephones. Specification, etc., may be obtained from Mr. S. A. Pickering, A.M.I.C.E., borough surveyor, Town Hall, Oldham. Tenders by April 9.

RESULTS OF TENDERS.

Llandudno.—The Urban District Council have accepted the tender of Babcock and Wilcox, at £1,964, for two tube boilers and steam pipes.

King's Lynn.—The Electric Lighting Committee have accepted the tender of H. and T. Danks, at £782. 10s., for supply and erection of a Lancashire boiler.

Hastings.—The Corporation have accepted the tender of Crompton and Co., at £68, for the supply of a booster, with necessary starting switch, resistances, etc.

Glasgow.—The Electric Lighting Committee recommend the acceptance of the tender of Willans and Robinson, at £8,035, for two 2,400-h.p. engines and dynamos, six boilers and accessories, on condition of the firm taking 11 engines and a number of dynamos.

London, N.W.—The Hampstead Borough Council have accepted the following tenders for various materials for one or three years, at the option of the Council, from April 1: Vacuum Oil Company, Norfolk-street, Strand, W.C., oils for machinery at the electric lighting station (three years); J. Gibbs and Co., engineer's tools and stores for ditto (three years).

West Ham.—The Corporation have received the following tenders for erection of an electric generating station and offices at Quadrant-street, Canning Town:

Gregar and Son, Jupp-road, Stratford (accepted)	£53,999
Thomas and Edge, Anglesea-avenue, Woolwich	53,965
Johnson and Son, 90, High Cross-street, Leicester	55,848
F. G. Minter, Page-street, Westminster	55,994
Shillitoe and Son, Bury St. Edmunds	57,000
Leslie and Co., Kensington-square, W.	58,795
Foster Bros., 148, Birchanger-road, Norwood	59,833
G. Wise, works manager, West Ham	59,773
Yates and Co., 106, Campbell-road, Bow	61,521
West Bros., Cuxton-road, Strood	61,650

Morecambe.—The School Board have received the following tenders for the wiring of the new schools, Station-road; about 270 lights were required:

Collinson Bros., Bradford	£402	0	0
Maund and Robson, Southport	241	10	0
Firth and Son, Manchester	288	0	0
Edmundson and Co., Morecambe (accepted)	280	0	0
A. Dickenson, Leeds	356	4	0
S. Smith, Morecambe	327	10	0
Scholes and Son, Manchester	226	0	0
Mortimer and Sampson, Warrington	400	0	0
C. T. Briscoe, Blackburn	450	16	0
R. B. Abbott, Morecambe	250	0	0
Woods and Co., Blackburn	415	0	0

London, S.W.—The Fulham Borough Council have accepted the following tenders for the supply of electrical stores during year ending March 31, 1903: (Section 1) Wakefield and Co., oils (subject to a satisfactory test of their oil); (2) Willcox and Co., packing, &c.; (3) (a) R. Carr and Co., cast copper terminals, (b) J. Knox and Co., for remaining items of section; (4) De Grelle, Houdret, and Co., incandescent lamps; (5) R. Woods and Co., lamp globes, &c.; (8) (a) R. Carr and Co., cut-outs and service boxes (subject to their making a slight alteration in the design), (b) Henley's Telegraph Works Company, Limited, Franklin ventilating frames; (9) R. Woods and Co., binding wire, &c.; (10) R. Carr and Co., compound; (11) Henley's Telegraph Works Company, Limited, cable and sundries.

London County Council.—The Highways Committee have received the following tenders for the supply of 1,000,000 stoneware ducts required for the electrical cables in connection with the reconstruction for electrical traction of the London County Council tramways. Option was given for firms to tender for the supply of the whole or for any quantity not less than one-fourth of the whole of the ducts required; but with the exception of Messrs. Stanley Bros., Limited, who tendered for 500,000, the tenders received were for the supply of the whole. The tenders were as follows:

				Rate per 1,000 ducts.		
Stanley Bros., Limited, Nuneaton (for 500,000 only)	£9,125	0	0	£18	5	0
G. Skey and Co., Limited, Tamworth	18,250	0	0	18	5	0
H. R. Mansfield, Burton-on-Trent	18,250	0	0	18	5	0
Sutton and Co., Ashby-de-la-Zouch	18,375	0	0	18	7	6
T. Wragg and Sons, Limited, Swadlincote	18,375	0	0	18	7	6
Boothorpe Pipe Company, Burton-on-Trent	19,000	0	0	19	0	0
Ashgrove Brick, Tile, and Fireclay Company, Elland, Yorkshire	20,000	0	0	20	0	0
Ensor and Co., Limited, Burton-on-Trent	20,000	0	0	20	0	0
J. Stiff and Sons, Lambeth	21,000	0	0	21	0	0
Leeds Fireclay Company, Limited (E. Brooke and Sons' Branch), Huddersfield	25,000	0	0	25	0	0
G. Jennings, Limited, Lambeth	25,000	0	0	25	0	0
J. Place and Sons, Limited, Darwen	28,125	0	0	28	2	6
Oates and Green, Limited, Halifax	32,000	0	0	32	0	0
Leeds Fireclay Company, Limited W. Ingham and Sons, Limited, Branch), Wortley	32,000	0	0	32	0	0
Albion Clay Company, Limited, Burton-on-Trent	35,000	0	0	35	0	0
Hamblet's Blue Brick Company, Limited, West Bromwich	36,458	6	8	36	9	2
Sharp, Jones, and Co., Parkstone, Dorset	37,500	0	0	37	10	0
H. Tugby and Co., Limited, Ashby-de-la-Zouch	41,666	13	4	41	13	2

The committee have recommended that the respective tenders (a) of G. Skey and Co. for the supply of 500,000 ducts for the sum of £9,125, and (b and c) of Stanley Bros. and H. R. Mansfield, each for the supply of 250,000 ducts for the sum of £4,562. 10s., be accepted.

BUSINESS NOTES.

TRACTION.

Dornoch Light Railway.—It is announced that this railway will be opened in the first week of May.

Heckmondwike.—The District Council have recently decided to ask for permission to borrow £6,500 for electric traction purposes.

Wallasey.—Mr. H. Jackson, A.M.I.C.E., A.R.S.M., is the engineer-in-charge of the Wallasey electric tramways, just successfully opened.

Shields and Sunderland Tramways Bill.—The Standing Orders Committee of the House of Lords have decided to allow this Bill to proceed.

Croydon.—The local Bench have inflicted a fine of 20s., and 10s. 6d. costs, on an omnibus driver for wilfully obstructing an electric tramcar.

Preston and Lytham Light Railway.—An agreement has been come to between the promoters of the above scheme and the Fylde Rural District Council.

Bath.—The Electric Traction Committee have now formally consented to the overhead trolley system being adopted throughout the proposed new system of tramways.

Haslingden.—Negotiations are proceeding with a view to the purchase by the Haslingden and Accrington Tramways Company of the Church and Clayton sections of the tramways.

Windsor.—With reference to the scheme for a light railway from Windsor to Maidenhead, the public enquiry into the application of the promoters for an order will be resumed on April 8.

Chester.—Owing to the recent great increase in the tramway traffic it is urged that the Corporation should lose no time in considering the question of introducing electric traction on the system.

Metropolitan Railway.—The Metropolitan Railway Company have let the contract for their electrical power station at Neasden to the British Westinghouse Electrical and Manufacturing Company, Limited.

Northfleet.—The local authority are compelling the British Electric Traction Company to place the cables for the tramways under the roads. The company wished to put them under the margin of the pavements,

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Wimbledon.—The draft agreement between the Urban District Council and the London United Tramways Company with reference to the construction of electric tramways in the town has been approved by the Council.

Littleborough.—The District Council have approved the appointment of Mr. James Moore, C.E., as valuer of the tramways undertaking on behalf of the local authorities interested in the acquisition of the tramways.

Finchley.—The Urban District Council have decided to lodge objections against the proposals of the Middlesex County Council for a light railway between the boundary of the district with Hornsey and Totteridge-lane.

Royton.—Mr. R. P. Wilson, of London, has been appointed engineer for the purpose of carrying out the tramway and electric lighting schemes as recommended by the Joint Committee of the Royton and Compton Councils.

Yarmouth.—Mr. F. L. Turner, traffic superintendent to the Corporation of Blackpool, has been appointed traffic manager of the new electric tramways, at a salary of £150 per annum, rising by annual increments of £10 to £200.

Anglo-Argentine Tramways Co.—The directors of this Company have decided to declare a final dividend of 2s. per share, which, with the interim dividend of 2s. per share paid in October last, will make 4s., or 4 per cent. for 1901.

North Metropolitan Tramways Bill.—This Bill was read a second time in the House of Commons on Tuesday after some discussion, during which it was stated that the directors of the company had agreed to an "all-night" service.

Crewe.—At a ratepayers' meeting on Tuesday night a resolution in favour of the Town Council's scheme for a light railway from the station through the centre of the town to the west end at a cost of £35,000 was lost by 207 votes to 116. A poll was demanded.

City and South London Railway.—A breakdown occurred on this line on Saturday morning owing to a failure of the current. Several trains were detained for a short time in darkness in the tunnels, and in some cases passengers got out and walked to the nearest station.

Flamborough and Bridlington Light Railway.—The Light Railway Commissioners have now granted an extension of six months to the promoters of the Flamborough and Bridlington light railway on condition that at the end of that period the promoters are in a position to carry out the order.

Mexborough and Swinton Tramways Bill. — This Bill has come before the Standing Orders Committee of the House of Lords on the report of the Examiner of Private Bills of non-compliance with the Standing Orders. The committee agreed to dispense with the Standing Orders, and allowed the Bill to proceed.

Dover.—Sir William Crundall and other local gentlemen are promoting electric light railway schemes to connect Dover with outlying districts as far as St. Margaret's Bay on the one hand and Alkham and Kearnsey on the other. The Light Railway Commissioners will hold a local enquiry into the matter about the middle of April.

Newcastle Tramway Bill.—The Standing Orders Committee of the House of Lords have allowed the Newcastle-upon-Tyne Corporation Tramway Bill to proceed, the portion of the Bill having reference to tramways outside the borough having been withdrawn, owing to the consent of the local authority not having been obtained.

Private Bills.—In the House of Lords the Newcastle-upon-Tyne Corporation Tramways Bill and the Birmingham and Midland Tramways Bill have been read a second time. In the Commons the following Bills were read a second time: Cornwall Electric Power, Erdington Tramways, and the Middlesex County Council Tramways Bills.

Ayr.—Delay in the progress of the extension of the Corporation electric tramways to Burns Monument has been caused on account of the half of the rails not being delivered. There is a good deal yet to be done in all departments of the work, and the opening, which was expected for the end of this month, will, it is said, have to be postponed for six weeks or two months.

A Life-Saving Device.—A Berlin correspondent says that a device invented by Mr. Karl Froscheck for preventing people being run over when knocked down by an electric tramcar has been tested in Berlin and found satisfactory. "By means of a revolving cylinder in front of the car," the message reads, "the person knocked down is gently pushed aside without injury or bruising."

London County Council Tramways Bill.—The Standing Orders Committee of the House of Lords have decided to allow this Bill to proceed, subject to the tramways respecting which the examiners have found that the Standing Orders have not been complied with being struck out. The full list of the lines rejected and those to be constructed under this Bill was given in our last issue.

Leeds.—A complimentary dinner has been given to Mr. J. B. Hamilton, the new general manager of the Leeds Corporation tramways, by his late colleagues of the Glasgow Corporation tramways. Before taking up his new duties Mr. Hamilton will spend a few weeks in America, in order that he may make himself fully acquainted with the working of the electric tramways in the States.

Cardiff.—Notice of motion has been given for the next meeting of the Town Council to the effect that the question of running the tramcars on Sundays, as involving a case of Sunday labour, be referred to the ratepayers for decision A satisfactory trial of one of the new electric cars was made over the Newport-road and Queen-street sections on Tuesday, under the direction of Mr. A. Ellis, the electrical engineer.

Matlock.—It was announced by the Chairman at a meeting of the members of the District Improvements Association last week that he had been approached by the engineers of the proposed light railway scheme between Sheffield and Bakewell with regard to the suggested extension to Matlock. The matter was referred to a committee with full power to take what steps are deemed necessary in the interests of Matlock.

Manchester.—The Corporation Tramways Committee on Tuesday entered into contracts for the supply of various materials required in the department to the aggregate value of nearly £118,000. The contracts included one for a supply of iron and steel work for the new car-shed in Hyde-road, 5,000 tons of granite setts for the permanent way, 6,000 tons of steel rails, 225 car trucks or under-carriages, and 205 electrical equipments for cars.

Hull.—It is stated that the deputation representing the Hull Tramways Committee which visited Newcastle to inspect the new lifeguards on the trams in accordance with the suggestion of the Board of Trade, have not been satisfied with the working of the new lifeguards, which were claimed to be a great improvement on the system in Hull. It is further reported that several new devices are to be tried on the Hull trams before any particular lifeguard is adopted.

Liverpool.—The tramway receipts for the fortnight ended March 8 were £17,708. 4s. 6d., as compared with £15,787. 6s. 2d. in the corresponding period of last year, being an increase of £1,920. 18s. 4d. The mileage run was 439,397, against 389,982 last year, an increase of 49,435 miles. The passengers carried during the fortnight numbered 3,835,979, as compared with 3,430,497 in the same two weeks of last year, an increase of 405,482. On the service there were 373 electric cars and six horse vehicles.

Dundee. — The Fairmuir section of the Corporation electric tramways, which has been under reconstruction for a considerable time, is now within sight of completion, and it is fully expected that the electric cars will be running on the route by May. An improved service on the Seagate and Blackness-road tramway routes has been established. A double line of rails has been put down in Seagate, so that full advantage can now be taken of the route without the inconvenience of working on a single line.

Liverpool Fatality.—An inquest was held by the city coroner on Saturday relative to the death of a little girl of six years who was knocked down by an electric car. She fell under the lifeguard, and it was impossible to extricate the body until the car was raised from the ground with screwjacks. It was then found that the child was dead. The jury returned a verdict of accidental death, and exonerated the driver from blame. They also recommended that the shelf lifeguard be speedily removed from all the cars and another kind substituted.

Hounslow.—The Light Railway Commissioners (Lord Jersey, Colonel Boughey, and Mr. Stewart) held an enquiry here on Wednesday week into the application of the London United Tramways Company for orders in respect of three new lines, to two of which there was considerable opposition—viz., those between Southall and Hounslow, and between Hampton and Sunbury Cross. Eventually, as a result of this opposition, these two lines were dropped, and only the third proposal for a line between Sunbury Cross and Hanworth was passed.

Corwen.—A scheme for constructing a light railway from Corwen to Bettwsycoed has been set on foot by a number of prominent persons in the neighbourhood of Cerrig-y-druidion. It is now announced that a syndicate of London gentlemen have offered to take the preliminary steps necessary to bringing the matter before the Light Railway Commissioners if the localities interested will contribute a sum of £300 towards the expenses. A largely-attended meeting was held at Cerrig last week, and it was unanimously decided to support the scheme.

Exeter.—The Electric Tramways Bill promoted by the company in opposition to the Council came before the Standing Orders Committee of the House of Lords on Thursday week, when it was agreed to allow the Bill to proceed on the condition that that part of the scheme relating to the tramways within the boundaries of the city be struck out. The effect of this is that the company are only allowed to construct the short lengths of line from Mount Pleasant to Pelsloe Bridge, from Heavitree Hill through Heavitree, and the small piece at Alphington.

Bradford.—It is expected that the Cheapside route of the city tramways, which has been in process of construction for some weeks, will be completed by the end of the present week. A frequent service of cars will then be run through from Forster-square to Frizinghall. The Shipley District Council are laying down the remainder of the section through their district, but the lines will not be ready for use before May 1. The cars will then be run by the Bradford Corporation, and the price to be paid to Shipley for electric current will be settled by arbitration.

Glasgow.—On Saturday evening an exciting accident occurred here on the tramway up the steep incline leading to Cathedral-square. A Springburn car had just passed George-street corner, when the trolley jerked off the overhead conductor. The driver immediately applied his brake, but the car gradually slipped down the incline, increasing its speed as it went. The car was full of passengers, many of whom jumped or fell into the street. Ultimately it collided with an up-coming car, the driver of which had fortunately locked his brakes in full time to bear the impact without material damage.

Birmingham and Midland Tramways Bill.—The Standing Orders Committee of the House of Commons had appointed to meet Tuesday for the purpose of considering whether they would concur with the decision of the Standing Orders Committee of the House of Lords and allow the Birmingham and Midland Tramways Bill to go before a Select Committee for enquiry on merits on condition that the assent of the Oldbury Town Council to the Bill was proved before the committee. A quorum for the Standing Orders Committee, however, could not be obtained, and the hearing was postponed till Friday, April 11.

Aberdeen.—The effect of the dislocation of the tramway system owing to the operations going on in connection with preparing the lines for the electric cars is shown by a falling off in the traffic returns. A statement of the drawings shows these receipts to have amounted to

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£543. 16s. 9d. last week, being £35. 7s. 7d. less than the takings of corresponding week last year. It has been decided to extend the existing car-shed in order to make room for the increasing number of cars being brought into use. In connection with the conversion of the Rosemount section to electric traction, the Tramways Committee have decided not to double the lines turning into Rosemount-place.

Manchester-Salford Tramways.—It is claimed that by the agreement arrived at between the Manchester and Salford Corporations with reference to the interchange of tramway traffic, Manchester has suffered defeat. One of the main objects of the Manchester Bill was to obtain running powers over Bury New-road to Prestwich, and to extinguish the right of the Salford Corporation to purchase the carriage company's tramway in Bury Old-road. The effect of the agreement just come to is said to be that Manchester will have to relinquish all powers as regards Bury New-road, and find some other route if they intend to run a tramway to Prestwich, which was the original idea.

Stanmore.—A curious resolution was adopted at the last meeting of the Parish Council. It was to the following effect: "That this meeting is of opinion that if the Middlesex County Council apply once more for leave to bring a light railway through Stanmore, a protest should be addressed to the Light Railway Commissioners, pointing out that this parish feels very strongly that the matter ought not to be forced upon them for the third time in less than two years, and respectfully request the Commissioners not to grant a further hearing of the application within so short an interval." The feeling is that the parish ought not to be compelled to go to the expense of opposing these continued applications.

Wigan.—A copy of the regulations proposed to be made by the Board of Trade with respect to the use of electric power on the overhead trolley system on the tramways is now in the hands of the Tramways Committee. The committee have agreed that a bogie car with four motors and covered top be ordered from Messrs. Dick, Kerr, and Co. A letter has been received from the "Never-Wet" Seat Company offering to give a three months' free trial of their patent seating on one of the Corporation cars. The offer has been declined. Mr. T. Lymm has been appointed assistant engineer at the electricity works. In consequence of a report of a sub-committee describing his action as "irregular" and "improper," Mr. Thomas Worthington, J.P., chairman of the Tramways Committee, has resigned his position as town councillor.

Bournemouth.—It was reported at the last meeting of the Town Council that the Poole and District Electric Traction Company have commenced an action for an injunction to restrain the Corporation from proceeding with the tramway in the Christchurch-road, on the ground that they have not made a substantial commencement of the line before the expiration of one year from the date of the order. The Corporation have entered a defence of the suit. An enquiry was held at the Board of Trade, before Sir Herbert Jekyll, last week, with respect to the application of the Corporation for powers to construct a tramway along Parkwood-road and Woodside-road, Pokesdown, terminating at the Sea-road. The inspector intimated that he was not prepared to give his decision that day, but the evidence would be carefully considered, and the decision forwarded in due course.

London-Brighton Electric Railway.—The Bill to authorise the construction of a high-speed electric railway between London and Brighton is "dead"—for this session, at least—the Standing Orders Committee having declined to dispense with the Standing Orders. In connection with this matter, Mr. Forbes, chairman of the London, Brighton, and South Coast Railway Company, is reported to have said in an interview with a member of the daily Press: "In the next session of Parliament we shall apply for powers to construct electric generating stations upon our system for the diffusion of electric power all over it. Our object in applying for these powers is just this—that as soon as ever a commercially practicable system is discovered, we may adopt it without any delay and without its being then necessary to seek for any powers. It is a precautionary measure so that we may be ready."

Motor Regulations.—Three resolutions on the subject of motorcar regulations have been passed by the executive council of the County Councils' Association. The first resolution set out that the council did not regard the committee's suggestion of a number on the car as essential if a name or any other means of identification might be desirable, and suggested that the Local Government Board should appoint a committee to obtain full information to enable them to decide on the means of identification. The second resolution expressed the opinion that Mr. Long's suggestion of giving increased authority to the police in regard to traffic was a valuable one. The third resolution was as follows: "That the executive council consider that the penalty for furious driving should be raised in the case of a second conviction to a fine of £50, and that the Court should have the option of passing a sentence of imprisonment."

Central London Railway Precautions.—The management of the Central London Railway, who have already decided to gradually supersede the existing locomotives by motors contained in the cars themselves have now placed in hand the fireproofing of the trains of the new type. The compartments in which the controlling and driving mechanism is contained have been lined with steel and asbestos, and the floors have been covered with iron, while a fireproof screen has been fixed between the "cab" and the body of the car. An ingenious cut-off device has also been installed, by which the current will be automatically switched off from the train at the moment that an irregularity occurs. To provide against every emergency, the planking laid between the rails will be painted dead-white, so that in case the passengers are obliged to walk from a disabled train to the next station their way will be clearly indicated.

London Underground Railways.—The appointment is announced of a Select Committee of the House of Lords to consider the London Underground Railway Bills before Parliament this session. Fourteen of the Bills which were deposited at the commencement of the session now remain—viz., the Charing Cross, Hammersmith, and District Electric Railway (two Bills), City and North-East Suburban Electric Railway (two Bills), King's-road Railway, King's-road Railway (Putney Extension), North-East London Railway (two Bills), Piccadilly and City Railway (two Bills), West and South London Junction Railway, London United Electric Railway, Brompton and Piccadilly-circus Railway (New Lines, etc.), and the Central London Railway (New Lines). Lord Windsor is chairman of the committee, and the other members are the Marquis of Bath, Earl Lauderdale, Viscount Knutsford, and Lord Zouche of Haryngworth. The committee will sit immediately after the Easter recess.

London County Council Subways.—The London County Council (Subways and Tramways) Bill has been read a second time in the House of Commons. Reporting on this at the meeting of the Council on Tuesday, the Parliamentary Committee explained that in addition to the proposed subway for tramways under the new street from the Strand to Holborn, it was also originally sought in the Bill to obtain a general power, subject to strong limitations, to make subways in streets for the reception of pipes and wires, and to work tramways therein. These proposed general powers, however, gave rise to considerable opposition on the part of persons who considered that their interests might be prejudicially affected by the exercise of such powers, and after consultation with the Highways Committee the Parliamentary Committee thought it advisable to arrange for the withdrawal of these clauses, and the Bill was read a second time on the understanding that the clauses in question would be omitted from the Bill at the proper stage.

Middleton.—The Board of Trade inspection of the newly constructed tramways here was made on Friday, by Major Druitt for the permanent way, and Mr. Trotter for the electrical equipment. The lines have been laid down by the Middleton Electric Traction Company, and consist of about 8½ miles of track. The Corporation, however, are supplying current for the working of the cars. The new tramways connect Middleton (1) directly with Rochdale, through Castleton; (2) with Oldham, through Chadderton; and (3) with Prestwich, through Rhodes. These three routes radiate from Middleton as a centre, and at their termini connect with important systems completed or to be completed. The Prestwich section runs nearly to Heaton Park, where eventually the Manchester trams will meet the company's system. This will form a through connection from Manchester to Rochdale, and it may be mentioned that eventually there will be direct connection also from Manchester to Middleton, *via* Blackley, when the extension now being constructed by the City Corporation, for the Middleton Corporation, is completed.

Auckland Electric Tramways Co.—This Company have this week made issue at par of 28,503 ordinary shares of £10 each. The company was formed in March, 1899, with a capital of £300,000, to acquire from the British Electric Traction Company, Limited, certain horse tramways, about 7½ miles in length, in Auckland, New Zealand, and they have since acquired certain rights obtained by the New Zealand Electric Light and Traction Company, Limited, in connection with the electrical equipment and tenure of these tramways, together with extensions within the city of about 2½ miles in length. An order for extension of the lines in the suburbs of Auckland, consisting of about 8¼ miles, and to be worked electrically, has been obtained by the local authorities, who have delegated their powers to the Company, making the total route length over 18 miles. It is estimated that the net profits when all the tramways are in full operation will amount to £36,000 per annum, and the directors are of opinion that £22,000 of this should be available for dividend on the present share capital. The whole of the present issue has been underwritten by the British Electric Traction Company at a commission of 5 per cent.

Tramways in Kent.—The Croydon and District Electric Tramways Bill has been before the Standing Orders Committee on the report of the examiner, stating that with respect to Tramway No. 23 (Thesiger and Kent House roads) the Standing Orders of the House had not been complied with. A petition was presented by the promoters, asking that the Standing Orders might be dispensed with, and that Tramway No. 23 might be allowed to proceed, provided they obtained the consent of the necessary road authorities before the Bill reached the committee stage. A counter-statement of the Beckenham Urban District Council was presented in opposition, objecting on general grounds to the introduction of tramways into their district, but should it ultimately be found necessary or expedient that tramways should be authorised, they, as the local authority, were prepared to undertake the construction thereof, and they had already prepared a scheme with that object. The Council further stated that they were the owners of the electric light undertaking, with a generating station in the centre of their district upon which they had spent £60,000, and that this would be available for the supply of energy to the tramways when constructed. The committee eventually decided that the Bill be allowed to proceed on condition that Tramways Nos. 23 and 24 be struck out.

London County Council.—At the usual weekly meeting of the Council on Tuesday, the Highways Committee recommended the acceptance of three tenders for the supply of stoneware ducts for electrical cables in connection with the reconstruction of the southern tramways—viz., those of Stanley Bros., Limited; G. Skey and Co., Limited; and H. R. Mansfield. The three firms in question tendered at the rate of £18. 5s. per 1,000 ducts, and as will be seen from the full list in our "tenders" columns, the highest tender received was at the rate of £41. 13s. 2d. per 1,000 ducts. The committee explained in their report that as the rate per 1,000 in each of the three first-named tenders was the same, they thought it desirable that each of the three firms should supply a portion of the number of ducts specified. Under this arrangement each of the three firms would be delivering a supply of ducts at the same time, and the work of laying them would thus be expedited, which is a consideration of great importance. With reference to the undertaking of the South-Eastern Metropolitan Tramways Company, which was purchased by the Council on Jan. 21 for

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£50,000, the Highways Committee reported that arrangements had been made for the Council taking over the undertaking at midnight on March 31, and from April 1 the tramways would be worked by the Council. The following report was presented by the Parliamentary Committee: "We are giving our most careful consideration to the numerous proposals now before Parliament for the construction of tube railways in London and contained in 26 Bills, which include nine Bills suspended from last session. We have appointed a special sub-committee on the matter upon which we have the assistance of members of the Highways and Housing of the Working Classes Committees, and we hope to be able to report fully to the Council on the whole subject after the coming recess. We think it desirable, however, at this stage to call attention to the following paragraph (19) in the report made by the Joint Committee of Parliament of 1901 on London underground railways: 'The question of underground railways in London and the suburbs and of their working is so complicated, and of such importance, from a financial as well as traffic point of view, that the committee are disposed to agree with the views of the Corporation of London and the London County Council, that in some way there should be a more direct control and supervision of all projects for such underground railways. Whether this should be effected by the supervision of some public department as the Board of Trade, or by some body like the Light Railways Commission, or by a joint committee of members of both Houses of Parliament, appointed at the beginning of each session, to consider all projects affecting the relief and distribution of traffic in or near London, is a question which appears to them to deserve serious consideration.' So far as the Council is concerned, every effort has been made with a view to some action being taken in the direction indicated by the Joint Committee. We have communicated with the President of the Board of Trade, and a deputation from the Highways Committee which waited upon him on the subject of shallow underground tramways also adverted to the matter, and we gather that the President of the Board will give favourable consideration to the question next session. In the meantime some of the schemes now before Parliament have been referred to a Select Committee, and the remaining ones will probably be similarly referred, to be dealt with as ordinary private Bills. In referring to the report of the Joint Committee of 1901, we may remind the Council that the question of the construction of shallow underground tramways was dealt with in paragraph 22 of the report. This will be of interest in view of the second reading of a Bill (referred to above) which the Council is promoting in the present session for the construction of such a tramway."

LIGHTING AND GENERAL.

Removal.—Mr. William Fairley, C.E., has removed from 53 to 69, Victoria-street, S.W.

Alnwick.—The Urban District Council are corresponding with the Northern Counties Electricity Supply Company, Limited.

Kingston.—The resolutions adopted at the recent town meeting have been referred to the Lighting Committee for consideration.

Kinning Park.—On Monday Mrs. Dreghorn inaugurated the electric lighting for the burgh by switching on the supply for two streets.

Glossop.—The Town Council are urging the Urban Electric Supply Company, Limited, to begin the work in connection with the electric light scheme.

St. Albans.—It appears that the delay with regard to the electric lighting is caused by the illness of the counsel whom the Town Council are consulting.

Removal.—Messrs. Bennett and Ward-Thomas, consulting electrical engineers, have removed their offices to Winter's-buildings, St. Ann's-street, Manchester.

Lowestoft.—Mr. J. C. Pottinger has held an enquiry into the application of the Town Council to borrow £7,143 for works connected with the electric lighting undertaking.

Pacific Cable.—The cable steamer "Anglia," engaged in the laying of the Pacific cable, has reached Doubtless Bay, thus completing the laying of the Australia-New Zealand section of the line.

Direct United States Cable Co.—The directors announce an interim dividend of 3s. per share, free of income tax, being at the rate of 3 per cent. per annum for the quarter ending March 31.

Darlington.—The Darlington Forge Company are altering and extending their already extensive works, and a large building is being erected by them for the reception of two 75-ton electric cranes.

Tipton.—A Bill confirming the provisional order which has been granted to the Tipton Urban District Council enabling them to supply electricity for lighting purposes within their district has been read a first time.

Leeds.—At the meeting of the Associated Chambers on Tuesday it was stated that the Postmaster-General had said that when an underground telegraph wire from London should be laid it would come through Leeds.

Lancaster.—At the annual meeting of the Lancaster and District Chamber of Commerce on the 20th inst., a resolution was passed urging upon the Lancaster Corporation the pressing need for a muncipal telephone service.

Coronation.—We have been asked to state that Mr. G. Braulik, Upper Thames-street, E.C., is making special arrangements for the manufacture of devices, letters, and crowns in incandescent lighting for the Coronation.

Medomsley.—The Council having decided to take steps to have the village lit by electricity instead of gas, have asked the Consett Iron Company whether they are prepared to supply current for Medomsley, and upon what terms.

Agency.—Messrs. Paterson, Cooper, and Co., Limited, electrical and mechanical engineers and contractors, Patella Works, Paisley, have opened an office at 57, Gracechurch-street, E.C., in charge of Mr. J. Walter Brown, A.M.I.C.E.

Petworth.—Lieut.-Colonel Simpson, Mr. Maybank, Mr. Nevatt, Mr. Weeks, and Mr. Whitcomb have been appointed as a Lighting Committee to make enquiries into the subject of what system of lighting would be best for the town and report to the Council.

Electric Motors.—The concluding meeting of the winter session of lectures under the auspices of the Bradford Scientific Association was given on Friday by Mr. Herbert A. Jones, who read a paper on "Electric Motors, with special reference to machine driving."

Surbiton.—The Board of Trade have passed the agreement between the Urban District Council and Callender's Electric Lighting and Cable Construction Company, and that the Local Government Board have also sanctioned the borrowing of the money for carrying out the scheme.

Ipswich.—Three members of the municipal corporation of Ipswich were in Edinburgh on Monday enquiring into the system of the electric lighting of the city. Representatives of the Town Council's Electric Lighting Committee afforded the deputation every assistance, and afterwards entertained them to luncheon.

Bridlington.—The Parliamentary and General Purposes Committee of the Town Council have authorised the employment of a consulting electrical engineer, who, in conjunction with the borough surveyor is to prepare plans, specifications, and estimates with a view to application to the Local Government Board for sanction to the borrowing of the money required to carry out the works authorised by the order.

Aston.—The District Council have received 351 tenders for the erection of a generating station and cables for the electric lighting of the district and the electrical equipment of the tramways, of which nine, representing in the aggregate a sum of £62,970, have been accepted. The site of the proposed station is on the Old Wharf at Chester-street, which adjoins the fire station, this spot having been reserved some time ago for the purpose.

St. Andrews.—A deputation of the Town Council has been in London during the past week adjusting terms of an agreement with Messrs. Crompton and Co., the promoters of the order, as to the terms upon which the public lighting of the city was to be undertaken. In the order there was a maximum of 6d. per Board of Trade unit, but the deputation arranged that the lighting of the streets and public buildings should not exceed 3d. per Board of Trade unit. There being no opposition, the order is expected to pass during the ensuing month.

Hanley.—At a meeting of the Town Council on Tuesday the Electric Lighting Committee reported that the accounts for the past year showed a gross profit of £4,352. 3s., out of which £2,156. 6s. 1d. had been paid for interest, and £2,148. 4s. 5d. for sinking fund charges, leaving a net profit of £47. 12s. 6d. The sinking fund now stood at £10,167. 19s. 8d. The committee recommended that application be made for sanction to borrow £12,000 for extensions of mains and generating stations, provision of transformers, motors, instruments, meters, and general stores. The report was adopted.

Ripon.—An active interest is being aroused in Ripon over the introduction of the electric light and the absence of any definite action by the Corporation to put in force the powers obtained under provisional order, which will expire in July, 1903. The City Spa and Improvement Association have taken the matter in hand, and it is urged that the city is eager and ready for the electric light, and as a municipal installation is probably impracticable, arrangements should be made for the purchase of electricity in bulk, as it is unlikely the Board of Trade will grant an extension of existing provisional orders.

Stourbridge.—At a recent special meeting of the Urban District Council a report was presented by the Destructor and Electric Powers Committee on the electric light question, which was considered in committee. It was subsequently stated that the committee had opened negotiations with the British Electric Traction Company for the purpose of endeavouring to obtain from them a proposal for taking over the Council's electric lighting order. The committee asked the Council to give the authority to continue those negotiations, and they would report further. A resolution was passed empowering the committee to pursue the negotiations with the British Electric Traction Company or any other company.

Newcastle.—Several of the principal thoroughfares of Newcastle, including Northumberland-street, New Bridge-street, Blackett-street, Pilgrim-street, Mosley-street, part of Westgate-road, and Grainger-street were greatly improved in appearance last week by the lighting of the new electric lamps, placed in the centre, of those thoroughfares. Eighty arc lamps, each of 1,200 c.p., were switched on at the power station by Mrs. Barker Ellis, wife of the chairman of the Lighting Committee of Newcastle Corporation. Arrangements have been made for the lamps to be lighted each night during the present month at a quarter-past six o'clock, each alternate lamp to be turned off at midnight, the others at a quarter to six each morning.

Newmarket.—The Town Committee submitted to the Urban District Council on Tuesday tenders from the electric light company for the public lighting of the district for a period of three years from Sept. 1 next. There were two schemes. Under the first, the company offered to replace each of the existing gas lamps with a 32-c.p. electric incandescent lamp, and to keep 226 lamps burning 1,965 hours per annum, and 28 burning 3,880 hours, as required by the Council, for £967. 15s., the price to be inclusive. As an alternative they proposed that 16 arc lamps of 2,000 c.p. each be placed in the High-street, and that the rest of the district be lighted with 218 32-c.p. lamps. For this scheme, which offered a candle-power of 39,000, the Council's tender was £1,003 per annum inclusive. It was decided to adjourn the consideration of the matter to April 4.

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Perth.—The resident engineer's scheme for extending the cable to Bridgend, Dalhousie, and Glasgow-road, at a cost of about £2,500, has been adopted by the Electric Lighting Committee. The recommendation will come up for confirmation at the next monthly meeting of the Town Council.

Hamilton.—The Electric Lighting Committee have entered into an arrangement with Messrs. Edmundson's Electricity Corporation, Limited, to supply electricity to the burgh. We understand that the Corporation have the option to purchase the installation and plant at the end of five or ten years.

Middlesbrough.—At the last meeting of the Streets Committee a sub-committee recommended the inclusion of £468. 13s. in the estimates for the installing of the electric light and ventilating fan in the town hall. It was decided that a ventilating fan be fixed, but the question of electric lighting was deferred.

Bath.—At the last meeting of the Town Council the electric street-lighting estimate was approved at the amount of £4,588, being based on £24 per arc lamp. The surveyor (Mr. C. R. Fortune) explained that for electric lighting the estimate last year was £5,138, and the actual expenditure to date was £4,616. 18s. 1d.

Salford.—The special committee appointed by the Council to conduct an enquiry into the alleged electricity scandals, have decided to recommend the appointment of a legal gentleman to conduct the enquiry. A complete enquiry will therefore take place, and all evidence adduced will be given on oath in presence of representatives of the Press.

Wimbledon.—The electrical engineer in his last report upon the electric light undertaking gives the following figures: private lamps applied for in 8 c.p. equivalent up to Feb. 28, 1902, 35,489; street lamps connected, 4,643; street lamps to be connected, 380; total lamps to provide for, 40,517; number of consumers, 677; maximum load reached, 505 kw.

New Tredegar.—The large electrical plant erected at the Elliot Collieries, New Tredegar, was started last week by the Misses Edith, Gertrude, and Mabel Phillips, daughters of Alderman Phillips, J.P., manager of the Powell Duffryn Collieries, New Tredegar. The installation consists of two engines and generators of 25 h.p. each, of the marine type, with five condensing engines.

Croydon.—The Lighting and Electricity Committee have adopted an estimate for next year providing for £7,265 for arc lighting for the streets. In consequence of the coal tenders being more favourable than for the current year, the charge for the arc lamps for public lighting has now been reduced from £21 to £18 per lamp per annum, and the rent of electric current meters has been reduced by one-half.

Presentation.—At a smoking concert held on Thursday last week by the staff of the Bath Corporation electricity works, Mr. A. H. Snewin presented the city electrical engineer, Mr. Francis Teague, with a handsome oak smoker's cabinet, bearing the following inscription: "Presented to Francis Teague, Esq., city electrical engineer, by the staff of the Bath Corporation electricity works, March 20, 1902."

Hammersmith.—At Wednesday's meeting it was reported that since the last Council meeting 11 additional consumers have been connected, representing a maximum of 488 8-c.p. lamps, and during the same period four consumers have been disconnected, and that the present number of consumers taking current from the mains is 981. A number of increases of 5s. per week were recommended to be granted to various members of the staff.

Bedford.—The Electric Lighting Committee have been authorised to obtain 37 meters at a cost of £138. 10s. The public lighting with electricity of Ombersley-road, Aspley-road, and Endsleigh-place is to be proceeded with, and the necessary cable procured for private extensions at an estimated cost of £40. Mr. G. E. Sanders, the shift engineer, having resigned, one of the candidates for the post of engineer was appointed to succeed him.

Cults.—A meeting of consumers and others interested was held in the Cults Public School on Monday to consider what steps it would be most desirable to take in order to secure a continuance of the electric light supply. It was proposed that an offer should be made for the present electric station and plant. Various other suggestions were thrown out, but the prevalent opinion was that it would be inexpedient to make the proposed offer under the circumstances now existing.

Electro-Chemical Industries.—Dr. John Shields last week delivered an address in the Young Laboratory buildings, John-street, Glasgow, on "Electrolytic Process as applied to Metallurgy." After dealing with electro-deposition and the refining of metals, the lecturer passed to an interesting description of the influence of temperature, concentration, and current density, concluding the paper with an explanation of the relation between cost of electric energy and value of products.

New Issue.—The Electric and General Investment Company, Limited, have been offering this week for subscription at par 28,503 £10 ordinary shares of the Auckland Electric Tramways Company, Limited. The company was formed in March, 1899, with a capital of £300,000 in £10 shares, to acquire 7½ miles of horse tramways in Auckland, New Zealand, and subsequently acquired rights of extension, making a total length of 18 miles to be worked electrically. We understand that the subscription of the present issue is guaranteed by the British Electric Traction Company, Limited.

Sudbury.—The Town Council on Friday decided to apply for sanction to borrow £12,000, and to proceed at once with the electric lighting scheme. The borough surveyor (Mr. T. W. A. Hayward) read a report of the Electric Lighting Committee, stating that the committee found that the wiring of consumers' premises could be done in a satisfactory manner, and a good lamp provided at a cost of about 15s. per light. Progress had been made as regarded the preparation of plans, specifications, etc., by Mr. Hawtayne and the borough engineer. The borough engineer having submitted to the committee a plan of the site with the buildings shown thereon, the committee had approved it, and directed him to proceed with the work.

Scientia Series.—We beg to acknowledge receipt of Nos. 13 to 18 of this splendid series of booklets descriptive of the latest scientific developments. They are: "Cryoscopie," by F.-M. Raoult; "Franges d'interférences et leurs applications métrologiques," by J. Macé de Lépinay; "La géométrie non euclidienne," by P. Barbarin; "Le phénomène de Kerr," by E. Néculcéa; "Théorie de la lune," by H. Andoyer; "Géométrographie," by E. Lemoine. All the volumes, which are well furnished with drawings, designs, diagrams, and formulæ, are uniform, and are published by the well-known scientific publisher, M. C. Naud, 3, Rue Racine, Paris.

Glasgow.—The Electricity Committee have received a long report from Mr. Chamen, in consequence of which the committee recommend the purchase of two new engines of 2,400 h.p. each and relative dynamos, with six boilers and accessories, to be put down in Pollokshaws-road station; that additional feeders be laid down in Abbotsford-place, South Portland-street, and over the Suspension Bridge; that the offer of Messrs. Willans and Robinson for providing the two engines at £24,074 be accepted on the condition that the 11 engines and certain dynamos in the Waterloo-street station be purchased by them at £8,035; that tenders for the plant required to meet the requirements of next winter be advertised for; and that the Waterloo-street station be abandoned. Consideration of the report has been deferred.

Kent Electric Power Bill.—A committee of the House of Commons, of which Colonel Welby was the chairman, have found the preamble of the Kent Electric Power Bill proved. The object of the Bill is to supply electric power in the administrative part of the county of Kent, and it is anticipated that it will afford assistance to local authorities in carrying out provisional orders. Generating stations are to be erected at Canterbury, Tonbridge, and Rochester, a proposed fourth at Dover having been abandoned owing to opposition. Mr. S. Z. de Ferranti gave evidence in support of the Bill, stating that the maximum price was 4d. per Board of Trade unit, with a sliding scale down to 3d. per unit. There was no opposition, as the points objected to by the local authorities had been withdrawn in consequence of the conference recently held at Westminster.

Whitehead.—At a recent public meeting of ratepayers the following resolution was carried: "That we take steps to promote a limited company for the lighting of Whitehead with electricity; that application be made to the County Council to strike a rate to cover the cost of the public lighting of the place; that we make arrangements with a firm of electrical engineers to lay down the necessary plant with as little delay as possible, and that a guarantee fund be opened to guarantee the preliminary expenses." Mr. M'Vea seconded the motion, which was passed unanimously. The following were appointed as a committee in charge of the matter: Messrs Thomas Bell, A. E. MacFarlane, N. J. Ledgerwood, J.P., R. J. Blakeley, J.P., J. M'Vea, J. E. Magill, J. Adams, D. Barbour, James Waterson, John M'Loughlin, and Otto Wiesener, with power to add to their number.

Hull.—A new feeder main is to be laid at a cost of £578. It has been decided to remove the two steam dynamos and their switchgear from the Dagger-lane station to the Sculcoates-lane station, and four transformers and switchgear are to be purchased in substitution of this plant. Sanction has been received to the expenditure of £47,900 on the Sculcoates-lane works, with respect to which an enquiry was recently held. The engineer in his last report states that a sum of £15,000 is required for the following works: Dagger-lane sub-station, four transformers and switchgear, £3,368; Earle's-yard sub-station, four transformers, switchboard and connections, and overhead travellers, £3,204; mains, high-tension feeder from Sculcoates-lane works to Earle's-yard, £6,000; low-tension distributors and feeders in Earle's-road, Sculcoates-lane, Prince's-road, and Commercial-road, £2,022; contingencies, £406.

Swansea.—The total expenditure in connection with the electricity undertaking of the Corporation to Feb. 28, 1902, was £59,510. 0s. 10d. The engineer in his last report states that the number of consumers connected to the mains is 173, and that 24 others have applied to be connected, the total being equivalent to 22,696 8-c.p. lamps, including public arcs and incandescents. The equivalent of 978 8-c.p. lamps were applied for during the past month. A committee has been appointed to approach the Great Western Railway Company, in view of the possible acquisition by the Corporation of land, the property of the company, situate behind the electricity station. The town clerk has notified the National Telephone Company that the Council desire to terminate all the existing agreements with regard to wayleaves. A canvass is being made by circular for subscribers to the proposed municipal telephone service.

Copper.—The Central News states that Mr. Schwab and othe capitalists have purchased the controlling interest in the Canadian Copper Company, and also a large interest in the Nickel Corporation, London. The purchasers propose to form a holding company with a capital of £9,000,000 to cover these interests and those of the Orford Copper Company. The Rio Tinto Company have kept regularly going for the last 18 years, giving employment to at least 500 men, and producing weekly the large amount of 500 tons. Recently the management of the Cwmavon copper mines found that by a new scientific process the precipitate could be calcined at their mines in Spain. This would necessarily reduce to some great extent the cost of copper, as the dross from the ore could be left at the mines, instead of the ore being conveyed from the mines to the works at Cwmavon. Accordingly the directors of the company have caused works to be erected in Spain, and owing to this arrangement 120 men have been discharged at the Cwmavon works, with a likelihood of another 100 being dispensed with at an early date.

Hendon.—The Urban District Council, in answer to questions put by a ratepayer, have decided to reply that their application for electric

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lighting was for sanction to borrow £36,400. The Council had, however, conciliated the authorities of the Mill Hill Grammar School, who had threatened opposition to the scheme, by pledging themselves to a further expenditure of £5,910 in order to carry the current to the school; therefore, the total amount would come to £42,310. The Council hoped to utilise the light for public lighting if advised that such a course would be economical. It is thought that no further loan will be necessary. It was proposed to combine a dust destructor with the generating station, for which an additional loan would be required, but the dust destructor would reduce the cost of the generating station. Tenders had been provisionally accepted to the extent of £23,689. 15s., but it was open to the Council to vary the amount of the tenders. The Council did not anticipate any loss once the scheme was in working order. The Council, further, were of opinion that it was impossible to defer the scheme. Every effort had been made to extend the time, and a further application for extending the time was now under the consideration of the Board of Trade.

London Gazette.—An adjudication order has been made out in the estate of G. H. Redgrave, electrical engineer, lately carrying on business at 53, Regent House, Regent-street, London, but whose present address is unknown.—The last day for receiving proofs in the estate of G. J. Lloyd (trading as G. J. Lloyd and Co.), lately carrying on business at Castle Mill-street, Bristol, is March 31. Mr. H. W. Freshwater, Brighton-chambers, St. Stephen's-avenue, Bristol, is trustee.—A receiving order has been made out in the estate of L. Bayliss (carrying on business as Cordwell and Co., and as the Thames Electrical Manufacturing Company), electrical accessories manufacturer, carrying on business at Brunswick Park-road, Wednesbury, as F. Terrell and Co., at Riding-lane, Wednesbury, in the partnership firm of Lewis Bayliss and Co., and at 110, Cannon-street, E.C., as Cordwell and Co., and at 1 and 2, Bucklersbury, London, as the Thames Electrical Manufacturing Company, on debtor's petition.—The last day for receiving proofs in the estate of H. D. McIntyre (trading as the Glanamman Colliery Company), electrical engineer, Glanamman Colliery, Glanamman, Carmarthenshire, is March 29. Mr. A. B. Davies, 58, Wind-street, Swansea, is trustee.—A first and final dividend of 5½d. per pound has been declared in the estate of W. V. Scott, electrical engineer, lately residing at Shaftesbury-road, East Hammersmith, payable any day (except Saturday) between 11 and 2 at Bankruptcy-buildings, Carey-street, W.C.—The estate of T. A. Flather, electrical engineer, 406, Meanwood-road, Leeds, is released from trusteeship.

London County Council.—At the usual weekly meeting of the Council on Tuesday, it was agreed to lend the Hammersmith Borough Council £7,295 for electric light installation. Sanction was also given to a loan of £4,873 to the Islington Borough Council for electric light installation. Regulations in regard to the electric lighting and heating arrangements at theatres, houses, rooms, and other places of public resort within the administrative county of London were approved. Attention was drawn to a serious settlement at the Blackwall tunnel electric lighting station. The ground on which the station stands is of a very inferior character, with a great depth of peat and peaty mud, and during the construction of the station in 1896-7 it was found necessary to pile the foundations under the walls. On the night of March 11 the foundations of the wall between the boiler and dynamo rooms sunk 1½in. in a few hours, with the result that it became absolutely necessary to stop the machinery, but to avoid putting the tunnel into darkness arrangements were made with the Metropolitan Borough Council of Poplar to connect its mains with the Council's switchboard, and the tunnel is now being lighted by electricity supplied by that body. An expenditure of £150 was approved for connecting the switchboard at the electric lighting station at Blackwall tunnel with the electric main of the Metropolitan Borough Council of Poplar. It was also agreed that, subject to the passing of the annual maintenance votes for 1902-3, the necessary instruments to enable communication to be maintained by means of wireless telegraphy between the street station at Streatham-green and the temporary fire station at 45, Mitcham-lane, be retained until the completion of the new Streatham station, the payment to Marconi's Wireless Telegraph Company to be at the rate of £25 per half-year.

Wireless Telegraphy.—It is stated that preliminary investigations have been undertaken with the concurrence of the French Government by the Société Français des Telegraph sans Fil, with a view to the establishment of wireless telegraphic communication from Gabes, on the coast of Tunis, and the French possessions at Lake Chad. The steamship "Campania," which arrived at New York on 22nd inst., reports a new feature in wireless telegraphy occurring in mid-ocean. The "Campania" tried to reach by wireless signals the liner "Lucania," which was passing towards England. The signals failed, being caught by the steamship "Philadelphia," which, acting as intermediary, transmitted several messages between the two Cunarders. The following interesting letter recently appeared in the *Standard*: "Sir,—The following extract from the *Spectator* of Dec. 6, 1711, reads curiously in these days of wireless telegraphy. The writer 'doth attain to something of prophetic strain.' The essay bears the letter C (Clio) at the foot, and is, therefore, by Addison: 'Strada, in one of his prolusions, gives an account of a correspondence between two friends, by the help of a certain loadstone, which had such virtue in it that if it touched two several needles when one of the needles so touched began to move, the other, though at never so great a distance, moved at the same time and in the same manner. The two friends, having each one of these needles, made a dial plate inscribed with the four-and-twenty letters. A needle was fixed on each plate, so that it could move round without impediment, and easily touch any of the letters. Upon the two friends separating from one another into distant countries they agree to withdraw themselves punctually into their apartments at a certain hour of the day, to converse with one another by this, their invention. . . . By this means they talked together across a whole continent, and conveyed their thoughts to one another in an instant over cities or mountains, seas, or deserts." The mechanical arrangements alluded to seem to me to distinguish it from other curious forecasts.—I am, sir, your obedient servant, C. B. SEIFFERTH, Godmersham Vicarage, near Canterbury, March 21."

Bristol.—The Sanitary Committee have adopted the following report for presentation to the Council: "The committee have had under consideration the desirability of extending the lighting of the streets by electricity, and they have prepared the following scheme for erecting 366 additional arc lamps, partly in the centre of the city, and partly as extensions of the existing installations in the main roads leading to the suburbs: Stapleton-road and Fishponds-road, from Seymour-road to Royate-hill, 30 lamps; Church-road, St. George, from Lawrence Hill Bridge to the junction of the Bath and London roads, 30; Bath-road, from the Three Lamps to Sandy-lane, Brislington, 22; Wells-road, from the Three Lamps to Beaconsfield-road, 18; North-street, Bedminster, from Cannon-street to Luckwell-lane, 10; West-street, Bedminster, to Bartlett's-lane, 10; Bath-street, Temple-street, Philip-street, Passage-street, Narrow Plain, Broad Plain, and Tower-hill, Nelson-street, Colston-street, Park-row, Perry-road, Upper and Lower Maudlin-street, Marlborough-street, Dighton-street, and Jamaica-street, 96; Caledonia-place, Portland-street, Clifton-park, College-road, Cecil-road, Guthrie-road, and Beaufort-road, Clifton, 50; Redland Park-road, Clyde-road, Zetland-road, South-road, Redland-road, and Westbury-park, to the city boundary, 50; Cheltenham-road and Gloucester-road, from Arley-hill to the city boundary, 34; Ashley-road, Lower Ashley-road, Cornwallis-place, and Warwick-road, 16. The proposed lamps will each be 1,000 c.p., giving a total power of 366,000 candles, and the price at which the Electrical Committee are prepared to provide, light, and maintain them is £14. 10s. per lamp per annum. The Electrical Committee are also prepared, in the event of these lamps being installed, to reduce the price charged for the existing 310 public arc lamps by the sum of £2 per lamp per annum. Five hundred and twenty-seven gas lamps will be discontinued, having a total power of 15,176 candles, and costing £1,822 per annum; but your committee consider that if gas lighting were continued in the streets comprised in the scheme, 28 additional lamps would be immediately required in the streets situate in Clifton and St. George to bring the lighting up to the standard usually adopted in the city, and therefore the case may be regarded as if 555 gas lamps would be displaced, having a total power of 15,610 candles, and costing £1,904 per annum. The additional cost to the Corporation will be as follows: cost per annum of 366 additional arc lamps at £14. 10s. per lamp per annum, £5,307; less reduction on 310 arc lamps at £2 per lamp per annum, £620, and cost of gas, etc., on 555 gas lamps discontinued, £1,904—£2,524; net additional cost per annum, £2,783. Comparing the cost per candle of the proposed electric light installation with the displaced gas lamps, the former amounting to 366,000 candles, at a cost of £2,783 per annum is equal to 1·8d. per candle per annum; and the latter, amounting to 15,610 candles, at £1,904 per annum, is equal to 28d. per candle per annum. Your committee recommend that they be authorised to arrange with the Electrical Committee for carrying out the proposed scheme for additional arc lighting."

Hastings.—The borough electrical engineer in his last report stated that from a number of recent tests of the pressure made at different parts of the town it was found that the pressure was everywhere well above the standard specified by the Board of Trade. In order to keep the pressure in Castle-street, it had been necessary to feed that point with a transformer in a pit opposite Messrs. Mastin Bros.' premises. This transformer is supplied with a branch feeder off one of the main duplicate feeders supplying the music hall. It is necessary to assure the satisfactory isolation of any faulty feeder that the feeders so run from one sub-station to another without any branches in between. In order, therefore, that the successful duplication of supply to the east end of the town shall be complete, it is desirable that this transformer should be removed. To maintain the full pressure in Castle-street without the aid of this transformer, it will be necessary to complete the main between the top east side of Wellington-square and the bottom of the same. The cost of connecting up this link of the network is estimated at £114. 8s. The work is to be carried out, and application made for sanction to the borrowing of the amount required, and also for a booster, etc., in consequence of another report by the borough electrical engineer, in which it was stated that after testing the new Parsons turbine the exciting current required was considerably less than had been specified, which tends to make the working of the machine very much more economical, but with the present exciting arrangements it is necessary to introduce a considerable amount of useless resistance to absorb the energy saved by the more economical excitation. The energy wasted in this way costs to produce about £60 per annum, added to which the switching arrangements are complicated by the introduction of a number of resistance coils, which are liable to break down. This waste might be prevented and the cause of complication removed by connecting the field coils of the Parsons turbine in series instead of in parallel, and by employing a booster to increase the pressure of the battery sufficiently to excite the coils when in series. Mr. Bennett in his report recommends the Town Council to obtain a municipal telephone license. Upon the capital expenditure he states as follows: "I propose to lay about seven miles of underground pipes, which would enable the wires to be put out of sight to a greater extent than at present. All wires would be on the metallic circuit principle. The instruments would comprise all the latest improvements; they would be of handsome design and best workmanship, and bear the arms of the Hastings Corporation. I estimate that under these conditions £21 per line would be sufficient provision for a first-class metallic circuit exchange system for Hastings and Bexhill, constructed in accordance with the specifications annexed to the Post

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Office licenses to local authorities. The provision of underground ducts, etc., for extending from 750 to 1,500 lines would cost about £3,250. This works out: 725 subscribers and 25 public telephone lines (including junction lines to the Hastings post office and Bexhill), completed at £21, £15,750; ducts and pole accommodation for 750 additional lines, £3,250—total, £19,000." An average receipt of £5. 7s. 6d. per annum is expected.

Exeter.—Colonel Durnford has held an enquiry into an application of the City Council for sanction to borrow £70,000 for the purpose of electric lighting. The only persons who appeared to express their opposition were a councillor, whose admitted object was to advocate a system of steam-turbines involved in the scheme of a competing firm; another councillor, who was undecided which was the best system to adopt; a ratepayer, who handed in a scheme of his own, which the inspector considered it advisable not to read, but which he promised to forward to the Local Government Board; and a ratepayer who desired to offer his advice from a "layman's" point of view. The chief complaint of the objectors was that the scheme had been "rushed," and they persisted in this line of argument, despite the fact that the whole matter has been discussed a number of times within the last two years. The electric light undertaking was first started as a private speculation, and after it had cost the company a very much larger sum of money, it was purchased by the Council in 1896 for £7,500. The Council spent another £3,500 in improvements and extensions, and within three years they were obliged to apply for power to borrow a further £7,000, but with all that they were unable to cope with the demands made upon them, the progress of the undertaking being really extraordinary. At the time of the transfer to the Council the maximum load in kilowatts was only 197; it was now 410. The lamps connected were then 7,500; they were now 26,628. The units sold were 120,000; now 360,000. The committee had a large number of applications before them, and there were also prospective applications which were kept back solely from the well-known inability on the part of the Corporation to comply with the great demand. The works from beginning to end had never cost the city a halfpenny. They started with a business ready-made, which they had since extended and they had been able to pay all the interest and sinking fund of the undertaking, besides making a further profit, which was kept as an insurance fund. The works had not given the best results as they were designed at various times and added to at different periods, and with a plant of the newest description arranged in the best method, the expense of production might be very considerably decreased. As the city had been recently extended by about 1,400 acres with an increase in population of 10,000, provision must be made for the customers in that district also. Neither the present site nor the arrangement of the present machinery lent itself to an extension. The Corporation, however, had secured a site at the head of the Exeter Canal basin, and in touch with a branch line of the Great Western Railway, so that coal could be brought either by rail or by water right up to the premises. The scheme provided for a short branch from the railway being run into the works themselves. It was intended to erect a building and to establish a plant that would be equal to 1,300 kw., yielding an output of 800,000 units, with the further advantage that that would not occupy anything like all the site, but that it would be possible to extend the building and to place additional machinary there when the time came for a further extension. The land and branch line would come to about £2,000. The building contract amounted to £13,905, contingencies, including compensation, water-pipes from the basin, were estimated at £1,390, and railway siding £600. The equipment of the station, as per the tender of the Westinghouse Company, would cost £29,707; boiler, feeding pump, and weighbridge, £1,264; main feeders from the new station, £3,500; extensions of mains, including services for 400 consumers, laying, jointing, and making good roads and pavements, £9,030; substation extensions, switchgear, etc., for two-phase working, £1,000; alterations of motors, lamps, meters, and transformers for two-phase 60 cycles, £500; 10 30-kw. and two 6-kw. transformers, £1,138; 400 assorted meters, £1,805; instruments, £122. 13s.; experts' fees, printing, advertising, etc., for new scheme, £500; estimated cost of mechanical stokers and accessories, £1,400—making, with £2,000 which had been put down for contingencies, a total of £69,862. The Council had accepted the tender of the Westinghouse Company. Mr. Donald Cameron, the city surveyor, gave evidence in favour of the site. Mr. H. D. Munro, M.I.C.E., electrical engineer to the Council, said it was urgent to take immediate steps to lay down new plant, and to have the assistance of a new station, as they had now almost reached their safe working limit. With an up-to-date plant they would be able to considerably reduce the working cost in every direction, and there would be a corresponding reduction in the price to the consumers. There was now a customer waiting to take up to 150 kw. for motor work. The new plant would mean a diminution in the loss of distribution. The average price per unit to the customer was 5d., and with the new plant they ought to be able to sell at 4½d., and leave an adequate sum to provide for interest and redemption charges. He estimated the revenue at 4½d. would be £14,166, and the cost of production £6,666, leaving £7,500 for interest and redemption charges and for creating an insurance fund. He considered the system to be provided one of the very best. Mr. Robert Hammond, the engineer consulted by the Council, said he was in full accord with the change from the single phase to the double phase. There were 150 tenders in all submitted to him, and the competition was very great. The Council would obtain good value for their money in the tender accepted. Mr. Oliver Shiras, district manager and engineer of the Westinghouse Company, said the company accepted the responsibility for the general arrangement and satisfactory operation of the station. They had no hesitation in advocating the adoption of the two-phase system at Exeter. The tender, amounting to £29,000, was for a complete installation. After the enquiry the inspector visited both the old station and the proposed site.

PROVISIONAL PATENTS, 1902.

MARCH 17.

6473. Improvements in wireless telegraphy. George Lewis Hogan, 27, Chancery-lane, London.

6478. Improvements relating to storage batteries. Henry C. Porter, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6481. Improvements in wireless telegraph systems. Harry Shoemaker, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6484. Improvements in or relating to signalling devices for telephone systems. Henrik Thore Cedergren, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, Oct. 21, 1901, being date of application in Sweden.) (Complete specification.)

6485. Improvements in or relating to telephone systems. Henrik Thore Cedergren, 111, Hatton-garden, London. (Date applied for under Patents Act, 1901, Oct. 26, 1901, being date of application in Sweden.) (Complete specification.)

MARCH 18.

6558. Improvements in telegraph poles or the like. Auguste Bourgeat, 81, Avenue Ledru Rollin, Paris.

6567. An improved method of constructing contact faces in swivelling connectors for cables in trolleys or collectors used for electrically-propelled vehicles and the like. Henry Brecknell, Edward May Munro, and Hugh Innes Rogers, Thrissell-street, Bristol.

6607. Improved lifeguard for engines and cars and any vehicle worked by animal or any mechanical or electric power on rails or common roads. Henry Conradi and Emil Samuel Conradi, 19, Ebbsfleet-road, Cricklewood, London.

6629. Improvements in trolleys or current collectors for electrical tramways. Richard Drügemüller, 6, Lord-street, Liverpool.

6652. Improvements relating to the controlling of electric circuits. Edward Neville Bray, 18, Southampton-buildings, Chancery-lane, London.

6653. Improvements relating to the controlling of electric circuits. Edward Neville Bray, 18, Southampton-buildings, Chancery-lane, London.

6654. Improvements relating to switches. Edward Neville Bray, 18, Southampton-buildings, Chancery-lane, London.

6666. Improvements in dynamo-electric machinery. John Herbert St. Hill, Mawdesley, Norfolk House, Norfolk-street, Strand, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published April 10.

1901.

5713. Electrical switches. Lomax, Lomax, and Tomlinson.

7054. Systems of electrical distribution. Storer. (Date applied for under International Convention, Sept. 6, 1900.)

7256. Ozonisers. Electric Ozone Syndicate, Limited, and Smith.

8110A. Electric couplings and switching apparatus. Harrison. (Date claimed under Patents Rule 19, April 19, 1901.)

8997. Apparatus for governing electric currents. Gattie.

9023. Means for testing secondary batteries. Bristol.

9188. Induction coils. Forbes.

9745. Electric current circuit breakers. Moy and Bastie.

9801. Electric telegraphy. Brown.

9829. Automatic electric circuit breakers. British Thomson-Houston Company, Limited, and Wedmore.

9916. Collecting brushes and holders for dynamo-electric machines. Flood and Honey.

10654. Resistances for the control of electric currents. Weaver.

10758. Electric incandescent lamps in which the glower or light-giving body is a conductor of the second class. Ram and Nernst Electric Light, Limited.

11007. Combined electrical and mechanical motor arrangement applicable to motor vehicles. Benson and Price.

11135. Electric arc lamps. Johnson.

15804. Telephone selecting devices. Watkins, Bolster, Naylor, Davies, Coryelle, and Berry.

24887. Method of automatically and intermittently closing an electrical circuit which can be used in connection with railways. Burgess.

25175. Electric signalling for rail and tram ways. Struble.

26286. Contact makers for use in connection with electrically fired internal-combustion engines. Frenay.

26742. Electric motors for driving sewing machines or other similar apparatus. Wellman.

1902.

360. Contact devices for electric railways. Wetmore.

2774. Electrical switches. Hall.

3491. Brush-holder for electrical apparatus. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

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3490. Lightning discharges for electrical installations. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

3608. Manufacture of strands for telegraph and telephone cables. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

3610. Electrically-propelled vehicles for single-rail elevated railways. Behr.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	Mar. 8	585	581	+ 3	29,164	27,036
Birmingham Tramways	—	—	—	—	—	—
Blackburn Corporation	,, 21	655	551	+ 104	6,861	6,188
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 22	212	162	+ 50	1,936	1,736
Bolton Corporation	,, 23	1,342	1,238	+ 104	14,775	13,738
Bradford Corporation	,, 16	2,784	826	+ 1,958	19,732	8,367
Bristol Tramways Company	,, 21	4,094	3,576	+ 518	—	—
Carlisle Tramways Company	,, 15	122	123	− 1	1,282	1,192
Central London Railway	,, 22	6,324	6,188	+ 636	79,719	73,007
City and South London Railway	,, 23	2,813	2,089	+ 724	36,285	24,315
Cork E. T. and L. Company	,, 20	418	344	+ 74	3,951	3,901
Darwen Corporation	,, 22	169	154	+ 15	1,951	1,844
Darwen-Hoddlesden	,, 14	26	—	—	—	—
Dover Corporation	,, 15	172	156	+ 16	1,782	1,689
Dublin & Lucan Electric Railway	,, 23	97	72	+ 25	1,003	857
Dublin U. T., electric cars	,, 21	3,486	3,076	+ 410	—	—
Dublin S. District, Electric	,, 21	724	645	+ 79	—	—
Dundee Tramways Company	,, 19	628	532	+ 96	—	—
Glasgow Corporation	,, 22	11,161	8,338	+ 2,823	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 22	1,648	1,482	+ 166	85,719	71,266
Liverpool Corporation	,, 8	8,843	7,998	+ 845	26,399	77,857
Liverpool Overhead Railway	,, 23	1,392	1,475	− 83	16,451	17,744
Newcastle-on-Tyne Corporation	,, 15	1,913	—	—	—	—
Portsmouth Corporation	,, 22	1,160	472	+ 688	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 23	3,760	—	—	—	—
Southampton Corporation	,, 20	804	595	+ 209	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £245 decrease.
Barcelona Ensanche y Gracia, £12 increase. Barcelona, £432 increase.
Brisbane, £381 increase (month of Feb., £1,341 increase).
Buenos Ayres and Belgrano Electric, £286 decrease.
Calcutta, £20 decrease.
Cape Town (month of Feb.), receipts, £15,896; expenditure, £6,780.
La Capital Traction and Electric, Buenos Ayres (month of Dec.), £1,394 increase.
Mexico Electric (month of Feb.), receipts, £16,500; expenditure, £9,800.
Perth Electric, £157 increase.
Port Elizabeth (month of Feb.), receipts, £3,559; expenditure, £1,784.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Tramways.—	£	£
Anglo-Argentine, 1-260,007	5	4-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100	124-127
Blackpool and Fleetwood Tramroad	10	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	2⅞-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4½-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	6¾-7¼
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	9¼-9⅝
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	101-103 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	13-14
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12¼-12⅝
—— 5 per cent. Perpetual Debenture Stock	100	127-130
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1⅝-1⅞
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5-5½
—— 5 per cent. Deb. Stock, Red.	100	103-106
—— Prov. Cert., all paid	100	97-100
Cape Electric Tramways, Nos. 1-400,000	1	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	5-5½
—— 4 per cent. 1st Mortgage Debentures	100	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	11-12
—— 6 per cent. Pref., Nos. within 1-60,000	10	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	97-100
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb. Stock	100	112-114
Kidderminster and District Lighting and Traction, Pref.	5	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100	102-104
New General Traction, Ordinary	5	2½-3½
—— 6 per cent. Cum. Pref.	10	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10	10½-10⅝
—— 5 per cent. Cum. Pref.	10	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	99-102
Potteries Electric Traction, Ordinary, 26,667-40,000	10	10½-11½
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	10s.	¼
—— £50,000 ,, ,,	1	1
—— £500,000 4½ per cent. Debenture Stock	50 p.c.	50 p.c.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	⅝-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1	⅛-⅜
—— Ordinary, 1-125,000	1	⅛-⅜
British Insulated Wire, Ord., 1-70,000	5	9½-10½
—— 6 per cent. Cum. Pref., 1-40,000	5	5¾-6¼
—— 5 per cent. Mortgage Debentures	100	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	5¾-6
Brush Electrical Engineering, Ordinary	2	1⅝-1⅞
—— Nos. 90,001-105,731	2	1⅝-1⅞
—— Non. Cum., 6 per cent. Pref.	2	1¼-2¼
—— 4½ per cent. Debenture Stock	100	101-104
—— 4½ per cent. 2nd Debenture Stock	100	97-100
Callender's Cable, Debentures	100	111-115
—— Ordinary	5	17½-18½
—— 5 per cent. Pref.	5	5¼-6
Crompton and Co.	3	3-3¼
—— 5 per cent. Debentures	—	99-104 p.e.
Edison and Swan United, Ordinary	3	⅛-⅜
—— 5 per cent. Debentures	5	2-3
—— 4 per cent. Deb. Stock, Red.	100	78-83
—— 5 per cent. Second Deb. Stk. Prov. Crts.	—	83-88
Electric Construction, Limited, Nos. 1 to 112,100	2	1⅛-1⅜
—— 7 per cent. Cumulative Pref.	2	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	97-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10	9⅜-10½
—— 4 per cent. 1st Mort. Deb. Stock	100	100-103
W. T. Henley's Telegraph Works, Ordinary	5	17½-18½
—— 4½ per cent. Preference	5	5¼-6
—— 4½ per cent. Debentures	100	111-115
India Rubber, Gutta Percha, and Telegraph Works	10	21-22
—— 4 per cent. Debentures	100	100-103
Parker, Thos., Limited, Ordinary	10	15½-16½
Telegraph Construction and Maintenance	12	35-38
—— 5 per cent. Bonds	100	102-105
Telegraph Manufacturing, Ordinary	5	10½-11½
—— 5 per cent. Cum. Pref.	5	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5	9-10
—— 6 per cent. Cum. Pref., 30,001-60,000	5	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	105-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	100-105
Bournemouth and Poole, Ordinary	10	12-13
—— 4½ per cent. Cum. Pref.	10	9½-10½
—— Debenture Stock, Red.	100	103-106
Brompton and Kensington, Ordinary	5	8¾-9¼ xd
—— 7 per cent. Preference	5	8¾-9¼ xd
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	8¼-9¼
—— Nos. 20,001-30,000	5	8-9
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14½ xd
—— ,, ,, ,, £10 Ord.	6	10¾ xd
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	106-108
Charing Cross and Strand	5	9-10
—— 4½ per cent. Cum. Pref.	5	5¼-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	104-106
Chelsea Electricity Supply	5	5-5¼ xd
—— 40,501-50,936	5	5-5¼ xd
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	8¼-9¼ xd
—— 6 per cent. Cumulative Pref.	10	12-13
—— 5 per cent. Debenture Stock	100	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	101-104
County of London and Brush Provincial, Ordinary	10	8¼-9¼
—— 6 per cent. Cum. Pref.	10	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	6-6¼
—— 6 per cent. Cum. Pref.	5	6-6¼
—— 4½ per cent. First Mort. Deb.	100	106-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	4-4¼
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7-8 xd
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	10¼-11¼ xd
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9⅜-10⅛
London Electric, Ordinary	3	1⅞-2¼
—— 6 per cent. Pref.	5	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	95-100
Metropolitan, Ordinary	10	14½-15½
—— 4½ per cent. First Mortgage Debenture Stock	100	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9½
—— Preference	4	6¼-6¾
Notting Hill Electric Lighting	10	14½-15½
Oriental, 1879	1	1¼-1⅜
—— £5 Shares	5	7⅛-8
—— £4½ Shares, New	4½	6¾-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6 xd
—— 4 per cent. Debenture Stock	100	98-101
River Plate Electric Light and Traction, Deb.	100	65-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	104-106
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	1¾-2¼
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	2-2½
St. James's and Pall Mall, Ordinary, 101-20,080	5	14½-15½
—— 7 per cent. Pref.	5	8-9
—— 3½ per cent. Deb.	100	98-101
Westminster, Ordinary	5	11½-12½
Electric Railways.—		
Central London, Ordinary	100	100-103
—— 4 per cent. Pref.	100	103-106
—— ,, ,, deferred	100	98-101
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	116-118
City and South London, Consolidated Ordinary	100	65-68
—— Ordinary	10	—
—— Nos. 60,001-70,000	10	—
—— 4 per cent. Debenture Stock	100	112-116
—— 5 per cent. Pref. Stock '91	100	128-133
—— ,, ,, '96	100	122-126
Liverpool Overhead, 5 per cent. Pref.	—	13-13½
—— Ordinary, 1-50,000	—	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	92-96
Telephones.—		
National Telephone, Preferred	100	95-99 xd
—— Deferred Stock	100	60-64 xd
—— 6 per cent. Cum. First Pref.	10	13-15 xd
—— Preferred, 590,001-790,000	10	3½-3¾
—— 6 per cent. Cum. Second Pref.	10	13-15 xd
—— 5 per cent. Non. Cum. Third Pref.	5	4⅞-5¼ xd
—— 4 per cent. Deb. Stock, Red.	100	93-96
—— 3½ per cent. Deb. Stock, Red.	100	101-105
Oriental Telephone and Electric Company	1	⅛-¼

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NOTES.

A French Exhibition.—Particulars are to hand of an international exhibition to be held at Lille, France, this summer, under the patronage of the Municipality. The grounds known as the Champs de Mars have been secured for the purpose, and the exhibition will remain open from May 1 to Sept. 15. Intending exhibitors should communicate with the administrator of the exhibition at Lille. A technical committee has been appointed, who will take all measures necessary to safeguard the interests of exhibitors.

The New Pacific Cable.—The Colonial Secretary has received a complimentary telegram from the Postmaster of New Zealand notifying that the first section of the Pacific cable, connecting New Zealand with Norfolk Island and Australia, was finally completed on March 26 at Doubtless Bay. In reply, Mr. Chamberlain has sent a message to Governor the Earl of Ranfurly, in which he stated his appreciation of the honour done him of receiving the first message sent over the Australasian section of the Pacific cable, and his hope for the speedy completion of a project of such importance and significance to the whole Empire.

Electro-Harmonic Society.—The final smoking concert of the season will be held at the St. James's Hall Restaurant (Banqueting Hall), Regent-street, W., on Friday evening, the 11th inst., commencing at eight o'clock precisely. An attractive programme is promised. Messrs. Henry Baumont and George Stubbs will sing, Mr. T. E. Gatehouse will play a violin solo, and Mr. Alfred E. Izard is to give a pianoforte solo, the other instrumental music being furnished by the orchestra. Humorous recitations, conjuring tricks, and humorous songs will be given by Mr. W. G. Churcher, Dr. Byrd-Page, and Mr. Will Edwards respectively.

French Automobile Congress.—It is announced that an automobile congress is to be held in June next at Dijon, in France, at which the Automobile Club of France and the majority of the district clubs of that country will be represented. It will be a four-day congress, opening on June 5 and closing on June 8. Among the matters to be considered at the congress is the burning question of the restrictions to be placed on automobilists using the public highways. In this category, of course, is included the question of taxes and classification. The French Automobile Club is also arranging for an exhibition of automobiles for this year, which will include a series of tests of carburetors, accumulators, automobiles for city use, and of vehicles for suburban use. The first of these tests will be made in October next.

Electrical Progress in Siam.—Electrical development in Bangkok, Siam, during the last 10 years has been very marked. According to a consular report recently received by the United States Government, progress in that part of the world is well represented by the Siam Electricity Company, which has a capital of £175,000. This company at present has as many as 17,000 lamps installed of 16 c.p. It also owns a tramway track of 7½ miles in length, which is in operation, while another 3½ miles of track are under construction. It is expected that the extensions will be in operation before the present year is out. Electricity is also finding extended use in Bangkok for industrial power purposes, and the company is now considering a line of motorcars to be run in connection with its tramways. Besides this company there are 26 private electrical plants in operation in the various mills, forts, dock companies, and the navy yards of the city.

Proposed Wireless Telegraph Congress.—It is stated semi-officially that the Imperial authorities at Berlin are considering a proposal for inviting Great Britain, France, and the United States to send representatives to a congress to be held with the object of arriving at an international agreement which will prevent any monopoly in wireless telegraphy on the high seas. The matter is already receiving attention at the hands of the United States Administration at Washington, and the Chief of the Army Telegraph Bureau has been appointed to investigate the proposal and report on its advisability. The incentive for Germany's action in this matter is said to be found in the fact that when the "Deutschland," with Prince Henry on board, was on her way out from New York she sent a message to the Nantucket lightship (Marconi station) from the Prince for the German Emperor. The Marconi operators, however, refused to accept the message because it was transmitted to them by a Slaby-Arco apparatus.

Peat Fuel.—There have been numerous attempts to use peat as a fuel for large industrial operations, but as a rule the cost of reducing the peat into a form in which it is a rival of coal has at the same time made it more expensive than coal. A new attempt in the same direction is now being made at Stangfjorden, in Norway, where an electrical process invented by Mr. E. Jehsen is being experimented with. The peat is first dried and then squeezed into blocks, which drives off 20 per cent. of the water in it. It is then heated up in a retort by means of electricity, which causes it to give off a lighting gas, and also a liquid from which various valuable by-products, such as paraffin, sulphate of ammonia, etc., are obtained. The product left in the retort is not unlike charcoal, and will act as a substitute for it or for coke. It seems that five turbines, each of 128 h.p., coupled to five dynamos, are at present being used for heating up these retorts. In 12 retorts 50 tons of air-dried peat are expected to be treated in a working day. The cheap water power in Norway may make the process a success.

Industrial Freedom League.—We have received from Mr. Arthur H. Girdlestone, the secretary of the Industrial Freedom League, whose offices are at 53, Parliament-street, Westminster, S.W., some particulars of this new association, which has been formed to protect the interests of private enterprise. The official programme of the league is as follows: to prepare and publish statistics bearing upon municipal trading and its injurious effects; to arrange lectures, addresses, and debates throughout the country; to extend assistance to local traders unfairly hampered by restrictive by-laws; to assist ratepayers' associations in opposing wanton extravagance on the part of the councils; to watch cases giving rise to suspicion of municipal corruption; to urge action on the part of Ministers and private members of Parliament; and, generally, to rouse public opinion and secure the revival of that spirit of industrial toleration to which the past commercial success of the nation was so largely due. At present no information can be published as to the directorate of the league, but we understand that some highly influential personages are interesting themselves in the movement.

Two Telpherage Plants.—The *Electrical World* of New York illustrates two recent telpherage plants which have been laid down in America, where the system is now being widely adopted in factories and workshops. The first of these is of a factory in New England, in which the telpherage line runs from one building to another. The system is worked automatically with a switch at either end. The line is 50ft. from the ground, and has a sustaining capacity of 1,200lb. Current is supplied at 250 volts. The line is used for carrying saws in a water-proof carrier

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from one building to the other. The second illustration referred to shows the system in use in a New York factory for handling ashes and refuse along the water-front. Work of this kind suits the telpher plan admirably. In the case in point the plant has a capacity of clearing out 150,000lb of ashes in 10 hours. From the illustration it seems that the telpher hauls a trailer, and the average energy consumed is 1 h.p. At the present time the line is handling the ashes from 23 boilers, as well as other refuse. The elevated position of the line permits rubbish to be dumped into the centre of a barge, thereby obviating entirely the employment of labour to distribute and level, which was necessary when dump carts were used.

Simultaneous Telephoning and Telegraphy.—While several of the large railroad companies in America are experimenting in simultaneous telegraphy and telephony, the *Telegraph Age* publishes a short description of a metallic telephone and telegraph circuit which is in actual operation between Wheeling, W. Va., and Cambridge, Ohio. It is stated that the arrangement is very much like that of the Van Reysselberghe system in principle, except for the intermediate stations, and has so far given general satisfaction. At the intermediate station, Bridgeport, a 50-ohm coil is placed on each side of the Morse telegraphic relay, and a condenser bridged across the circuit. These accessories are intended to eliminate all foreign noises from the telephone such as those arising from the clicking of instruments in the telegraph circuit, while at the same time they do not prevent the operating of the magneto telephone call bells. This arrangement, it is claimed, gives practically two circuits between the stations mentioned, one telegraph and the other telephone. From Cambridge there is another length of single wire extending to Canal Dover, Ohio, 50 miles distant. A gravity battery of 60 cells at Canal Dover and one of 60 cells at Wheeling give the required voltage for working the circuit successfully.

Ultra-Violet Absorption Spectra.—A recent paper by Mr. G. P. Drossbach on this subject appears in abstract in the current number of the *Journal* of the Chemical Society, from which it seems that the author, in determining how far certain substances (mostly in 10 per cent. solution) absorb the ultra-violet rays, finds a marked absorption in the case of some salts of heavy metals, nitrates, and organic substances with high molecular weight. Hydrochloric acid, sulphuric acid, potassium chloride, chlorate and sulphate, sodium and calcium chlorides, aluminium and manganese sulphates, are found to be colourless, that is, light up to 230$\mu\mu$ passes through these as easily as through water. In the following cases, where absorption takes place, the number gives the length of the shortest wave which can pass through: nitric acid, 340; oxalic acid, 294; potassium carbonate, 244; potassium oxalate, 294; potassium nitrate, 340; ammonia, 272; barium chloride, 236; barium nitrate, 340; aluminium nitrate, 340; zinc chloride, 290; ferrous sulphate, 394; ferric chloride, 400; nickel chloride, 400; lead acetate 294; chromium chloride, 390; uranium chloride, 400; manganese nitrate, 340; copper sulphate, 296. It is to be noted that the salts of colourless metals give the spectra of the corresponding acids; thus the limit for all such nitrates is 340.

Lightning Research Committee.—This committee, which was organised in January, 1901, for the purpose of obtaining accurate records of the action of lightning strokes on buildings, with a view to improving, if possible, the means of protection, have succeeded in enrolling the services of over 200 observers in the United Kingdom, besides a considerable number in the Colonies and India, and in foreign countries. Out of 60 cases tabulated by the committee up to the end of December, 1901, no fewer than 12 relate to buildings fitted with some form of lightning conductor. As regards the system recommended by the Lightning Rod Conference of 1882, data to hand are not at present complete enough to afford a practical test of its efficacy. The recently issued report, however, of his Majesty's inspectors of explosives goes to show that the system has been found wanting, and that there is ample justification for the present enquiry. Valuable help has been given to the committee by the Royal Institute of British Architects, the Surveyors' Institution, the Institution of Electrical Engineers, and the Royal Meteorological Society, by circularising their members with a view to getting observers. The committee are continuing their investigations. Members and others willing to assist by their observations are requested to communicate with the Secretary, Lightning Research Committee, 9, Conduit-street, W.

A Portable Electric Welding Machine.—Letters patent have lately been granted to Mr. Henry E. Meyers in the States for a portable electric welding machine—a device which can be conveniently carried by hand and employed for heating rivets and similar metallic articles. The mechanism is enclosed in a rectangular casing having a suitable handle. Inside a block is secured composed of laminated metal plates bolted together. This block is provided with two parallel slots or openings, forming an intermediate core, about which is wound a primary coil, preferably of armature wire, this coil being held in place by blocks secured in the slots over the same. The secondary coil surrounds the primary coil, and fits closely into the slots. It consists of bar metal approximately twice as wide as thick, the ends or terminals of the same projecting through the wall of the casing and spaced apart. The terminals may be employed for many different forms of welding, it being understood, of course, that the articles to be welded must be of smaller area than the terminals of the secondary coil, otherwise the insulation of the primary coil would be burned out, and also cause a burn-out of the secondary coil. The whole arrangement with casing measures about 7ft long, 7ft. wide, and 4ft. deep, and weighs about 40lb. The primary coil is connected with special binding posts secured to the exterior of the casing, so that any suitable source of alternating electrical current may be connected thereto.

Islington Electric Lighting.—The metropolitan borough of Islington have just issued their first annual report. In it is included an account of the electricity undertaking, which was opened on March 4, 1896, and carried on by the old vestry until it came into the hands of the Borough Council in 1900. When this occurred the expenditure on capital account amounted to £307,735, and this was increased during the first five months the Council were in office to £322,334. The last annual report of the old vestry reviewed the finances of electric lighting in the borough for the year which ended Dec. 31, 1899. The period for electric lighting finance has since been altered to correspond with the Council's financial year, and the report in question, therefore, embraces the 15 months from Dec. 1899, to March 31, 1901. The income during that period amounted to £42,496 (of which sum £16,556 was the amount debited to the Council on account of street-lighting), the working cost to £29,567, and the interest and repayment of capital to £13,693, there thus being a deficiency of £1,027 in receipts as compared with outlay over the 15 months in question. This deficiency is mainly attributable to the large increase in the cost of coal. The number of arc lamps connected for street-lighting at Lady Day last year was 398, as against 349 at Lady Day 1900.

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During the year under review the number of consumers increased from 454, representing 32,603 lamps of 8 c.p. each, to 578, representing 40,398 lamps of similar capacity, a very encouraging growth.

Battersea Polytechnic.—A conversazione was held in the engineering department of this polytechnic on March 22 to mark the opening of new engineering rooms and in connection with the Polytechnic Engineering Society. A recent extension of the building has given new laboratories for mechanical and electrical engineering, and more drawing office and workshop accommodation. During the evening a meeting was held, when Sir Alexander Binnie formally declared the rooms open, and spoke of the value of technical training to the young engineer. Among those who also took part in the meeting were Mr. Charles Hawkesley (the president of the Institution of Civil Engineers), Sir John Jackson (the president of the Institution of Junior Engineers), Prof. Unwin, F.R.S., Dr. Garnett (secretary of the Technical Board), and Principal Wells. The expense of the building and equipment has been met by grants from the Technical Education Board of the London County Council. The conversazione was very largely attended, and included an interesting exhibition of engineering machine tools and other apparatus lent by different makers, and a good collection of models lent by the Society of Model Engineers; the Electrical Company, Limited; Messrs. B. J. Hall and Co.; the Daimler Motor Company; the International Pneumatic Tool Company, Limited; Messrs. C. A. Parsons and Co., engineers; Mr. W. H. Harling; Messrs. Smith and Stevens; Prof. W. E. Dalby, M.A.; Messrs. Charles Nurse and Co.; and Messrs. Charles Churchill and Co.

Institution of Junior Engineers.—On the 15th ult. this institution held its annual conversazione at the Westminster Palace Hotel, the guests being received by the president (Sir John Jackson) and Lady Jackson, and by the chairman (Mr. Percival Marshall) and Mrs. Marshall. There was a crowded attendance, and all the arrangements were carried through in a very successful manner. Prominent in the exhibition of models, etc., were some fine examples of the work of members of the Society of Model Engineers; a steam and an electric track were erected and model locomotives run upon them. In the lantern room a lecturette, entitled "Engineering in Miniature," was given by the chairman. Band selections were rendered in the large hall, and in the music-room there were short concerts by the Occasional Pierrots. A visit was paid by some of the members of the institution on March 22 to the Victoria and Albert Museum, South Kensington, to inspect the collection of naval, mechanical, and scientific models, etc. Mr. W. J. Last kindly conducted the party round, and pointed out the features of special interest. To some old Maudslay's men the sight of the beautiful models which used to be on view in the Board-room at Lambeth proved particularly attractive, and gratification was expressed that they were thus preserved as a complete collection. Mr. Last showed the members the workshop for the making and repair of models and plant for compressed air, by means of which, at a pressure of 5lb. to the square inch, some of the models are actuated.

Importance of Electrical Methods in Chemistry. The current number of the *Journal* of the Chemical Society abstracts a very interesting paper by Prof. Nernst under this title. After passing in review the well-known theories of electro-chemistry, the author points out that they all lead to the view that electricity consists of positive and negative electrons, which may combine (1) with matter to form compounds (the ions) which differ widely from the original matter, or (2) with each other to form a neutral electron molecule. This leads to the following theory of chemical combination: all elements and radicles possess affinity for positive or negative electrons, with which they unite to form the ions; they also possess non-polar attraction for each other, to which the formation of compounds of the metals, of hydrogen molecules, of iodine chloride, for example, is due. When a positive element combines with a negative one, however, an electron molecule is added, and this separates into its positive and negative electrons when the molecule is ionised. Such compounds differ much more from their constituents than those which contain no electron molecule. For example, the compounds of metals are metallic, those of non-metals retain the characters of non-metals, whilst a compound of a metal and a non-metal is a substance belonging to a new class altogether. It is possible that elements exist which combine with the positive electrons, without the negative electrons being simultaneously taken up by another substance; in this case, the negative electrons might be set free and appear as the Becquerel rays.

Post Office Appointment.—It is with much pleasure we note the appointment of Mr. J. Gavey to be engineer-in-chief of the Post Office on the approaching retirement of Mr J. Hookey. Mr. Gavey's connection with Government telegraphs dates from 1870, when, on the transfer of the telegraphs to the State, he took up the position of superintendent of the South-Eastern and subsequently of the Great Western Sub-Division of England. Eight years later Mr. Gavey was transferred to the South Wales district, where he became superintending engineer of telegraphs. From there he went to headquarters, and from 1892 to 1897 held the appointment of chief technical officer at the General Post Office, St. Martin's-le-Grand. Becoming assistant engineer-in-chief in 1897, he was made first assistant engineer-in-chief and electrician two years later, which position he at present holds. Both before and after Sir William Preece's retirement from the engineering department of the Post Office, Mr. Gavey has taken a very active part in the development of the telegraphic and telephonic systems of the State, and, notwithstanding his heavy and responsible duties, he has found time to contribute many valuable papers bearing on his special subject to the Institution of Electrical Engineers and kindred societies. During his lengthy service as superintendent engineer for South Wales he took a deep interest in all local engineering matters, and read several papers before scientific societies in Cardiff and district. His appointment as chief of the engineering department of the General Post Office will be generally welcomed by electrical engineers, among whom he stands in the front rank.

Decomposition-Tension of Sodium Hydroxide.—The *Journal* of the Chemical Society for March furnishes a good abstract of a paper by Mr. J. F. Sacher on this subject. The author states that when sodium hydroxide is fused in an iron vessel it soon assumes a red tinge, and when this has happened the iron has become passive, so that on immersion of an iron wire into the fused mass there is no polarisation current; up to the time when this passive state has been induced, a polarisation current of very variable strength is obtained. The only metals suitable for electrodes in the electrolysis are iron and platinum, the former being preferable. The discharge potential and the cathodic and anodic decomposition-tensions of fused sodium hydroxide have been determined in an iron vessel with an iron electrode, and with a platinum vessel and electrode, at temperatures varying between 385deg. and 563deg., and between 575deg. and 694deg. The curve of cathodic decomposition shows two well-marked breaks, as

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also does that of the anodic decomposition; the values found for the points at which the curve shows a sudden change are: for the cathodic discharge, 1·16 volts (at 390deg.) and 2·06 volts (at 389deg.), and for the anodic, 0·11 volt (at 395deg.) and 1·31 volts (at 393deg.). The higher cathodic point corresponds with the separation of sodium and the lower with the separation of hydrogen. The higher anodic point is due to the discharge of hydroxyl ions and the lower to that of O″ ions. This lower anodic point disappears as the hydroxide becomes free from water, and the author concludes that the sodium hydroxide dissociates into Na· and OH′, and the water either itself gives the ions H· and O″, or causes these to be formed from the OH′. The polarisation of fused lead chloride was determined by the decomposition method in glass vessels of various forms, using carbon electrodes. Two breaks occur in the curves obtained; the position of the lower break varies greatly with the distance between, and the size of the surface of, the electrodes. At 575deg. the higher break occurs at 1·256 volts, at 681deg. it is at 1·190 volts. When the electrodes are encased, the lower break entirely disappears. This lower break is due to a depolarisation effect produced by the depolarising action of a cloud of lead vapour which diffuses from the cathode to the anode. The higher break corresponds with the reversible action: $PbCl_2 \rightleftarrows Pb + Cl_2$. Similar conclusions are to be drawn from the results obtained by determining the discharge potentials.

Wireless Telegraphy.—This week we have had an opportunity of perusing the text of the agreement between the Canadian Government and the Marconi Wireless Telegraph Company, under which the former will contribute a sum of £16,000 towards the cost of the Marconi station in Nova Scotia, a site for which has already been chosen. The first point of importance is that the company undertakes that the rates to be charged for messages between Canada and the United Kingdom shall not exceed the rates for similar messages between the United Kingdom and any other portion of North America. The rates agreed upon for general messages to and from Great Britain are to be fully 60 per cent. less than those now charged for cablegrams—that is to say, that whereas the present rate per word is 25 cents, the company are not to charge more than 10 cents per word for such messages. Press messages are to be transmitted at a rate not exceeding 5 cents per word. Next comes a provision which is most favourable to the Dominion Government, which, it will be seen, is practically financing the company so far as work in Canada is concerned. It is to the effect that the Government shall be free to erect wireless telegraphy stations, using the Marconi system, for communication with any of its lighthouses, or between the mainland and passing ships, and the company bind themselves to supply all the necessary apparatus free from any charge for patent rights or royalties. And, when established, these stations are to be at liberty to receive all messages sent by ships equipped with the Marconi system, and deliver them to the connecting land lines without any charge. The tolls for all such messages, however, collected on board the ships will belong to the company. The Government, on the other hand, will receive all tolls collected at its stations for messages transmitted to ships. Apparently some difficulty arose between the contracting parties with reference to the arrangement which the company have entered into with Lloyd's, and it is provided accordingly that in the event of the privileges to be granted to the Government mentioned above not meeting with the approval of Lloyd's, they shall be withdrawn; and in that case the sum to be contributed by the Government towards the construction of the Transatlantic station in Nova Scotia shall be reduced from £16,000 to £10,000. The last provision of importance is that any lighthouse or station maintained by the Government on the coast of Newfoundland shall be deemed to be a part of Canada, and all privileges which the company are bound to grant to the Government in Canada shall extend to such lighthouses or stations in so far as the company have the power to grant them at such places.

Gigantic Generating Units.—The steam-driven alternators of the Manhattan Elevated Railway in New York at present occupy the unique position of being the largest generating units in the world. Each of these machines, of which there are eight, is rated at a maximum capacity of 12,500 h.p. From a description of the same appearing in the twentieth anniversary number of the *Electrical Review* of New York it seems that these gigantic machines are composed of combination vertical and horizontal Allis-Corliss engines and Westinghouse generators The engines virtually consist of a pair of compound engines working together on the same shaft, each engine having its high-pressure cylinder mounted vertically and its low-pressure cylinder horizontally. Each of the two high-pressure cylinders is 44in. in diameter, and each of the horizontal low-pressure cylinders is 88in. in diameter, the stroke common to the two being 60in. The speed operation of the machines is 75 revolutions per minute. The various cranks are set so that the shaft receives eight impulses per revolution, making the turning effort so uniform that no flywheel save the enormous rotating field of the electrical generator is necessary. One of the advantages claimed for this type of construction is that the engines have no dead centre, and may be started from any position in which they happen to stop without difficulty. The dynamos attached to these immense engines are of the pattern known as revolving-field alternators, and are built to deliver three-phase current at 11,000 volts pressure under ordinary circumstances. If desired, this pressure may be increased to 12,000 volts in each phase. The revolving parts are made of great strength, and are designed to resist the stresses due to abnormal speeds or accident. The hub of the revolving part is built of cast steel, and the rim is carried by a structure of steel plates instead of by the ordinary spokes. The revolving field is no less than 32ft. in diameter, and at its ordinary speed of rotation of 75 revolutions per minute its rim runs at the rate of nearly 1½ miles per minute. The weight of the revolving element of each dynamo is 370,000lb. The field poles of these machines are 40 in number, and are wound with copper strap. The windings are held upon the poles by copper wedges driven between the pole-tips, and are calculated to withstand practically any possible speed of rotation. The exciting current is normally 225 amperes at 200 volts, though this may be increased some 50 per cent. in case of necessity. The armatures of these machines are stationary. Each consists of six heavy steel castings to which the lami nated plates are attached. The wave-form of the machines is reasonably smooth and closely approximates a sine curve. One of these 12,500-h.p. generating units has been running for some time now, and is reported to have given entirely satisfactory results. It is employed in operating the electric trains on the Second-avenue division of the Manhattan Elevated Railway.

Electric Traction and Post Office Protection.—We have received the official circular of the Tramways and Light Railways Association for March, which is a rather more bulky document than usual, and contains some interesting information. It first gives a good digest of the law governing the tramway concessions in Brussels, and

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also reprints Mr. W. L. Madgen's paper on "Industrial Redistribution" Further on is given a short account of the proceedings on the occasion of the visit of a deputation representing the Electrical Trades Section of the London Chamber of Commerce and this association to Lord Morley a short time ago with regard to the additional clauses it is proposed to include in all new powers for electric traction for the protection of the Postmaster-General. The additional powers sought are to enable the Postmaster-General, by his officers, to enter any electrical traction station and make tests, etc., for the purpose of discovering whether the working of the station and the lines it supplies are injuriously affecting the working of the Government telegraph lines. No limit is put to the frequency of such visitations, and the Postmaster-General may even call upon the owners of the station to suspend or modify their working at the direction of his representative. Among those forming the deputation were Messrs. Stephen Sellon, H. M. Sayers, W. L. Madgen, and A. M. Willcox, the former acting as spokesman. Mr. Sellon pointed out the possible vexations to which the industry might be exposed by the operation of the proposed clauses, and drew attention to the Board of Trade regulations for the protection of owners of other electrical lines. Therefore, he argued, it was the Board of Trade to whom the Post Office should appeal in any case of damage by electric traction undertakings to telegraph lines. Mr. Sellon also referred to the self-protection which was to be obtained by the use of insulated returns instead of earth returns—an obligation which the Post Office, by its special power over legislation, had escaped. He further dwelt at considerable length on the question of guard wires, which he condemned as being themselves the cause of many interruptions to tramway services and some public risks. The Post Office sought to protect its lines and instruments from accidents due primarily to the failure of its own wires or poles, and to do this at the expense of the traction undertakings, who had to put up these guarding arrangements. The deputation suggested to Lord Morley that the Board of Trade should be given power to determine the methods to be used to guard against damage by electric traction concerns. It was stated that the guard wiring regulations were now under discussion between the technical advisers of the Post Office and the Board of Trade, and that hopes were entertained that the result would be much less objectionable than the draft regulations recently circulated by the Board of Trade for the comments of traction engineers. Lord Morley, in the course of his reply to the deputation, promised that he would, so far as practicable, use the means at his disposal to prevent the industry being unduly trammelled. And with this cold comfort the deputation withdrew.

Electrolytic Refining of Copper.—The Raritan Copper Works, situate on the outskirts of the thriving town of Perth Amboy, N.J., are counted the largest copper-refining works in the world, but apart from that they have great interest for electrical engineers from the fact that electrolytic methods are employed in the process. In order to give some idea of the magnitude of the works, it may just be mentioned that the monthly output from the refining furnaces varies from 15,000,000lb. to 18,000,000lb. The *Scientific American* for the 15th inst. gives a detailed account of the electrolytic process adopted at these works. The raw product arrives in the shape of copper pigs, and it receives its first treatment in the furnace house in order to get rid of the slag The tank-house, where the product receives its second treatment, is, however, of more interest to electrical engineers, as this building contains the whole of the electrolytic plant. The main floor space of the building, which measures 200ft. by 600ft., is given up to 1,600 depositing tanks, arranged in four groups of 400 each, while in small additions at the end of the main building there are 32 liberating tanks. Four powerful electric cranes for handling the electrodes run the length of the building—*i.e.*, one crane to each of the four groups of 400 tanks. The tanks are operated on the regulation multiple system, they being arranged electrically in series, while the electrodes in each tank are parallel. The latter are about 2ft. wide by 8ft. long and 3ft. deep, and each contains 22 anode and 23 cathode plates arranged in multiple. They are filled with dilute sulphuric acid and sulphate of copper electrolyte, and with a view to securing a constant circulation of the electrolyte the tanks are arranged in sets, with a solution well and a pump to each set. The liquor is drawn from the bottom of one tank and flows over to the next tank below it, the electrolyte being thus brought in thorough contact with the whole surface of the plates in the series of tanks. The thin cathode sheets which are used in the depositing tanks are formed in what are known as "stripping" tanks, of which there are 180. The cathodes in the stripping tanks consist of rolled plates of pure copper, smeared with grease or plumbago, with their edges protected against the formation of copper by grooved wooden strips. After the cathodes have been in the stripping tanks for 36 hours they are removed, and the thin sheet of copper is peeled from the plates, the grease serving to prevent any close adhesion of the surfaces. The thin cathode sheets are then flattened out by beating with wooden paddles, and are hung by means of two thin copper loops, riveted to the plates from copper rods, the ends of which rest upon the edges of the depositing tank. The anodes as they are brought to the tank-house from the casting furnace are hung on special iron frames, on which they are so positioned that they will have the proper spacing in the depositing tanks. The travelling crane picks up the frame with its complete set of 22 anodes, and places them in position in the tanks, the total weight of the complete set being between four and five tons, while the 23 cathodes together weigh 160lb. The action of the current is to transfer pure or practically pure copper from the heavy anode plates and deposit it upon the thin cathode sheets. The latter increase in weight from 6lb. to 8lb. to 75lb. to 80lb. during the seven days that they are in the tank. At the end of seven days they are withdrawn, loaded on to cars, and taken to the refining furnaces. Fresh cathodes are supplied, until the anodes, at the end of 42 or 43 days, have been so reduced as to have to be themselves replaced with fresh anodes. The product of the tanks, in the shape of heavy deposited cathodes, is taken to the 50-ton refining furnaces, where it is melted down and brought to "pitch," or, in other words, to a purity of 99·8 per cent. From the refining furnaces the copper is cast into the various forms required. The treatment of the slimes is next proceeded with, the first process in which is to extract the copper, and this is done by boiling the slimes in concentrated sulphuric acid and blowing air through the liquid during the process. The slimes are afterwards washed, dried, and smelted on the hearth of a cupel furnace, and, as a result, a bullion of gold and silver is recovered. As may be imagined, a power-house of considerable size is required to supply the necessary current to such large works. It is equipped with the most up-to-date plant, the engine-room containing five vertical cross-compound condensing engines, each direct-connected to a General Electric generator. The largest of these delivers 4,500 amperes at an efficiency of 93·5 per cent.

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THE NELSON ELECTRIC SUPPLY AND TRAMWAYS UNDERTAKING.

The new electric supply and tramways station of the Nelson Corporation was formally opened on Wednesday, March 12, by Councillor W. Reed, J.P., chairman of the Electricity and Tramways Committee. The Corporation first started supplying current from a station erected in the gasworks yard in 1892, but having obtained, last year, two light railway orders, and in view of the conversion of the then existing tramline from Nelson to Burnley from steam to the overhead electric trolley system of working, they decided to erect an entirely new station, and at the same time change over the general supply from a two-wire system at 118 volts to the three-wire system with a pressure of 460 volts between the outer conductors. Having some spare land adjoining their refuse destructor, they decided to erect the station there, utilising the steam from the destructor boiler for running the traction set during daytime.

MR. B. BALL,
BOROUGH SURVEYOR, NELSON.

COUNCILLOR W. REED, J.P., CHAIRMAN OF THE
ELECTRICITY AND TRAMWAYS COMMITTEE, NELSON.

MR. W. A. FRASER,
BOROUGH ELECTRICAL ENGINEER, NELSON.

Mr. W. A. Fraser, A.I.E.E., was appointed electrical engineer to the Corporation in May last, and in conjunction with the borough surveyor, Mr. B. Ball, designed the buildings. A block plan and an elevation of the station buildings are shown in Figs. 1 and 2 respectively. The buildings consist of a very fine engine-room 88ft. long by 33ft. wide, capable of accommodating six steam dynamos of 200 kw. output each; a boiler-house adjoining, 63ft. by 63ft., providing room for five Lancashire boilers, 30ft. by 8ft. each; accumulator-room; pump-room; repairing shop; mess-room and offices, etc. The offices for the electrical engineer and staff are on a level with the switchboard gallery, from which they can be entered from the engine-room. In designing the works the borough surveyor and electrical engineer have evidently followed the Continental practice of providing plenty of room round the machinery, so that all parts may be easily got at. Roominess is not a feature which English stations can boast as a rule, and an exception in this respect is therefore pleasing to find. There is sometimes a necessity governed by exceptional local conditions for crowding a large output into a relatively small space, but where this can be avoided it is certainly the right policy to take the opportunity and do so. The erection of the new works was commenced in the middle of July last and finished by the end of February of this year. Hence the buildings have been put up in exceedingly smart time. The works are conveniently situated near the centre of the town. In the boiler-house (Fig. 3) there are at present installed two 30ft. by 8ft.

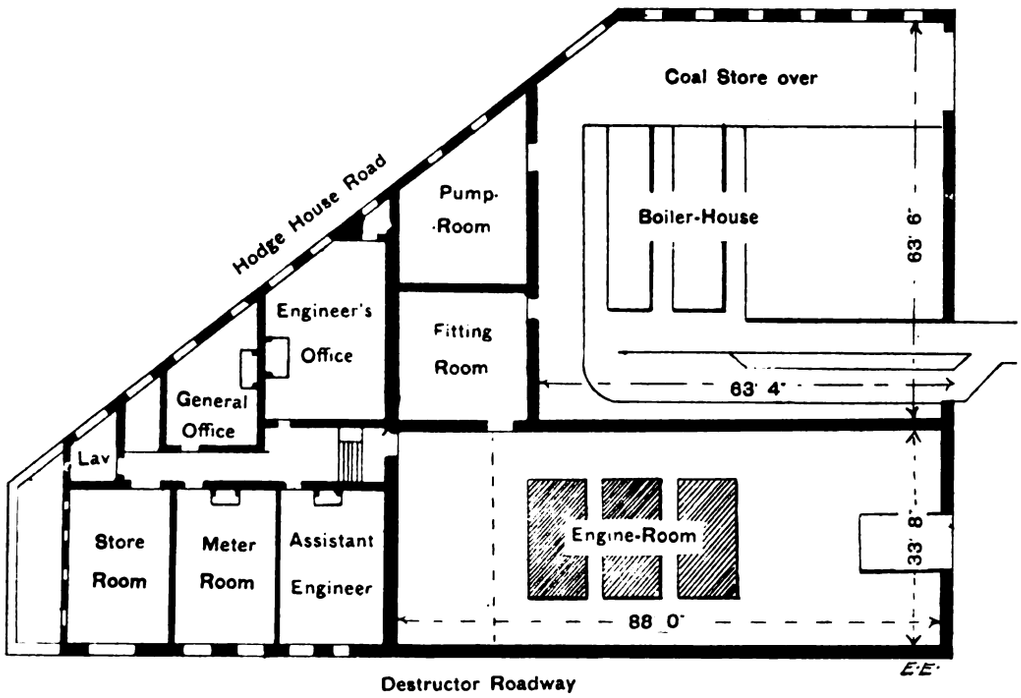

FIG. 1.—Block Plan of Station Buildings, Nelson.

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Lancashire boilers, supplied by Messrs. E. Danks and Co., of Oldbury, and fitted with Proctor's mechanical stokers.

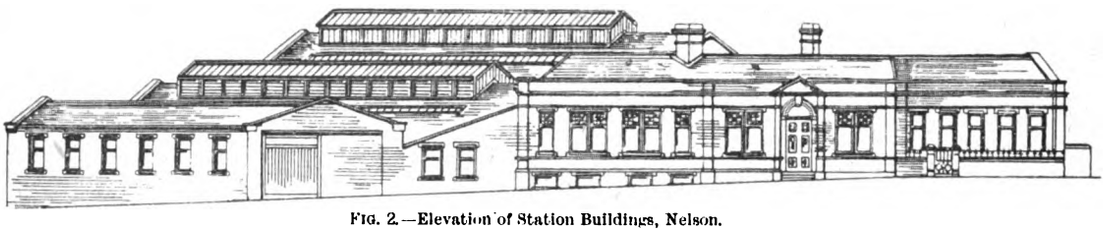

FIG. 2.—Elevation of Station Buildings, Nelson.

The working pressure of the boilers is 150lb. per square inch. An economiser, consisting of 192 tubes, by Messrs. E. Green and Son, Limited, Manchester, is placed in the main boiler flue. The boiler feed pumps, supplied through Messrs. Danks, are of the Weir type. The steam-pipes and condensers were supplied by Messrs. Cole, Marchent, and Morley, of Bradford. The present equipment of the engine-room (Fig. 4) comprises three 200-kw. steam dynamos. The engines were supplied by Messrs. Willans and Robinson, Limited, Rugby, and are of their three-crank type, capable of each developing 300 i.h.p. at a speed of 350 revolutions per minute and a steam pressure of 150lb. per square inch when working condensing on a 20in. vacuum. They are direct coupled to generators supplied by Messrs. D. Bruce Peebles and Co., of Edinburgh. These generators are of the four-pole traction type, with fixed lead for traction or lighting. When running as a shunt machine on the lighting load the output of each dynamo is 400 amperes at 460 to 480 volts; but on traction load, with the series winding in circuit, the terminal pressure may be increased

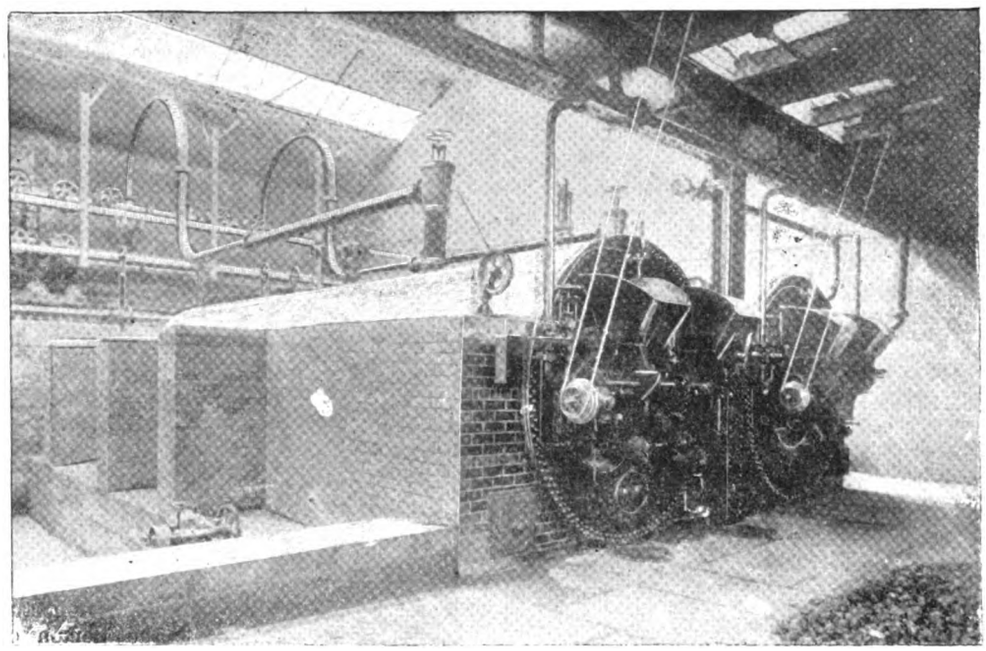

FIG. 3.—Interior of Boiler-House, Nelson.

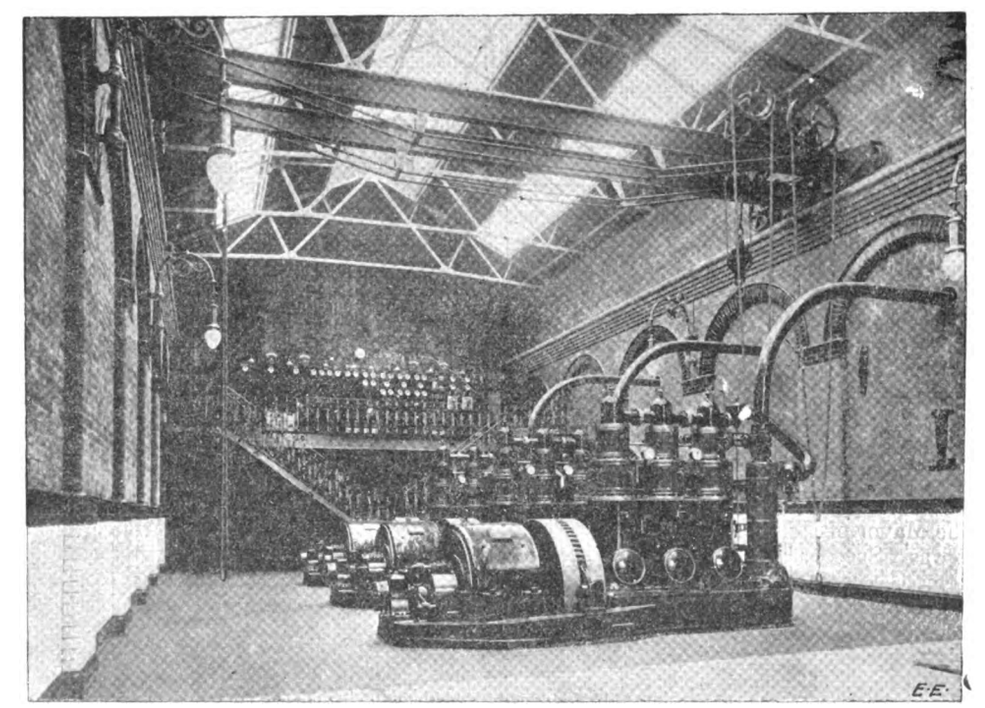

FIG. 4.—Interior of Engine-Room, Nelson.

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from 500 to 550 volts at constant speed. The balancer and booster set was supplied by Messrs. Greenwood and Batley, of Leeds, and consists of four separate armatures mounted on two coupled shafts. The balancer works with one armature on each side of a three-wire system, each armature running as either a motor or a generator with a current of 150 amperes. Each booster armature is capable of raising the charging volts by 50 with a current output of 75 amperes.

The lighting and traction switchboard was supplied by Messrs. Dorman and Smith, of Manchester. The board has three dynamo panels, and is so arranged that any machine can be used separately either for lighting, traction, or charging purposes. There are also three traction feeder panels, the lighting feeder panels, Board of Trade panel, etc.

The battery, supplied by the Tudor Accumulator Company, Limited, is made up of 268 cells, and is capable of giving a discharge of 137 amperes for 10 hours or 263 amperes for three hours, the E.M F. at the end of the discharge not being less than 1·8 volts per cell.

Now we come to the outside work. The whole of the mains have been supplied by Callender's Cable and Construction Company, Limited, and have been laid under the supervision of Messrs. Burton and Fradgeley, representing Messrs. Callender's. The cable is laid in wood troughing, and run in solid with bitumen. In all 19 miles of cable have been laid in about six miles of streets. The feeding points terminate in feeding pillars, whence the distributors are taken. It may be mentioned that the refuse destructor working in conjunction with the above-described plant is of the Meldrum regenerative type, supplied by Messrs. Meldrum Bros., Limited, Atlantic Works, Manchester, and consists of furnace, combustion chamber, Lancashire boiler, and regenerator. It is hoped to obtain sufficient steam from the boiler to work the traction load during the daytime, in addition to supplying steam for working mortar mills, and a turbine-driven generator which supplies current for lighting the destructor house, etc. We are indebted to Mr. W. A. Fraser for the loan of the drawings and photographs from which the accompanying illustrations have been prepared, and also for the particulars given of the plant.

Opening Ceremony.

The opening ceremony was duly performed on Wednesday, March 12, as above stated, by Councillor W. Reed, J.P., chairman of the Electricity and Tramways Committee, in the presence of a large number of gentlemen representing the Nelson Corporation and the out-townships interested in the undertaking. In his address to the assembly Councillor REED explained that the new works had been rendered necessary by the ordinary increase in the demand for electricity for lighting purposes, and by the decision of the Town Council some time ago to supply electrical energy for traction purposes on certain lengths of the Burnley and district tramways, together with two projected lengths of light railway. They were going to spend something like £30,000, but had not embarked upon such an undertaking without first availing themselves of the experience gained by other towns.

The formal inauguration of the new supply having been completed, an adjournment was made to the town hall, where the guests were entertained to tea by Councillor Reed.

Alderman R. FOULDS (ex-Mayor of Colne), in proposing the toast of "The Nelson Corporation," expressed a hope that electric traction would soon be extended in the direction of Colne, and they would see either Colne trams running to Nelson or Nelson trams running to Colne.

Dr. JACKSON (the Mayor of Nelson) responded.

The next toast was "Success to the Electrical Undertaking," proposed by Councillor HORSFALL, of Brierfield, who said that Brierfield had some interest in the works opened that day, the Urban District Council having made an arrangement whereby Nelson should supply their district. By this arrangement they had agreed to take a supply of current from the Nelson Corporation for the term of six or seven years.

In responding, Councillor REED gave a brief history of the electricity supply in Nelson, dwelling upon the rapid progress which the undertaking had made. With regard to the appointment of their resident electrical engineer, Mr. Fraser, he believed he re-echoed the views of the whole committee when he said they had no reason to regret their choice. The works they had opened that day were a monument of his fitness to help to erect an electricity supply works. They had entered into an arrangement to supply current in Brierfield for traction and other purposes. Two lines of light railway were projected—one of which he hoped would be ready at an early date. It would take the full capacity of one steam set to supply the demand arising for traction purposes. One of the other sets would not of itself suffice to meet the remaining demand. They had intended one of the sets as a stand-by, but he felt pretty certain now that this stand-by set would have to help with the maximum load.

Other speeches followed.

THE WASTES OF WIRING.

BY J. WHITCHER.

It is a source of great annoyance to the wiring contractor, to note the alarming way the scrap heap of insulated wires and cables grows up, as a monument of waste, in some untidy corner of his store. There, despite all his rules and instructions, it establishes itself, and flourishes; always gaining, seldom losing, recking nothing of emphatic injunctions that it *must* be made use of; revelling in absolute inutility in face of all. Until, at intervals, with impatient imprecation, he consigns it to the metal merchant, weary of seeing it, and angered by its seeming defiance of him. Worst of all, he knows that what comes back to store is only part of the waste that happens on a job. Much is thrown away, particularly so if, in his impotent struggles against wasteful habits, he show any keenness in punishing the making of excessive amount of scrap. Then the waste still goes on; but it is concealed from him; and he loses as well the price of the old metal. To be over-sharp on the fault defeats the very purpose in view. Quiet watchfulness seems the better treatment, with words of gentle warning on opportune occasions. How otherwise to combat the demon of waste that possesses many wiremen is a hard problem to solve. Of course, one ought to be cautious to employ careful men—that is, men of reasonably thrifty habit with their materials; able to discriminate between what is worth taking pains and time to save, and what is not. The workman who knows how to strike a fair balance between labour lost and material saved is worth encouragement. He is an intelligent fellow, and without doubt is a safe man in other directions also. On the other hand, there are men showily smart at their work who are great and incurable wasters. The money value of their wastefulness should be debited against the sum total of their usefulness. If this be done, it may even be found inadvisable to retain such men. At the other extreme there are a few who are too nervous with the stuff. They undervalue their time and overvalue the material. These can usually with a little patient oversight and explanation be made to see the error of their ways. Of course, if it be done with the ulterior object of spinning out time, more drastic measures are advisable.

It is really nothing special in the way of care that is demanded to make a substantial reduction of the wastage. A little play with the rule or trying up will save many a remnant of wire or cable from the general scrap heap. where, once it arrives, it stands scarce a chance of rescue. Regarding the financial aspect, a five or six yards length of $^{3}/_{22}$ S.W.G. vulcanised indiarubber-insulated wire costs about 9d.; and its old metal value is about $\frac{1}{3}$d., an insignificant proportion of the original cost. Any length over, say, three yards is worth an honest attempt to utilise. A wireman should make a practice of keeping a few remnants by him at his work, and bringing them in where he can. Short of going a journey of search, he should make a point of not cutting into a coil for his shorter runs. Scrap heaps would not grow formidable if this were generally done, even in these anti-joint days.

Much remnant making would be avoided if the wires were supplied in larger coils. There is no very plausible

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reason for the conventional 110-yard coil. The standard, for the smaller sizes at any rate, might as well be two, three, or even four hundred yards. As long as the weight is reasonable, no great objection could be raised. The tangling tendency of long and much-handled coils, is easily obviated by adopting a system of binding or taping up in sub-sections, as well as over all. This would be a good practice if used generally, and the writer offers the idea to manufacturers as one that would be of immense convenience to those who use their goods. Thus, if coils were bound up in sub-sections of 22, 44, 66, 88, 110 yards or any desirable divisions, they would not get into the messy state they do. The wireman's time saved would easily cover the cost of it.

Bell wires might well be put up in quarter-mile lengths, for the necessity of great variety of colours is not so dreadfully urgent. The electric light man gets on very well without such aid under very similar conditions, now the distribution board system is practically universal. The use of light iron drums for containing coils of wire "on tap" would help wiremen to keep their wire in tidy order, and conduce to economy; but perhaps this is too much of a refinement to become general.

It would be an extremely beneficial measure, from the wastage point of view, for the wiring contractor to standardise the sizes of conductors he uses, and to make these as few as possible. There is no valid reason whatever for the manifold varieties in common demand. The absurd fetish of "1,000 amperes per square inch of sectional area" is responsible for all this. The imbecilities of some consulting engineers put a veto on his doing so for work under their control, but on work of his own design he should certainly make it his firm policy to use a few standard sizes and admit no others. The principle he should work on is to use a comparatively small conductor uniformly for all lamp circuits; and to choose liberally for mains and sub-mains, from a few standard sizes of cables. For instance, on high-voltage systems the following selections are desirable, and would be good work, spite of fads and fancies to the contrary: For lamp circuits, $^{3}/_{22}$ S.W.G. suitable at 200 volts, and by I.E.E. *safe* rule for a 10 16-c.p. light fitting; although in good practice this would not be required, since all multi-lamp fittings over five or six ought to be divided between two circuits. The size, indeed, meets every incandescent lamp circuit requirement: For arc circuits and sub-mains to three-way distribution boards, $^{3}/_{18}$ S.W.G., safe current by I.E.E. rule, 7·5 amperes: For sub-mains to six-way distribution boards, $^{7}/_{18}$ S.W.G., safe current by I.E.E. rules, 14 amperes: For sub-mains to 12-way distribution boards, $^{7}/_{16}$ S.W.G.: For mains to 18 distributing ways, $^{19}/_{18}$ S.W.G.: For mains to 24 distributing ways, $^{19}/_{17}$ S.W.G. Over these sizes the mains to be duplicated. The ways would average about $1\frac{1}{2}$ to 2 amperes, although the maximum of three amperes be worked up to. Convenience of arrangement in practice prevents the number of lights on a circuit rising often so high. We have here only six sizes of wires and cables, to cover all ordinary demands, and the consistent use of them, rejecting all divergencies, would be beneficial to both contractor and manufacturer. It is simply technical insanity that binds wiring practice so rigorously to the stake of mystic numbers and rules.

The now universal practice of "looping-in" not only increases the amount of wire used, but it also leads to a very aggravating form of waste. Careless wiremen are always profligate with the free ends, and one usually sees a foot or two dangling about, in the way of plasterers and other workmen, where 3in. would suffice. Looping means four of these waste ends in place of two. Now, in proper looping there ought to be no ends whatever to cut away; the wire ought not be cut at all.

It is a marvel to the writer that the fire insurance people and the consulting gentlemen, who take such a grandmotherly interest in the trade, have not yet discovered what a dangerous practice looping-in, as very commonly carried out, is. Dry joints have long been held up to detestation as the worst crime in the wiring calendar, but here we have the very worst form of dry joint. From all points of view the loop ought not to be cut, and the form of terminal clamp ought to be such as to suit a true loop; as the writer insisted some years ago, when vainly attempting to induce manufacturers to take up a master patent for the looping in ceiling rose. As touching the question of waste, there are plenty of wiremen who nonchalantly throw away 2d. or 3d. of their master's money at every looping end.

The problem remains, after all precautions against undue wastes are taken, what to do with the short ends of wire that still accumulate. The taboo against joints makes them impossible for electric light work. When the tee branch to switches and fittings was in vogue, there was a last chance for them; but that is gone. For the small sizes, we make the suggestion that they be jointed up and utilised for bell wiring. Ends below two or three yards must go the scrap heap. All above this up to 10-yard lengths, being a nuisance in store and little likely to leave it, to be given to a lad to joint neatly and lap with good proof tape, and put up in suitable coils. This will make a splendid bell wire, much superior to the stuff used, of low resistance, and it can be buried in plaster direct without zinc tubing to protect it. The demand for this purpose would much exceed the supply.

Larger size wires and cables have not a like use; but with proper care on jobs and in store, remnants of them ought not to accumulate very fast. They are more worth the trouble of working in, and a systematic method of sorting, labelling, and putting them in the way of being used can accomplish this. Lengths under four or five yards—sufficient for passing from floor to floor of a building—had better be cast to the scrap heap at once. The inflammable character of the insulation forbids their use for switchboard connections and the like. They will serve occasionally for meter or motor connections, and that is all.

Wire is by much the biggest item of waste in the wiring trade; comparatively the other wastes are insignificant. A good proportion of casing and capping is often spoilt, but there is less rubbish made of the steel conduit that is taking its place. Probably this is because the labour of cutting makes wiremen prefer to select cut lengths. Likewise with tubing work generally. Breakages of porcelain parts, lampholder interiors, rose and switch bases, etc., are frequent and annoying enough, but by keeping to single standard types and makes of each, replacements can be made easier, and the loss is the broken part only, not the whole fitting.

Finally, we would reiterate that the most effectual way of combating material wastage is to avoid variety of goods, sizes, and methods. Keep to a few standards, refusing countenance to all superfluous variations. It means economy in every direction. The art of standardisation can very well be applied to the wiring trade. In fact, the trade stands in great need thereof. The principle of standardising consists in the unsparing cutting out of all superfluity, and even the partially useful items, on the understanding that the cheapening and improvement, thereby possible in the standards retained, make them applicable over wider range. So every essential requirement is served.

REMINISCENCES OF WORKSHOP LIFE.

BY A CENTRAL-STATION ENGINEER.

(*Concluded from page 444.*)

The removal to the erecting shop and consequent start with the fitters there was usually considered just cause for a demand for a further footing. That the footing should take the form of a bottle of Scotch was an old-established rule of etiquette amongst the erectors, and any disregard of this rule was considered a decided slight to the gang, and caused the newcomer to experience the bitterness of unpopularity from the beginning. Accordingly, I produced a bottle of "special" the day after my entering in at the broad portals of the erecting shop, and with due deference handed it to the chargeman, who received it with a kind of gruff condescension. A favourable opportunity for distribution was not long in coming, and he doled out the contents of the bottle—in a severely impartial way—with the help of a tin pannikin that might have held half a noggin. I had my sup with the rest, and immediately after went into the pit, under an engine recently brought

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in for repairs, to assist in taking down the "motion" of the engine and the brake rods, etc., which thickly fill the space between the wheels. I managed to knock several lumps of skin and flesh off my fingers and temporarily ruin my left-hand thumb-nail with a too vigorous application of the hammer, the blows of which should have been directed more correctly against the thick end of a pin punch to drive out the split pins that abound in these regions.

The old chargeman, who had reserved the last and longest pull for himself, soon got somewhat frisky; he sat on his bench and kicked his short, fat legs about vigorously. The foreman happened to come by soon after, and started sniffing about. The old gentleman, who had at last resumed his work, and was facing a valve in a novel way by deepening the hollows instead of paring down the hillocks on the valve face, was at once tackled, and asked what caused the extraordinary smell of spirits about. "Spirits be hanged," said the chargeman—his expression may even have been stronger than the above—"the smell is caused by the vile stink of the last quantity of rape oil you have supplied to us!" The foreman smiled and went away—he probably knew from experience it was useless arguing the point.

It was usual to have a special allowance of waste for stripping the engines, but in spite of this consideration it was not a nice job, and one soon got into a filthy state at this work. Great care had to be exercised in lowering the connecting rods and the motion generally, as the accumulation of grease on them produced "butter" fingers, and a tendency to allow them to slip on to the top of you. Woe betide you if the chargeman came round and found that you had failed to stamp each piece with the number of the engine before you delivered them to the labourer whose duty it was to take them to the water bosh, where they were cleansed of the oil that clung to them.

The chargeman was a Yorkshireman born and bred, but in spite of this qualification he was a terror to most of us. His grasp of workshop "Billingsgate" was astounding; a devout person would have shuddered at his oaths. His speech was not over clear, and was difficult to understand, being a compound of all the strange dialects that one meets with between the Humber and the Tweed. Our dulness of comprehension severely tried him at times, and he would eke out his guttural commands with weird swear-words whose evident heartiness boded ill to all the gang. As good luck would have it, I had been on a visit to the very town in Yorkshire where he last worked, and he brightened up at the mere mention of the place. This visit of mine proved to have been very useful, and I always got on first-rate with him.

The procedure at this shop would probably be considered rather antiquated now. To give an instance, the slide valves were all carefully faced upon an ancient faceplate that had worn quite hollow, then the porthole faces were faced to another valve, and a tedious job this latter was. By means of a long bar, ground diamond shape at the ends and resting on a fulcrum formed by a piece of iron stretching across the front of the valve chest, you scraped and scraped away, ever trying your valve against the faces round the portholes, ever straining to see by the light of a flickering dip where the valve bore! As a marked contrast to this I found on starting work at another locomotive shop the custom was to merely plane the valve, plane the valve seating with a special machine, and let them rub down to a face. Many of the locomotives had the regulating valve—the throttle valve—in the smoke-box. To take down the cover of this was sometimes rather a troublesome operation as the nuts became rusted on to the studs, and the only way to get it down was to chip them or split them, and to do this in the case of certain nuts meant striking upwards with the hammer and you caught the soot that came dancing down on your steaming face till you became as black as a sweep.

One of the apprentices who worked in the erecting shop had rather a stout father, who once took it into his head to visit the works. On arriving at the big doors that belonged to the erecting shop, he opened the small door in one of them and essayed to enter. He found it too small, it would not pass his bulk. He made another attempt and the large doors shook; fortunately he did not demolish the building—he was of an irascible temper, and if he had got his dander up there is no knowing what deed of violence he might have committed—for the foreman hearing the row, hurried some labourers to the spot. The two halves of the door were rolled back, and in sailed the old gentleman to meet the embracements of his son.

Through those same doors had entered, also on a certain occasion, another stout party—this time a lady. She had heard with dismay that her nephew—another of the apprentices—often complained of the extraordinary hunger he used to feel before dinner time. Her kind heart melted; she bethought herself of a remedy. Next day after her discovery of her nephew's martyrdom, she steered her steps about 11 a.m. to the works, and to his horror—he was at the moment surrounded by several men to whom he was telling a particularly "blue" yarn—she bore through the open door straight upon him, and with a charming smile handed him a large confectioner's bag containing a huge currant bun. The coarse men standing by made her gather her clothes around her apprehensively, and without waiting to hear the expected thanks, she retreated quickly, feeling a mild, plump satisfaction at her Christian deed. Scarce had her rounded figure disappeared through the doors when a series of loud guffaws greeted the mortified youth, who, mad with rage, dashed the bun on the greasy floor and jumped on it repeatedly. His companions never forgot that bun!

One of the fitters in the gang in which I worked was a particularly lean man, and never looked bright and happy; his expression was invariably sad! He used to work in a lackadaisical fashion, but never was a man more deceptive in his work, never could a man more easily "have" you. I have seen a brawny young fellow sit opposite to him when filing the horn blocks—the axle-box guides—in the frames. Work as hard as he could he was unable to keep up with the sad-featured one, who, with his two fingers caressing the point of the file, seemed to do no work at all. Yet he never wasted a stroke, and he had by long experience found out the most comfortable way of doing the greatest amount of work, which his muscular mate had yet to learn. Possibly he may also have measured or calipered the work beforehand and have chosen the easier side, this being a favourite dodge of the older hands when they expected to be put on this particular job. However, it was the same with all his work; it is rather a pity he did not work piecework, for he ought to have made his fortune.

I certainly preferred the work in the erecting shop to that in the machine shop, for I always felt satisfaction at seeing the engines gradually get properly fitted up, and there was always a keen sense of pleasure when the last touches had been put to one of the locomotives, and it was "pinched" out *en route* for the paint shop. It was the "Village Blacksmith's" feeling of pride at something attempted, something done, that swelled our bosoms then.

My general impression of apprenticeship in a workshop is this, that unless a youth is lucky enough to have someone who can tell him what he ought particularly to notice, it is probable he will go along mostly with his eyes shut, metaphorically speaking. Such a thing as estimating the cost of work seldom occurs to him; it is only later on that he finds out the great importance of this. It was also rather hard, so I found, to do much studying at nights after a day's work that started at 6 a.m.; still, this is only a matter for perseverance, and a stoical disregard of invitations to have evening jollifications with other young friends. At another workshop I was at it was customary to form "early rising" clubs. You paid a standing amount as a weekly subscription, and if you lost time in the morning you paid so much more. The money that accumulated was considerable, and to help to swell the capital the borrowing fraternity (there is generally one in each works) would borrow money from the club, and interest was charged at the rate of halfpenny per week on each shilling lent. In spite of this high rate of interest, the demand for loans was very regular, and the clubs did a roaring trade. At each half-year the total capital was divided equally, the secretary, of course, having his fee paid first, and quite a nice little sum was handed to each member. This sort of thing had its advantages, because

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when any man came to borrow from you, you could always refer him to an "early rising" club; it was so much more polite than having to refer him to his "uncle."

This reminds me of a tale I heard about a North-country timekeeper who was in the habit of lending out small sums to those of the workmen who wanted money. One morning a little girl, the daughter of one of the employés, came into the office sobbing bitterly. "Her father had died suddenly," she said; "he had been unwell for some time and had been taken off in the night." "Dead!" shouted the timekeeper; "dead!" Oh, —ll! why he owed me fourpence."

THE CONSTRUCTION OF HIGH-TENSION CENTRAL-STATION SWITCHGEARS, WITH A COMPARISON OF BRITISH AND FOREIGN METHODS.*

BY HENRY W. CLOTHIER, A.M.I.C.E. A.M.I.E.E.

(*Concluded from page 448.*)

Hinged Panel.—This ingenious construction, invented by Mr. Cowan, consists of an arrangement by which the vertical panels supporting the high-tension switches, instruments, and fuses can be hinged from

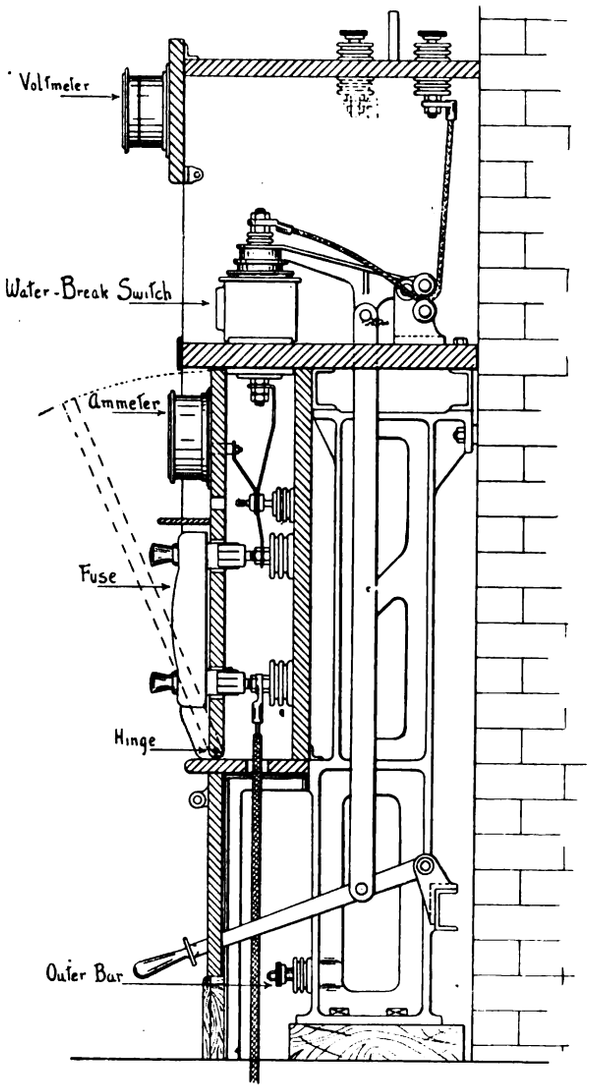


FIG. 12 Hinged Panel Type Switch Gear

the bottom. The operation of unhinging disconnects the entire panel from the 'bus bars, and affords ready access to the connections. This type, though very serviceable for small units, becomes difficult in construction when larger units are to be controlled, but Fig. 12 shows the method applied to meet the requirements of larger units by mounting the switch solidly at the top. The hinged panel below contains the other fittings. It is evident from the illustration (Fig. 12) that although there is still an interval between the flat panel and the wall, this space is so reduced that there is no chance, even if there were the necessity, for anyone to go behind.

* Paper read before the Manchester Local Section of the Institution of Electrical Engineers.

Cellular Type.—This construction, better known as the Ferranti switchgear, was first installed in Portsmouth in 1894 for 2,000 volts, and it has since been extensively, and, indeed, for the last three or four years almost exclusively, adopted throughout this country on 2,000 and 3,000 volt single-phase systems. Referring to Figs. 13 and 14, it will be seen that the framework consists of a number of heavy slabs of insulating material grouted into the station wall and protruding therefrom. The spaces between them are divided off into a number of cells by vertical division plates, also of insulating material, made to slide into grooves cut in the horizontal slabs. Porcelain insulators are mounted deep into these cells or recessess which carry

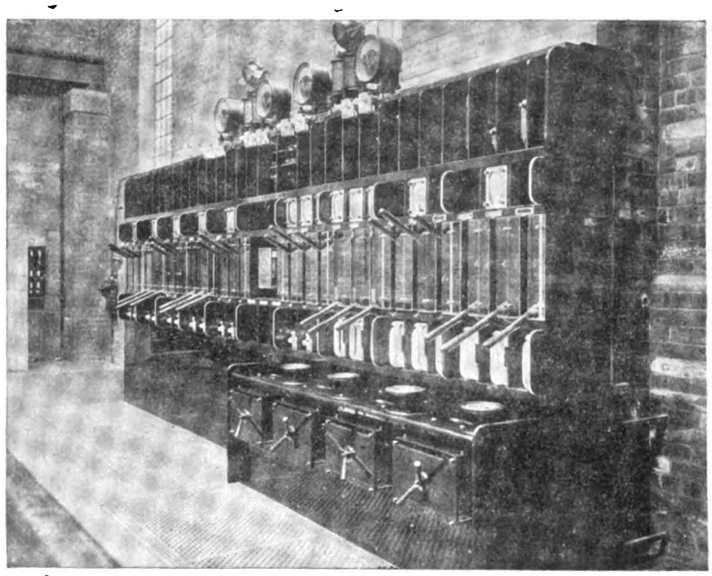
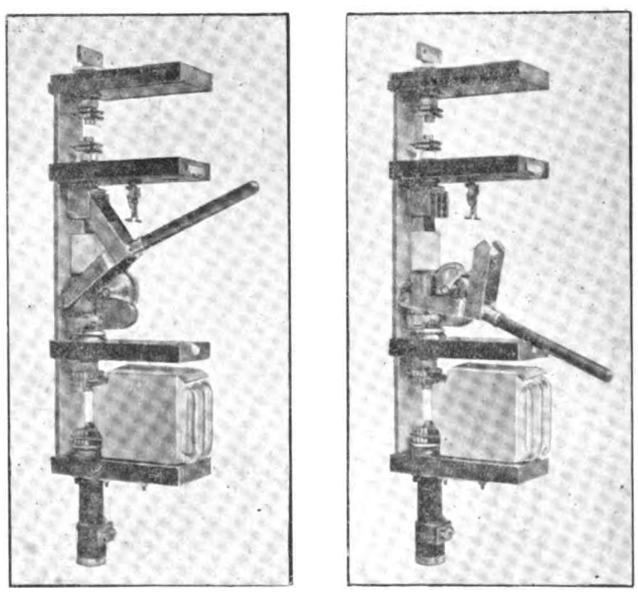


FIG. 13.—Ferranti Multiphase Cellular Switch Gear.

the high-tension conductors and several metal fittings for receiving the switches, fuses, instrumeots, etc. This arrangement entirely eliminates the space at the back common to the types before mentioned. While all the connections and conductors are visible and easily traced from the front, they are so shielded by the cellular construction of insulating material that it is, to all intents, impossible to make accidental contact with any two metal parts of differing potential at the same time. Moreover, the constructional framework is made up of non-inflammable material without resorting to a metal frame, thus affording great advantages both as to insulation and immunity from fire or accidents due to shock. Thanks to



Switch Open. Switch Closed.

FIG. 14.—Section through Alternator Panels.

this security in design, the record of this type of switchgear has not been marred by the occurrence of any serious or fatal accident. This is striking evidence when one considers that there are more cellular type high-tension alternating-current gears working in this country than all other kinds totalled together. Fig. 15 shows a section through a 3,000-kw. three-phase generator panel. The 'bus bars will be seen at the top. Each panel is furnished with a plug by which it can be readily isolated. All high-tension instruments, switches, and fuses are made to plug into contacts, and fixed in such a way that they can be quickly withdrawn even while the rest of the apparatus is "live." On all feeder panels the fuses are provided with duplicate contacts for this purpose. The drawing shows the position of the regulating table, field switch, exciting current ammeter, and

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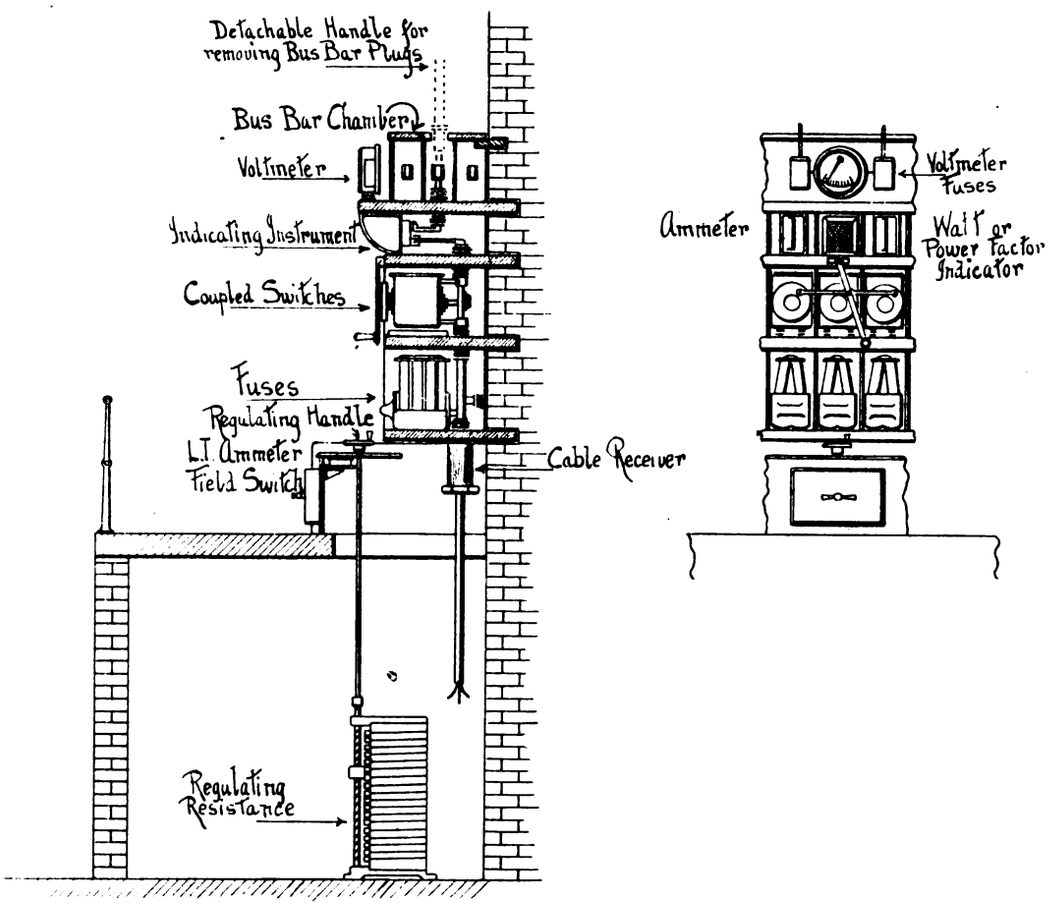
resistance, which are mounted separately, but in a line with high-tension panels. Another feature of this construction is the absolute absence of cable connections between the various components, and the mechanical means adopted to replace them; each high-tension part is contained in a complete cell, and so divided from any other part of differing potential. This concludes the description of the various constructions. There are, of course, others invented and used for alternating-current switchgear, but the foregoing are typical of the most important generic designs which have been tried and put to practical use.

'Bus Bars.—Complexity must inevitably give way to simplicity in all apparatus. In no part of a central station is this axiom more applicable than in the arrangement of the 'bus bars, which form the foundation of the connections. Numerous ingenious and complicated methods exist, involving the duplicity of parts, multiple 'bus bars, change-over switches, cross connections, and other elaborate provisions which seem to allow for every emergency. However, simple as they may be made to look on paper, in practice they tend to increase the difficulty of supervision and chances of mistakes. The confusion may be modified by complex systems of interlocking



Cellular Type Switch Gear

FIG. 15

devices, but for perfection in design these should be unnecessary. There should be no alternative ways of operating any part. Given one way the attendant cannot go wrong. For this reason alone, irrespective of the many other advantages, such as economy in running, uniform distribution of the load, etc., it is preferable to parallel all generators to one common set of 'bus bars. The arrangement of 'bus bars has such an important bearing upon the switchgear construction that it is opportune to consider some of the other methods as illustrated by diagrams on Figs 17 and 18, which, to save a repetition of lines, have been drawn to represent the connection of one pole only. The network involved by them on three-phase systems can be imagined. Each diagram represents the high-tension connections for our generators and eight outgoing feeders. It is interesting to note from them how a simple construction can be converted into a complicated one.

PART II.—COMPARATIVE NOTES ON BRITISH AND GERMAN SWITCHGEARS.

In these notes it is not the intention to criticise, but to assemble the main features and essential points of difference in general design, in order that fair conclusions may be drawn from them, and from the discussion, which the author hopes may tend to improve not only the imported material, but also the productions of this country. It must be understood that the methods of Germany herein mentioned are those which appeared to predominate among the extensive works and supply stations visited during the recent tour of the members of this Institution. It is only natural to conclude that the works exemplified the most modern and approved methods. The standard of British designs considered will be the cellular type, which has been installed in the majority of stations in this country. Figs. 15 and 16 have been drawn to the same scale to represent a comparison of the typical switchgears of both countries. The views are intended to illustrate a 3,000-kw. generator panel for a three-phase system at about 6,000 volts.

General Construction.—In this respect the description in the first part of this paper will point decisively to the fact that whereas, in this country, great endeavours have been made to render all parts of the gear visible and yet inaccessible by accident, in Germany the aim has been to attend only to the safety of the front portion of the construction. The gears are of the type with backs, and are designed on the "flat-board," "basement," and "multi-frame" principles; bare 'bus bars are usually mounted on insulators without any form of covering, and no attempt is made to shield other live fittings, which are mounted at the back. The intermingling of these fittings with the metal framework is the converse of the policy taught by our experience, which is to have no back, and to avoid the use of metal framework near high-tension conductors. Moreover, the absence of straggling cable and strip connections between the component parts of the gear is very apparent on the cellular construction as compared with the foreign boards with backs. The space occupied by the switchgear is often an important consideration in planning a central station. In this respect it is worth noting that the "cellular type" occupies about one-third the floor space as compared with the other types, and for the same number of machine, circuit, and inter-connecting panels, about two-thirds the length of platform required by a well-designed "multiframe gear."

Switches.—In Germany the main switches are invariably operated from handles projecting through the marble fronts. Oil-break switches contained in cast-iron boxes are used, but the general practice is to use those designed to open with a slow movement, allowing an arc to draw out, flare, and die away gradually, on the principle of the Siemen and Halske lightning arrester. This method is also directly contrary to the principle of quick-break devices for suppressing the arc, and the more efficient oil-break switches which have proved successful in this

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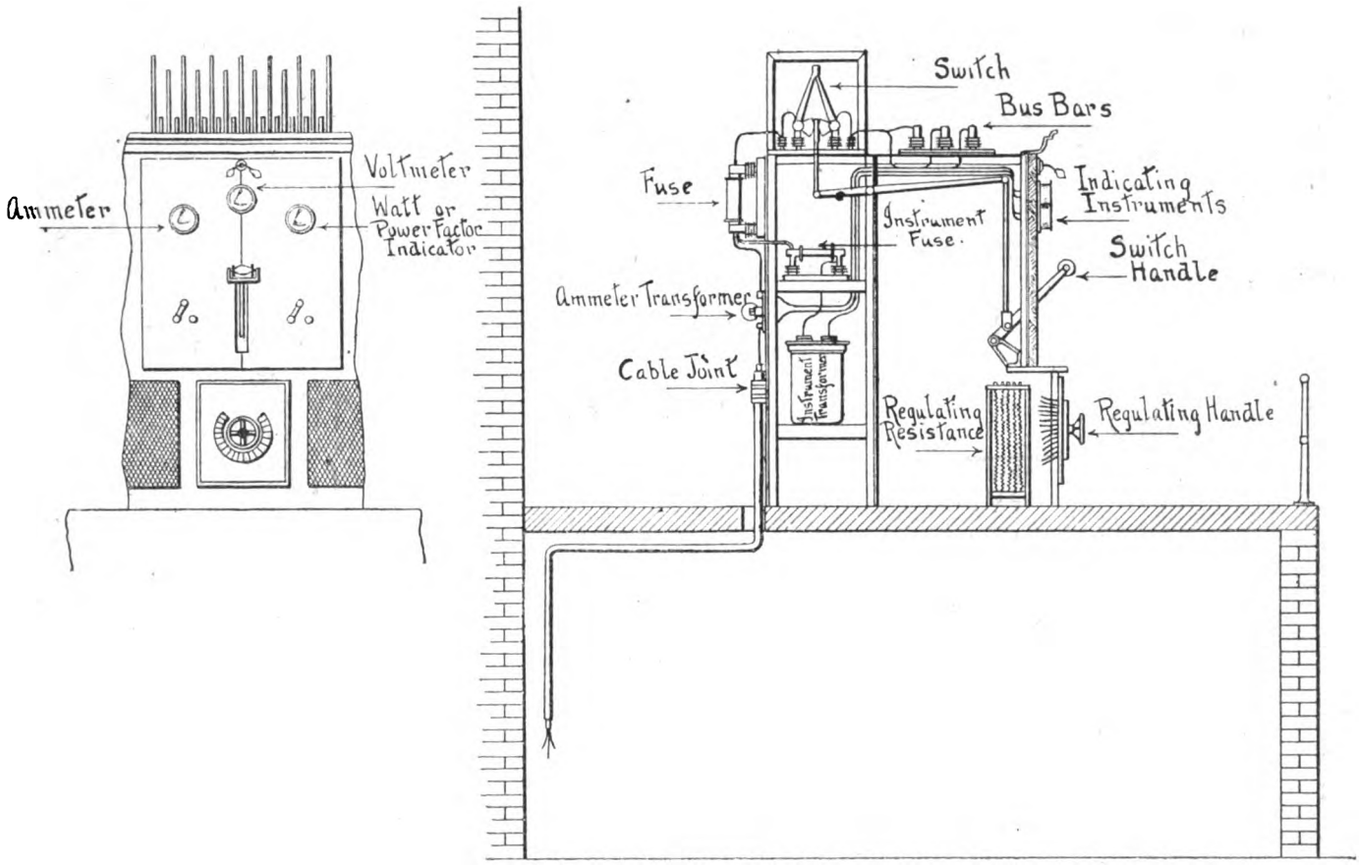
country. The high-tension fuse most extensively used in Germany is not unlike the well-known Bates fuses, consisting of an open-ended tube of porcelain, ambroin, stabilit, or similar insulating material, with plug terminals at each end. The fuse wire of copper or alloy is threaded through the tube and clamped by screws and plates or soldered to the terminals. For potentials of 2,000 to 10,000 volts the length of these tubes varies between 8in. and 15in. Several fine wires are connected in parallel for the higher voltages, each wire being enclosed in a separate internal tube or otherwise partitioned by insulating material, so that each wire has a column of air to itself. Unlike the Bates fuse, there is no handle moulded with the tube, but flanges are provided at the ends, and, moreover, in most cases, it is customary to have a long pair of wooden tongs close by the switchgear with which any fuses can be clutched while the operator is at a safe distance from it. Considering the massive tube fuses used at Deptford and Willesden, which are from 4ft. to 5ft. long, and also the expensive designs, such as the oil-break fuses of home manufacture, it would appear that either we overestimate the destructive effects caused in breaking high-tension circuits, or else the necessity of blowing a fuse without destroying the fuse-holder is not considered as a matter of importance in Germany. The variation in size and initial cost of the respective designs is very pronounced. It is very common in German practice to construct high-tension switchboards without fuses or automatic devices of any kind in circuit with the alternators, and to have plug fuses on the outgoing feeders, but no switches on these circuits. The fuses in such cases are placed in cellars or in basements away from the station attendants. There is thus no way of breaking a load on a feeder circuit other than by blowing its fuse. The visible switchgear in these stations is only that required for the control of the machines whilst under normal conditions. We were informed in one important station in Berlin that one man was never sent alone into the cellar or basement, but, for safety, was always accompanied by another to look after him. There are many points of difference in the instruments used on high-tension switchgears. Electrostatic voltmeters, almost universally used in this country, give way in Germany for electromagnetic or hot-wire voltmeters connected to the secondaries of transformers. But in a few instances where electrostatic instruments are used it is instructive to us to note that the cases are made of insulating material, and the difficulty, common to alternating-current systems, of sparking over, due to rises in potential, has been obviated by covering the fixed cells with a layer of insulating material such as mica shellaced over, thus forming an efficient insulating shield between the cells and the moving vane. For further protection a resistance is connected in series with the fuses. Unlike our Kelvin and Ayrton and Mather voltmeters, the German electrostatic instrument is not usually fitted with a spark gap. The scales, however, of these instruments—taken collectively—are not so open and boldly marked as on our patterns. Accustomed as we are to our long-ranged voltmeters and ammeters, of both dial and edgewise patterns, the instruments in common use in German central stations appear to us somewhat small, and the scales seem to require close inspection to read them. All possible means whereby connections and apparatus can be reduced, without affecting the utility of the whole, should be taken advantage of. With this in view there is something to the credit of the home designs in the method of using one common synchroniser and incoming machine voltmeter, instead of complicating the system by using separate synchronising transformers and voltmeters for each machine. As an example of the former, the Ferranti method is to make contact automatically with a common synchronising bar (or pair of bars for multiphase system) while the main dynamo switch is in a "half-cock" position. This arrangement has the advantage of simplicity in construction and also in working, as compared with the latter method, which entails the provision of separate plugs or switches on each machine panel. There are many other details of more or less importance where the best switchgear practice of the two countries differ, such as the method of connecting to the 'bus bars and of isolating panels by the use of 'bus bar plugs, the provisions for receiving cables, and for removing instruments and other parts of the gear safely and quickly without the use of special tools. These details have perhaps been more carefully dealt with in our best British designs than has been considered necessary in Germany. On the other hand, we may have to learn something concerning the methods of economy in design and production by which passable results can be obtained by a minimum expenditure in material and labour. But it is difficult to know where to draw the line in cutting down material and cheapening designs, because it is of such vital importance that, for apparatus on which so much depends, the efficiency must not be sacrificed for economy in design. To sum up, the main and great difference rests in the principles of construction; the details follow in sequence, and are to a certain degree dependent upon them.



Multiple Frame Type Switch Gear

FIG. 16

Conclusion.

It will form a fitting conclusion to this paper to consider, without taking up too much time, the absolute requirements for one of the common systems of transmission. The single-phase switchgear has become practically standardised, but the three-phase switchgear for 6,000 to 10,000 volts introduces many problems for dis-

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cussion. The first question to decide is the 'bus-bar arrangement. The diagrams on Figs. 17 and 18 show many methods, but of these, provided the switchgear is reliable, there is none more suitable than the simplest (represented in Diagram A) for any number of machines of modern design. There are, however, cases where it may be deemed advisable to split up the station plant into sections. For example, in this city it is proposed to run one set of generators on the traction load and another set on the lighting load. It would be interesting to know what effect the fluctuation of the traction load would produce on the lighting load if the two systems were run in parallel, assuming that motor-generators or rotaries convert the high-tension alternating current to a divided continuous-current supply for the consumers. It is quite possible that there is no need to have separate high-tension traction and lighting 'bus bars at all, then it will be more economical and convenient to run every machine on to one common set of 'bus bars; means being provided so that any generator or feeder panel can be readily isolated for adjustment, repairs, or cleaning purposes. With a balanced load only one ammeter is essential on a three-phase panel, but provision should

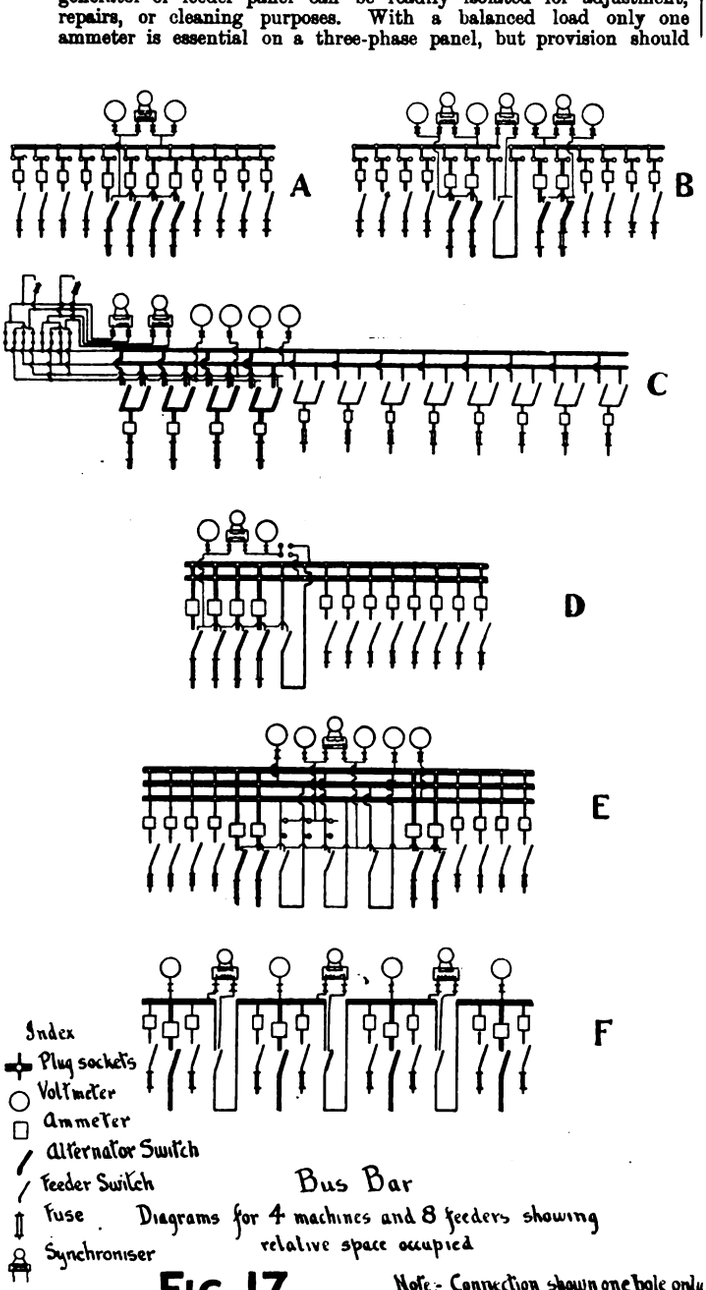

FIG. 17

Note:- Connection shown one pole only

of the circuit, but the more severe conditions to which they are likely to be subjected when emergencies occur. It must be remembered that tests which have been carried out in this country, and on a larger scale with higher voltages in America, show that the maintenance of an arc in open air, even for a short period, is liable to produce resonance effects, and high voltage oscillations, equal to two or three times the normal potential of the system. Whereas it would seem from tests carried out at the same time that excessive rises in potential are not experienced with oil-break switches. Spark gaps which will arc across when the pressure rises above the normal can be fitted to the 'bus bars or to the cable, but the switchgear should be constructed to avoid the necessity of these devices, which are likely to irritate the system and reduce the degree of safety by bringing conductors of differing potential close together on one apparatus. The capacity of the feeder cable has an important bearing on

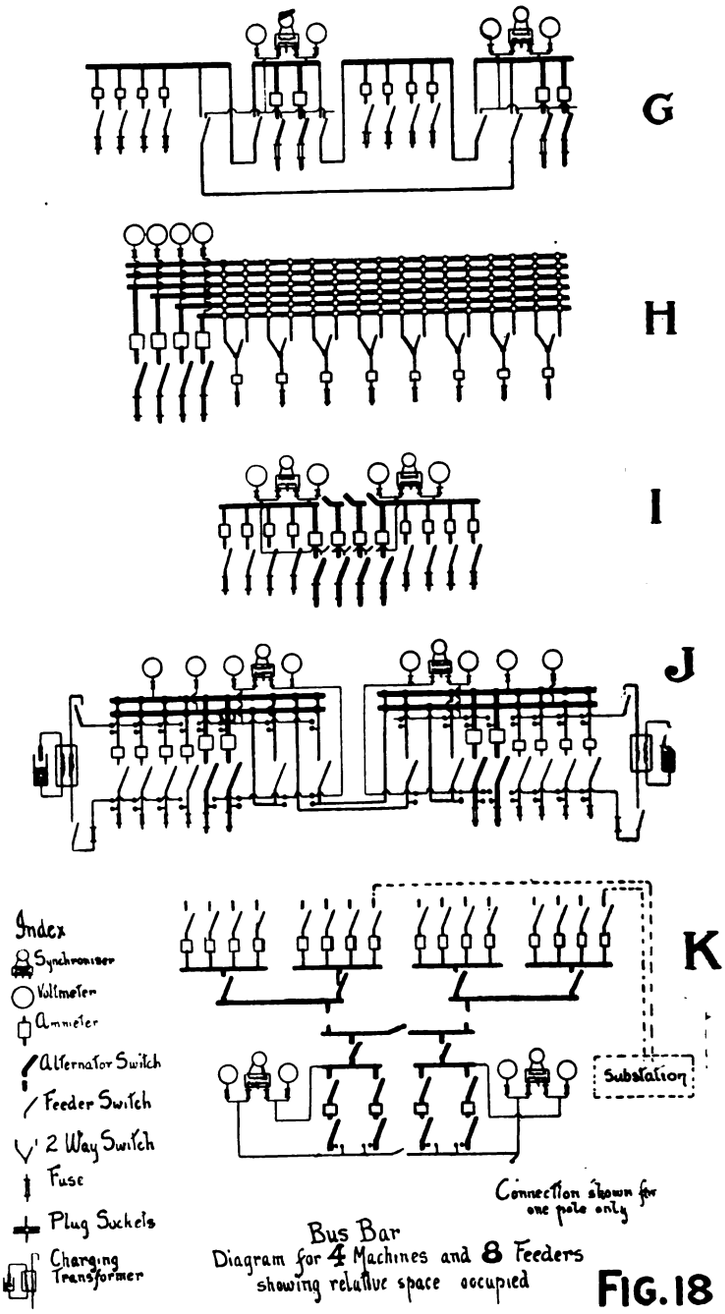

FIG. 18

be made to enable this or other ammeters to be used occasionally for reading the current on any or all three phases. There is no doubt that it is the best practice to supply fuses with duplicate contacts to each phase on the feeder panels. But for generators the conditions are different. With two or three alternators running in parallel, fuses have sometimes given trouble by opening the circuit of all the machines when a fault has occurred on one only. Reverse current automatic switches have been made to meet this objection, but complications are involved thereby, which introduce an element of uncertainty in action under emergencies. Another way of dealing with the question is to have no fuses or automatic devices on the generators. Modern alternators will stand a short for a few minutes, or at least for sufficient time to blow the feeder fuse, if the fault is on the mains, or if the fault is on the generator, to enable the attendant to isolate the defect. Machine and feeder switches must be of selected pattern which will open circuit without enabling a rise in potential to occur, and without causing injury to the switch contacts when used for breaking, not only the rated capacity

the design of feeder switchgear, due to the rise in potential occasioned by switching on and off a long length of main with capacity. Charging devices which will operate in conjunction with feeder switches are necessary in such cases. We have not had much experience with power-factor indicators, but provided a reliable instrument can be obtained to read the lag or lead of an alternate-current supply, it would be a serviceable, though not essential, addition to the feeder panel in that it would to some extent communicate to the central station the condition of the load and the regulation of the motor-generators at the sub-stations. With regard to recording or registering wattmeters the simplest practice is to mount them between the feeder and generator 'bus bars so that they will register the total energy generated by the entire plant. Indicating wattmeters can be mounted on the generator panels in the same way that the power-factor indicators are attached to the feeder panels (see Figs. 15 and 16). But given reliable ammeters it is not difficult to estimate the output of the alternators near enough for all practical purposes, and so where initial cost is of

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moment both indicating wattmeters and power-factor indicators can be dispensed with. The generator panels have obviously to include synchronising devices, and a regulating table containing field switches, field current indicators, and regulating resistances. It is only necessary to add the 'bus-bar voltmeters and possibly a panel for an auxiliary motor-generator to fulfil the principal requirements of a complete three-phase central-station switchgear. In view of the general tendency towards standardisation in the designs of any apparatus manufactured and used throughout the world for one common purpose, it is evident that many designs at present in vogue will disappear in favour of a switchgear which will be the outcome of the experience to be gained in the immediate future. On what lines will the switchgear of the future be based? The author hopes this paper will evoke suggestions that will help to solve this problem and so be a guide to our switchgear designers.

BOILERS AND WATER SUPPLY.

BY F. G. ANSELL.

(Continued from Supplement, February 28.)

I have known it suggested to add caustic soda to the solution of quicklime in order to more quickly and completely precipitate the magnesia, but I tried it myself on a water containing a fair amount of magnesia, and I came to the conclusion that it was not worth doing. It would not be advisable to add carbonate of soda to the quicklime, because this would act upon the carbonate of soda, and by depriving it of its carbonic acid convert it into caustic soda, which would quickly absorb carbonic acid from the air and so recarbonate itself. Quicklime or caustic lime also absorbs carbonic acid from the air and carbonates itself, but not quite so rapidly as soda, because the carbonate of lime being insoluble forms a protecting film upon the surface of still water, whereas carbonate of soda, being soluble, cannot do so. It must also be borne in mind that caustic soda acts upon magnesia in solution to form a hydrate of magnesia, which is very apt to form double salts likely to give trouble.

Many other modes of treatment have been suggested and tried, but I do not consider any one of them will compare with the foregoing. Tannate of soda has been used. This is not a bad salt to put in many waters, but its cost must be borne in mind, as well as the fact that when put in the boiler it remains there until blown out at the blow-off tap. Its object is two-fold—viz., the tannic acid may form on the surface of the iron plates inside the boiler a protecting surface of tannate of iron, at least until any free soda or lime attacks it, and removes the tannic acid from the iron, while the soda is able to precipitate the lime and magnesia. Old pieces of leather—*e.g.*, boots, harness, etc.—have also been put into boilers to soften the water, as well as potato peel, but it is difficult to see how they can do any good to ordinary water. Oyster shells and flint stones have also been used to attract the incrustation, but probably it would be found that they only attract their fair proportion, and make little or no difference to the incrustation on the plates of the boiler.

I can imagine some few people enquiring what is the objection to an incrustation of lime or magnesia in a boiler, and perhaps from their point of view it is a natural question. The objection is that being a very bad conductor of heat it shuts off a great portion of the heat of the furnace, and prevents it getting at the water, and so a lot of coal has to be burnt wastefully, while if no incrustation was between the water and the fire a little coal would enable the boiler to do just as much work. But there is a further and even more serious objection—viz., the water should be in close contact with all the plates of the furnace, and keep them at a reasonable temperature, far below red heat. If the water is prevented by the incrustation from touching the plates, what is to prevent them getting too hot? Obviously nothing, and so the plates get burnt and weakened, too great expansion of the furnaces may occur, and so the whole boiler suffer. It has been found by experiment that this incrustation can in a few days cause a loss of 8 or 10 per cent. of the heat of the fuel, and often in general practice the loss is found as high as 40 per cent. a very short time after cleaning the boiler. This loss is very serious, and being continuous offers a good margin to recoup the expense of softening the water. If the water is carefully softened, there is no difficulty in keeping the inside of the boiler quite free from all incrustation.

The Furnace.

As this article does not deal with the structure of boilers, but only with their economical and proper management, the first thing to be considered with regard to the furnace is the nature of the fire, but even this most interesting subject must be treated lightly in this short treatise, or, at all events, only so far as it concerns the boiler. The only property of the fire useful to the boiler is its heat, but unfortunately it also has other properties, such as forming slag or clinkers, which unite with the iron of the firebars, and so burn them away, as the common phrase goes, but in reality the iron unites with the silica of the slag, and so is easily melted. The readiness to form slag is greatly increased by the presence of potash, hence it is not advisable to burn wood, especially sticks, etc., cut fresh from a hedge with the coal. Soda would also act in the same way as potash. The whole subject of the chemistry of fire is most interesting, and I can well recommend it to the attention of my readers, some of whom may probably consider some of its properties physical rather than chemical. Let them begin by considering that the more the fire is urged—*i.e.*, the more air is passed through it—the more fiercely it burns, which seems to show that it depends entirely upon the latent heat of the oxygen of the atmosphere for its supply of heat, especially when we find that the air, after passing through the fire, is completely changed. Fresh air almost entirely free from carbonic acid goes into the fire, but a very great percentage of the fumes going up the chimney consists of carbonic acid, so that the carbon of the fuel is made into an invisible gas, and is poured into the air in great quantity, where, if it could accumulate, it would poison animal and human life, but Nature has made provision for this; and on enquiring further, we find that trees and plants have in their leaves a ready means of decomposing the carbonic acid, absorbing the carbon to form wood, and giving out again the free oxygen for the benefit of animal life in many ways. Our breathing supplies our bodies with warmth, and the expired air has a considerable proportion of carbonic acid just as the furnace gases have. There are other products of combustion, such as water, sulphurous acid, and carbon monoxide, which pass off as gas invisibly and make the fumes from the fire poisonous and noxious. Any colour in the smoke is combustible, and should be burnt for economy and also for health and comfort. The actual heat itself can and does pass through the iron plates into the water, which can only retain a certain amount, and the rest passes off with the steam in very great quantity, some as sensible and some as latent heat. The temperature of the steam is the same as that of the water in the boiler, and it varies with the pressure. Water boils in the open air at about 212deg. F., but in confined places such as steam boilers it acquires much higher temperatures—*e.g.*, at 50lb. pressure it boils at about 298deg. F., at 100lb. pressure it boils at about 338deg. F., these boiler pressures being above the normal atmospheric pressure of 15lb. In addition to this "sensible" heat, which can be felt and shows itself on the thermometer, there is the latent or hidden heat of the steam, which, when the steam is at 212deg. F., is about 966deg. F., but as the temperature of the steam rises the amount of the latent heat diminishes. The latent heat manifests itself when we turn a steam-pipe into a bucket of cold water by boiling the water with very great rapidity, and the latent heat of the air may be obtained by compressing it. The reverse of this is also true. Air compressed and cooled whilst under pressure absorbs heat when allowed to expand. If the expansion is allowed to take place under water, ice may soon be formed. These considerations show that the heat of the furnace does more than simply evaporate the water in the boiler. The heat does the work, and the water and steam are the means of conveying the heat to the places where the work has to be done. All experienced stokers know that the more work a boiler has to do the more fuel they must put on the fires, or in effect the more heat they must produce.

When coal is put on to a fire, the first effect is to produce gases, heavy oils, and soot. All these are very

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inflammable, but they cannot burn without air. Hence furnaces should be arranged so that air can be supplied to the top of the fire as well as underneath it. Obviously, if all the air going into the furnace is used in keeping the coke or cinders hot, there is not enough to burn the gases, smoke, etc., which pass away from the top of the fire, but if we can manage to get enough air over the top of the fire to these gases, etc., then they will be burnt, and will supply heat to the boiler, and at the same time disappear. For this reason the fire-doors are fitted with adjustable shutters, so that when coal is put on more air may be admitted to burn the gases, oils, smoke, and soot, and when these are all burnt then little or no air is wanted on the top of the fire, so the adjustable shutters are closed entirely, and all the air passing to the furnace goes through the firebars and through the fuel. It would, of course, be bad practice to let cold air get between the fire and the boiler, as it would rob the boiler of a certain amount of heat. Further than this, when the fire is very hot, cold air if admitted will often cause a crack in the boiler plates forming the crown of the furnace, as it produces unequal expansion in the plates. To facilitate the burning of the smoke, the fire should be well spread over the firebars and the fresh coal put on in front of the furnace, so that the smoke must pass over the fire further back and so be burnt. It is often found that the draught of the furnace has to be regulated by means of the dampers or sliding doors arranged like a portcullis at the back of a boiler, and this is especially the case with horizontal boilers, many of which are 30ft. long, and the fire passes through the middle, underneath, and then along the outside, so that often there may be more than 100ft. of furnace and flue open to the air on the fire side of the damper. This is a source of danger especially when the fires are "banked up" for the night. The common way of doing this is to let the fires down and then to put a lot of small coal on, so as almost to smother them, and to almost, if not quite, let the damper down so as to close the chimney entirely or very nearly so. Sometimes the fire-doors are closed, and sometimes they are left open. Obviously, it is far the safest plan to leave the damper so as not to entirely close the chimney, and to leave the fire-doors open so that any gases, etc., produced may pass safely away as soon as the fire and coal form them. If they cannot get safely away, it is by no means impossible that they may accumulate, and that sufficient air may find its way into the furnace to form an explosive mixture. The violence of an explosion depends upon the proportion of air mixed with the inflammable gas, and also upon the confinement in which it may occur. Therefore, the slightest explosion should be taken as serious warning, and prompt and efficient means taken to stop its recurrence. One of these will generally be to maintain a current of air through the furnace and up the chimney. Dampers are so very general that it would perhaps hardly be wise to do more than suggest that many furnaces would be quite as well without them, and that the draught could be better and more safely regulated from the front of the furnace. Whilst on the subject of safety, it is as well to mention that the water in the boiler must always thoroughly well cover the furnace, or the plates will be unduly heated, an explosion may result, or the top of the furnace may be forced down by the pressure in the boiler. It is not safe to allow the water to blow out of the boiler under any circumstances, not even for cleaning out, until the fire has been entirely withdrawn and the furnace allowed to cool a little.

It is not generally recognised that the water in the boiler absorbs all the heat of the furnace which passes through the plates, and that the plates, although exposed to very fierce heat, do not become very hot. This fact may be easily and convincingly demonstrated by means of the domestic kettle, which, although placed on a hot fire and boiling vigorously, is quite cool at the bottom, and may safely be taken off the fire and placed on the palm of the human hand. When removed from the fire, the heat of the boiling water is soon communicated to the bottom of the kettle.

Occasionally a boiler may be seen with water dropping from its fittings—such as its gauge-glass, taps, etc.—and when the clinkers are raked out they are allowed to lie close to the face of the boiler, and make the outside rim very hot. The author once saw a boiler seriously damaged from this cause and leaking badly. The iron flange and its rivets were much corroded.

Forced draught is undoubtedly a good thing in some places, such as where there is a short or faulty chimney, but where there is a good natural draught which can be regulated from the front of the furnace by the usual appliances, it is not worth while to incur the expense of putting in the necessary apparatus or of maintaining a jet of steam from the boiler to do the work which the chimney is already well able to do. However, the general efficiency of a chimney may be taken as in proportion to the square of its diameter and the square root of its height, so that supposing the chimney good and strong enough to carry an addition to its height (which very few are), even then this way of increasing its efficiency is necessarily slow and costly. In such a case it would be well to consider the advisability of putting in forced draught, and it would probably be the best and most satisfactory thing to do.

General Economy.

We have already stated that the quantity of steam generated by a boiler is in proportion to the amount of fuel burnt, and, of course, this statement supposes that the fuel is of uniform quality and that it is burnt with the greatest advantage. A fire to give its maximum effect should burn brightly and be kept free from ashes and clinkers, and it should burn its own smoke. A dull fire choked with ashes, etc., and not able to burn its own smoke, is obviously wasteful in a boiler furnace. As the coal bill is often very large, great attention should be paid to the quality as well as the price of the coal, for its real value is its calorific value, which is not necessarily the same as its price. Therefore, means have been devised for ascertaining the heating effect of coal, and perhaps the simplest is that of "Count" Rumford, which consists of a bath made of sheet copper weighing 2lb. per square foot, and capable of holding 100 gallons—*i.e.*, 1,000lb. of water. At the bottom of this bath is a small fireplace, well covered with non-conducting material so that no heat may radiate from its exposed sides, and capable of holding comfortably 1lb. of the coal to be tested. The chimney from this fireplace is made of sheet iron. Its sectional area is 1ft. by 1in.—*i.e.*, 12 square inches—and it is led spirally through the water from bottom to top. Its length is as great as possible for practical purposes, so that the heat of the products of the combustion of the sample of coal—*i.e.*, the furnace gases—may be the same as the temperature of the water in the bath. This being the case, obviously the water has taken all the heat generated by the burning of the coal. A thermometer will show how many degrees the temperature of the water has been raised during the experiment. Any number of samples of coal may be tested in this simple apparatus, and, all the circumstances being the same in each experiment, the best sample of coal will be that which generates the most heat with the least smoke and the least ash, etc. Of course the 1lb. sample must be very accurately weighed, and must be ignited in a definite way, such as by the addition of 1oz. of white-hot charcoal, or by holding a gas jet under it for 20 or 30 seconds. It must also be broken into proper sized pieces, and each sample must be treated exactly alike. In careful hands this apparatus will give good indication as to which is the best sample of coal, and it is not troublesome or dangerous to use. It must, however, be borne in mind that some furnaces will use one kind of coal and some another to the best advantage, and that the best coal for one furnace would not necessarily be the best for any other. The best is a practical test in the furnace where the coal is to be used, and under the usual working conditions. The report of a chemical analysis gives very valuable information if the sample has been fairly taken. The heat producers in coal are the carbon and hydrogen. The mineral matter, ash, etc, are worse than useless, as they produce no heat and have to be cleared away. Many trials have been made to ascertain the heating power of coal, and as many or more chemical analyses. A long series of experiments was conducted at Woolwich Dockyard many years ago, and the result tabulated and published in

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TABLE A.

Coal.	Pounds of water evaporated by 1lb. of coal.	Per cent. of clinker.	Per cent. of ash.	Smoke.	Carbon.	Hydrogen.
North Country	8·16	1·47	5·03	Heavy and black.	—	—
Staveley	7·69	·87	5·28	Light.	79·85	4·84
Aberdare steam	8·98	1·72	5·93	Light.	—	—
Merthyr	8·78	1·02	5·54	Light.	90·12	4·33
Anthracite	9·46	1·48	10·32	None or very little	91·44	3·46
Wallsend Elgin	8·46	—	10·7	—	76·09	5·22
Coke, consolidated	8·76	·14	19·11	—	—	—

Ure's dictionary, from which is taken the abstract given in Table A.

The simple apparatus of "Count" Rumford may be made a little more scientific by being carefully covered and surrounded by a non-conducting material, so that it may not lose heat. Its heat-absorbing power or capacity for heat is said to be about equal to that of 8lb. of water. This could be proved quite easily by actual experiment—viz., supposing the apparatus carefully covered with non-conducting material, and that it has acquired the temperature of the surrounding air, which is 60deg. F. Now put one gallon of water at a temperature of 62deg. F. into it, and swash it round so that every part of the inside of the tank shall have been in contact with the water a few seconds; then with the small thermometer observe the temperature of the water. Suppose it is now 61deg. F., then the gallon of water has lost 1deg. F., and this amount of heat has passed into the apparatus, which may be said to have as much capacity for heat as one gallon or 10lb. of water. The capacity for heat is generally called the specific heat, and the specific heat of water is 966deg. F., as already explained. Now, suppose we wish to ascertain how much water 1lb. of coal will convert into steam, all we do is to put into the tank 956lb. of water—*i.e.*, 9·56 gallons—and the apparatus having the heat capacity of one gallon of water, obviously we have the equivalent of 966lb. of water, and we know that it requires 966deg. F. to evaporate 1lb. of boiling water. We observe the temperature of the water before lighting the fire, and again as soon as it is burnt out. Each degree the temperature of the water has risen represents 1lb. of water evaporated by the 1lb. of coal—*e.g.*, if the temperature of the water in the bath at starting was 60deg. F. and at finishing 70deg. F., when 1lb. of this sample of coal would evaporate in actual practice 10lb. of boiling water.

This same information may be gained in a more elegant manner and more quickly by the following chemical means, but great care is necessary or an explosion might occur. It should not, therefore, be attempted by persons unacquainted with chemical manipulations and their necessary precautions. It has already been explained that the process of burning is chemically a process of oxidation, and that coal burns because it unites with the oxygen of the air.

(To be continued.)

LONDON COUNTY COUNCIL ELECTRIC LIGHTING RULES FOR THEATRES.

On the 25th ult. the London County Council adopted a series of new regulations with respect to the electric lighting of theatres and other places of public resort licensed by them. We have now a copy of these rules before us. We find that there are no less than 58 sections which have to be complied with by contractors and engineers in carrying out such electric lighting. The objects of these rules may be divided into two classes. The first provides that there shall not be any interruption to the lighting such as would throw the whole of the theatre into darkness, and thus cause a panic amongst the audience. From the rules which come under this heading we see that the Council now require three completely distinct systems of wiring in all theatres. One of these systems is to be used wholly for stage lighting, and the other two for the auditorium lights. Each of these systems of lighting has to be supplied from independent connections to the public mains. It is also required that the two systems of wiring for the auditorium shall each supply about one-half of the lights, and that the lights shall be connected on to the different circuits alternately. These requirements seem to us to be reasonable, and we note that when the generating plant is installed at the theatre the duplication is still to be arranged for. The owner has then the option of either installing two wholly distinct sets of plant, each capable of giving the normal full load required, or of installing one plant and a battery of accumulators dealing with this load for five hours. The other heading under which the rules may be divided out deal with the safety of the electric wiring, and to these we think considerable exception may be taken. The grounds for this exception are that while a number of the requirements are gone into with great detail, so much is left indeterminate. Other requirements, again, which we should have expected to find are not included. For instance, from regulation No. 24 we gather that wood casing may still be employed. Again, in the clauses dealing with iron pipes for containing the cables we fail to see any requirement expressed as to these iron conduits being always in metallic connection one with the other. The indeterminate clauses read, as a rule, somewhat like the following: "Metal fastenings for fixing conductors shall be avoided as far as possible." "All switches and cut-outs shall have sufficient length of break." "Arc lamps shall not be used inside such premises without special permission from the Council, etc." It seems to us that all these indeterminate matters which call for special permission from the Council involve a great waste of time on the part of the conductors, and also an increased staff in the electrical department of the Council. Taking the arc lamp question, for instance, there is no doubt that these are more safe than the lime-lights for stage work. Certain precautions have to be taken to prevent any fire risk from these arc lamps, and if these precautions were only insisted on in the regulations the special permission would become unnecessary. In fact, a firm specification allowing only the highest classes of electric wiring might well be drawn up by the Council's engineers as a *sine qua non* for work in theatres. The present regulations, with their "ifs" and "buts," allow a contractor to tender for the lowest classes of work, which will afterwards be rejected by the Council's inspectors, or which, if passed, will become dangerous in the course of a few years.

LEGAL INTELLIGENCE.

BOURNEMOUTH TRAMWAYS.

In the Chancery Division of the High Court last week, Mr. Justice Swinfen Eady heard the adjourned motion of the Poole and District Traction Company for an injunction restraining the Bournemouth Corporation from proceeding any further with the laying of a tramway in the Christchurch-road between the Hotel Metropole and Boscombe.

The contention of the company was that the Corporation had failed to make any substantial commencement of the work of construction in accordance with the obligations imposed upon them by their parliamentary powers. Evidence had been taken during the week in the form of affidavits.

Mr. Justice Swinfen Eady said there was no pressing need for an injunction to restrain the Corporation from continuing the construction, as in the event of the motion being decided in plaintiffs' favour, defendants would have to undo all the works accomplished.

The trial of the action was accordingly postponed by agreement.

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ELECTRIC RAILWAYS.

A paper dealing with the problems of electric railway equipments was read by Mr. J. Swinburne and Mr. W. R. Cooper at the last meeting of the Institution of Electrical Engineers, and is to be discussed by the members at their next meeting. We need hardly say that there is ample field for discussion in the many problems connected with electric railways, and the authors have widened this field by introducing a number of points which are really outside the scope of the paper. Thus, as they naïvely state in their conclusions, "Many of the methods mentioned will seem out of the way and curious, but whether they are or are not worthy of adoption or even serious consideration, they may be worthy of discussion, especially if capable of modification and improvement." The authors evidently expect the members of the Institution of Electrical Engineers in London to discuss some methods not worthy of serious consideration, which seems to us to entail a great waste of time. Surely we have a right to expect the contributors to the *Proceedings* of our parent Institution to display a critical knowledge of the subjects on which they write, and to confine their attention to points within the region of practical politics, and which will tend to advance the interests of the profession. In the paper before us, for instance, a vast amount of interesting calculations are given as to the energy that can be returned to the line by different systems of electric traction, and also the most economical way of running trains over suburban lines. One of the great advantages of the series constant-current system, which the authors advocate, is that the motors with the armatures reversed can be used as electric brakes to give a constant deceleration at all speeds. It is also shown that the energy for acceleration is the predominating factor for consideration, as it is much greater than that required to overcome frictional resistance. We are surprised, therefore, to find that on the last page of the paper it is stated that when once railways have been electrically equipped there will be no further need of signals. In the authors' words, "If the trains are worked electrically the power can be cut off without communicating with the driver, and the driver will have no need of signals . . . all the driver has to do is to keep a look-out for anything on the line. He has also to start and stop at stations." The authors seem to forget that the cutting off of the current will not pull up the train. In fact, if a line were to be equipped on the constant-current system they advocate, the signalman would prevent the driver from using the electric braking, which is one of the great advantages claimed for it, and that at a time when it is most urgently needed. We quote this case as a sample of the numerous discrepancies which will occur to an electrical engineer when reading through the paper before us, and there are also many difficulties which have not been met in any way by the authors. Thus on p. 28 he will find amongst the advantages of the series system with constant current that the collection of the current should be simpler than with the usual constant voltage system, as it is smaller. Then on p. 38 it is stated that 2,000 volts will be used per train and 500 amperes. The authors add that the collection with this series system is more difficult, as the current is greater, and there must be double conductors. They add that they have not dealt with the problem of collecting, "not because it is not real, but because there is no solution to offer. They add, "It may prove very difficult to collect 500 amperes at 75 miles per hour." Other difficulties in connection with the insulation of the motors on the train, which with four trains in series may reach at least 4,000 volts from earth with the middle point of the

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8,000-volt circuit earthed, is dismissed with the statement that a Raffard or some such coupling would have to be used. There is also the problem, which is not even mentioned, as to how the engines driving the main dynamos are to be controlled. For instance, with the four train in series all at nearly full speed, there would be practically 8,000 volts and 500 amperes output required from the generator. If, now, three of the trains wish to stop and have their motors reversed, the engine will have to act as a brake in some way to absorb 4,000 volts and the same current. This problem of working steam-engines at constant torque and variable speed, even when the torque may require to be reversed, is one which is well worthy of consideration and at least of partial solution before bringing a series constant-current system of electric traction before the Institution. Presumably the direction of rotation of the engine should be reversed, compressed air forced into the boilers, but the process of combustion in the boiler furnaces would not even then be reversed. With a single train at work on the section this trouble would occur frequently, and might necessitate the use of braking resistances in the central station, such as have been used in connection with the three-phase mountain railways in Switzerland. In conclusion, while the paper will give rise to a long discussion, the value of this discussion will be minimised by the introduction of schemes "not worthy of serious consideration."

FORTHCOMING EVENTS.

FRIDAY, APRIL 4.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper: "Compressed Air and its Applications," by Mr. L. G. Crawford.

MONDAY, APRIL 7.

Royal Institution.—At 5 p.m., general monthly meeting.

Institution of Electrical Engineers (Newcastle Section).—Ordinary meeting. Paper: "Mains Department of a Direct-Current Supply Station," by Mr. J. F. Moore.

Institution of Electrical Engineers.—Students' visit to Newcastle. Those travelling from London leave by the 10 a.m. train from King's Cross.

TUESDAY, APRIL 8.

Royal Institution.—At 3 p.m., Dr. A. Macfayden on "Biological Enquiry" (Lecture I.)

Institution of Electrical Engineers.—Manchester Section: At 7.30 p.m., ordinary meeting. Paper: "Large Gas-Engines for Driving Electric Generators," by Mr. A. R. Bellamy.—Glasgow Section: At 8 p.m., ordinary meeting. Paper: "Notes on the Testing of Tramway Motors and an Investigation into their Characteristics," by Mr. M. B. Field.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Papers to be further discussed: "The Greenwich Footway Tunnel," by Mr. W. C. Copperthwaite; and "Subaqueous Tunnelling through the Thames Gravel: Baker-street and Waterloo Railway," by Mr. Arthur H. Haigh.

WEDNESDAY, APRIL 9.

Institution of Civil Engineers.—At 2.30 p.m., students' visit to the works of Messrs. Doulton and Co., Limited, High-street, Lambeth, S.E.

Institution of Electrical Engineers (Students' Section).—The meeting fixed for this day in London has been postponed till April 30, in consequence of the students' visit to Newcastle.

THURSDAY, APRIL 10.

Royal Institution.—At 3 p.m., Prof. Dewar on "The Oxygen Group of Elements" (Lecture I.).

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Paper to be further discussed: "Problems of Electric Railways," by Messrs. J. Swinburne and W. R. Cooper.

FRIDAY, APRIL 11.

Royal Institution.—At 9 p.m., Prof. Dewar on "Problems of the Atmosphere."

Electro-Harmonic Society.—At 8 p.m., St. James's Restaurant, final smoking concert of season.

Physical Society.—At 5 p.m., ordinary meeting. Papers: "An Apparatus for Vapour-Pressure Measurements," by Mr. Grant: "The Use of Cathode Rays for Alternating-Current Measurements," by Mr. Morris; "An Experiment on the Current Growth in an Inductive Circuit," by Mr. Morris; "An Electric Heater," by Dr. R. A. Lehfeldt; and "Note on the Compound Pendulum," by Mr. S. A. F. White.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TUNBRIDGE WELLS TELEPHONE ENQUIRY.

SIR,—It is to be hoped that no importance will be attached by those interested to the so-called report of the proceedings at this enquiry which has appeared in the last three numbers of the *Electrical Review*. The *Electrical Review* is said to rejoice in three editors, so it is to be presumed that its articles are usually edited. That may or may not be true as a rule, *but I am certain this one has been!*

It should be noted that, notwithstanding anything in the *Electrical Review*, it was proved at the enquiry:

1. That, apart from certain extras ordered by the Telephone Committee, the cost of construction was in agreement with the estimates.
2. That the undertaking showed a profit during its first six months of working. (Did the *Electrical Review* do *that*, I wonder!)
3. That the Corporation service is efficient and in great esteem.
4. That the number of Corporation subscribers has increased three-fold in six months.
5. That the Corporation, in one short six months, had provided telephone communication in places which had been entirely neglected during the previous 18 years' monopoly.
6. That all local societies, chambers of commerce, ratepayers' associations, etc., petitioned in favour of the additional loan.

The desperate and sustained attack that the Corporation undertaking has been subjected to must be taken as a sure proof of its great success. It has got to be stopped if humanly possible—that's a fact! But it won't be, all the same.

It is noteworthy that no local witness went into the box for the opposition. Not one of the anonymous correspondents who have inundated the columns of a local print with mendacious statements during the last six or eight months had the courage to appear. The opposition consisted entirely of a serio-comic barrister and a local solicitor (who appeared to appear for each other, and also for a third party, who didn't appear for himself); a singularly ineffective chartered accountant, who demolished the borough accountant's figures by assuming a basis that was entirely erroneous; a youthful ex-employé of the National Telephone Company, posing as a telephone expert, who had had no training outside the National Telephone Company's London system (universally reported the worst in the world), and who didn't know a terminal insulator when he saw one; and Mr. Kingsbury, who admitted that he had never laid out or managed a telephone system in his life!

Truly, the opposition made a marvellously poor show for the money it must have spent!—Yours, etc.,

Glasgow, March 31, 1902. A. R. BENNETT.

ELECTRICAL ENGINEER ON BOARD SHIP.

SIR,—Would you kindly advise reader through your columns how to obtain charge of a plant on board ship. I have had two years' experience in electrical work, which time has been served as an apprenticeship. I can competently wire a house for bells or telephones, and possess a fair knowledge of main switchboard connections. Could I go as an assistant, or should I have to be thoroughly competent to take charge of plant; if so, how could I obtain the practice necessary? Would any corporation take me for a short time if I partially or wholly gave my services free? Particulars as to whom I should apply, your advice, etc., will be appreciated.—Yours, etc., A. S.

[N.B.—We would advise our correspondent to get some experience in connection with dynamos and steam-engines before applying for such a post on board ship. It would be well to get this experience with a manufacturing firm, as he evidently has not done much heavy engineering work.—ED. *E. E.*]

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ENAMELLED CASING.

SIR,—Can any of your readers oblige us with the name and address of the firm who supplies white enamelled wood casing in London?—Yours, etc., D. AND S.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

469. What is the best 10-c.p. auxiliary standard for use with a photometer for incandescent lamps having regard to (*a*) very small changes of pressure on the lamp under test; (*b*) the type of screen used; (*c*) the colour of the light.—PHOTOS.

470. Given two house services 50 yards long laid under the following conditions, what is the best way to calculate the drop? First condition—two service lines of $^{19}/_{16}$ cable in two 1½in. galvanised iron pipes; second condition—$^{19}/_{16}$ concentric cable in galvanised iron pipe. The supply is alternating in both cases at 115 volts, periodicity 50, demand 73 amperes. Can any empirical formula be worked out to apply to different sizes of single and concentric cables in iron pipes? If the service was laid in earthenware casing would the drop be due to copper resistance alone?—R. S.

ANSWERS.

Question No. 463.—It is found that the iron loss in the core of a dynamo due to hysteresis and eddy currents is from 1½ to 3½ times that calculated on the basis of even flux distribution in the teeth and core. On full load the loss is still greater. Can any of your readers give a formula for this which will give something like accurate results, or give some reason for this extra loss?

Best Answer to No. 463 (*awarded* 10*s.*).—The existence of a considerably greater core loss than that calculated by the ordinary rules for hysteresis and eddy currents has been repeatedly noticed during the past few years, and various explanations have been given. The principal cause is undoubtedly the presence of eddy currents in the rotating masses of solid metal used to support the armature and in the pole faces, though part of the excess is accounted for by the fact that the distribution of the flux in the core is very far from uniform, the parts near the periphery and about the roots of the teeth working at a considerably higher density than the inside parts of the core. The further increase in the loss which occurs at full load is usually not large, and is due to the increase in density in the teeth and other parts of the core consequent on the distortion of the flux distribution by the armature reaction. The eddy currents in the pole faces depend largely on the relative widths of slot and tooth and of slot and length of air-gap between magnet and armature, but no satisfactory formula has as yet been developed for their calculation. Eddy currents in the winding supports at the ends of the armature, in the armature hub, and other solid rotating parts, are naturally too complicated to permit of direct calculation.

It is, however, a fairly simple matter to determine the core loss experimentally—at least at no load. The most satisfactory method of doing this is to drive the motor to be tested by means of some other small motor, either directly coupled to it or connected by a light belt. A reading of the motor amperes and volts is first taken with the test machine unexcited and running at its normal speed. Then the machine is separately excited to the required amount, and a second reading of the motor input is taken. The difference between the two inputs represents the core loss of the test machine, assuming that the loss in the auxiliary motor remains constant, and that no magnetic pull on the bearings of the test machine occurs when it is excited. If the test is repeated at various speeds it will usually be found that the core loss per revolution (or per cycle) is considerably greater at the higher than at the lower speeds. This points fairly conclusively to the presence of eddy currents, and, in fact, enables the relative amounts of eddy-current and hysteresis losses to be determined, since the former are proportional to the square of the speed, while the latter vary directly as the speed.

Mr. Parshall has published (*Street Railway Journal*, 1900) a curve of total core losses per pound of iron determined from experiments on 23 multipolar generators. This curve

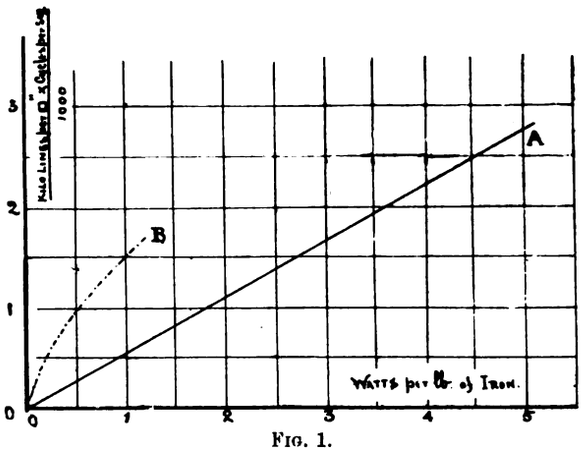

FIG. 1.

is reproduced at A (Fig. 1). It will be seen that it connects watts per pound and

$$\frac{\text{Kilo lines per square inch} \times \text{cycles per second}}{1{,}000}.$$

The assumption that increase in density has the same effect on the losses as increase in the number of cycles per second is not strictly correct, for that part of the loss which is due to hysteresis varies as the 1·6th power of the density, but only directly as the number of cycles per second. The assumption is, however, correct as far as the eddy-current loss is concerned, as that varies as the square both of the density and of the number of cycles per second. The curve, on the whole, probably gives as close results as can be expected from any method intended for general application, especially considering the very indeterminate nature of the eddy currents and their dependence on the type of machine. To use the Curve A it is only necessary to obtain the kilo lines per square inch of iron below the teeth

$$\left(= \frac{\text{Total flux per pole in thousands of C.G.S. lines}}{\text{Net length of iron parallel to shaft (inches)} \times \text{Radial depth of iron below slots (inches)}} \times 2 \right)$$

and multiply it by the number of cycles per second

$$\left(= \frac{\text{Revolutions per minute} \times \text{number of poles}}{120} \right)$$

and divide by 1,000. The watts per pound corresponding to the value so obtained is then read off the curve, and, when multiplied by the total weight of iron in the core, gives the total core loss.

For the sake of comparison, the curve of hysteresis loss in an average quality of sheet steel at 7½ cycles per second (as given by Mr. Parshall) is shown at B, Fig. 1. It will be seen that Curve A shows from 2½ to 5 times as great a loss as Curve B. Though the above Curve A will give more reliable results than the ordinary methods, involving the use of such a curve as B, Fig. 1, yet for accurate results it is essential for each manufacturer to determine the curve for his own particular type of machine by a series of experiments somewhat on the lines described above.—Q.

Answer to No. 463 (*awarded* 7*s.* 6*d.*).—Many different formulæ have been published for the determination of these losses which are given out in heat, and the different coefficients that have been deduced are still more numerous. Not one, however, can be regarded truly reliable, since

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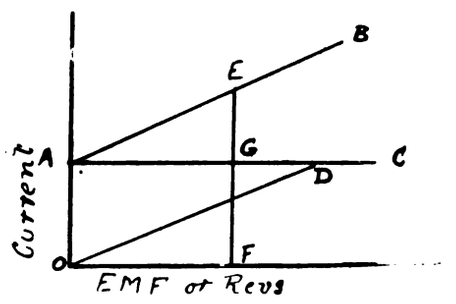
when applied under conditions differing but slightly from those contemplated by their inventors they may lead to results which are far from being what was expected. The reason for this is that the eddy-current loss has never been given a prominent and separate place in calculating the watts lost over an armature; it has, in most cases, been entirely left out of sight, owing to the difficulties in ascertaining its value in a machine under test and estimating its probable amount in designing a machine. As compared with the watts expended on the resistance of the armature, the hysteresis loss is most important in small machines, where the speed is very high and the induction generally very high; but in the case of large drum armatures, not only is the periodicity low, but the induction is very seldom pressed so high as in small ring armatures. Many of the published formulæ are only applicable to some standard speed, say 3,000ft. per minute, or to armatures wound with round wire and of no value for armatures with large bars of rectangular section; an alteration which at first seems unimportant may make a great difference in the estimated eddy currents. With a given field, a given winding, and a given core the eddy loss will be directly proportional to the square of the speed, because if the speed be increased n times the eddy E.M.F. will also be increased n times, consequently the eddy current will be increased n times. It may, therefore, be expressed by a coefficient × the square of the speed, the value of the coefficient being different for different cases. Mr. Kapp has devised a method by which these eddy-current losses can be experimentally determined. It is, briefly, as follows: Run the machine as a motor without load at various speeds, and noting the current through the armature, the E.M.F. applied to it, and the speed, the excitation being kept constant at the desired value. Now, the power absorbed by a motor (exclusive of excitation and loss over armature resistance) $= (E - C_a R_a) C_a$, where E = E.M.F. impressed on the armature, C_a = armature current, and R_a = armature resistance. With large armatures of low resistance, $C_a R_a$ is practically negligible (when running light) as compared with E—*i.e.*, the back E.M.F. is nearly equal to the impressed E M.F. It is well known that, other things being constant, the speed is proportional to the E.M.F. impressed on the armature. Now, the hysteresis (as will be explained later) and the friction losses are simply proportional to the speed, while the eddy-current losses are proportional to the square of the speed. So the total power absorbed by a motor may be divided into two portions—viz., watts spent in hysteresis and friction = H N, and those spent in eddies = F N^2, where N = revolutions per minute, H and F = two constants. If the speed of the motor is increased, so are the watts lost in hysteresis and friction, but the back E.M.F. is increased in equal proportion. So if we regard C_a as split into two portions—one to overcome hysteresis and friction and the other to overcome eddy losses—the value of the former must remain constant in order that its product with the back E.M.F. may vary as the speed, and a curve showing its relation to the speed will be a horizontal straight line, as at A C. But as the



watts lost in eddy currents increase as the square of the speed, the portion of C_a which is spent in overcoming the eddies must also increase equally with the speed. Therefore, the curve showing the relation of this second portion must be a straight line inclined at some angle to the horizontal axis as O D. Adding the ordinates of the two curves, we obtain a third curve, A B, representing the total current in the armature. If we experimentally find A B and draw A C parallel to the horizontal axis, we can easily find values for F and H. To find power in watts absorbed at any point of the curve, it is only necessary to multiply the abscissa, in volts by the current. Thus for the point E total watts absorbed = F E × O F, and of these the watts absorbed by hysteresis and friction = O F × F G, and the watts observed by eddy currents = O F × G E. This method includes eddies in polar face, but these are so small as to be negligible. The watts lost can easily be calculated. The energy so expended has been found by Prof. Ewing for all conditions of magnetisation. The table gives these values expressed in ergs per cubic centimetre per cycle, one cycle corresponding to one revolution in a bipolar field, so the following formula can be used to find hysteresis losses $= \frac{h \, V \, n}{10^7}$ = watts where h = ergs per cubic centimetre per cycle found from the table, V = volume of armature iron, n = revolutions per second. A great deal more could be said about these losses, but space will not allow.—G. D. P.

Answer to No. 463 (*awarded* 5*s.*).—The core losses in an armature are mainly twofold: (*a*) hysteresis loss due to molecular friction in the iron core, brought about by the changing magnetic flux; (*b*) loss due to eddy currents in the core, armature conductors, supports, etc

It is clear that the loss (*b*) is made up of too many uncertain factors to be calculated with any degree of accuracy. It is probable that the difference between the calculated and actual losses referred to in the question arises from the fact that the margin allowed for the eddy-current part of the total loss is not sufficiently liberal. These eddy-current losses depend on the square of the flux density, square of the periodicity, thickness of plates, and the care with which the plates are insulated from one another, this latter being, of course, a very variable and uncertain factor. To allow for this eddy-current component of the total loss the calculated values should be multiplied by from 1·25 to 2·5, according to the likelihood of additional losses. Such allowance is rendered necessary by the fact that machine work on the core, such as turning, slotting in the case of toothed armatures, and even smooth filing, are processes destructive to the isolation of the plates one from another, and thus tend to produce a more or less continuous conductor parallel to the coppers of the armature—an ideal condition for the production of eddy currents. The writer has known cases of cores rejected in the test-room in which the losses have been greatly reduced by a careful removal of burred edges, hammer marks, etc. For the following approximate rule for losses in fairly large cores the writer is indebted to "Electric Generators," by Messrs. Parshall and Hobart. The constant 1·7 is the average value given by a curve plotted from a large number of experimental results: Watts per pound of core = 1·7 × cycles per second × kilo-lines density per square inch section of core.—A. M. T.

Answer to No. 463 (*awarded* 5*s.*).—The great increase of the iron losses in the core are most probably due to the discs having been turned, or slotted, or even filed after being built. In many shops, for the sake of cheapness, the discs are bought from the makers in the form of plain ring or drum stampings, and slotted after building in a milling machine. This is quite a common practice, and is a bad one from every point of view. The discs being of soft iron, it is impossible to slot or file them without burring over the edges, and thus making a more or less continuous surface of iron, and consequently increasing the eddy currents abnormally. The stampings should be bought in slotted, or, if otherwise, they should be taken off the shaft and the burr removed before winding. Stampings as made by reliable firms do not require any touching up, but it is quite a common thing for the core builder to give them a good filing and dressing after threading on the shaft. This is quite an unnecessary piece of work, besides being detrimental to the working of the machine. For hysteresis losses good results may be calculated from the following formula:

$$h = n \eta B^{1.6} 10^{-7},$$

where h = loss in watts per cubic centimetre;
n = cycles per second;
η = hysteretic constant;
B = flux density.

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It is very improbable that hysteresis had much to do with the great increase of the losses; however, from the above formula their value can be determined. Values for η can be obtained in any pocket-book, and for armature discs may be taken as ·0025 to ·003.

For calculating the eddy currents

$$W = (t\ M\ B)^2\ 10^{-16},$$

where W = watts per cubic centimetre;
t = thickness of plates;
M = cycles per seconds;
B = flux density per square centimetre.

Another cause might be the flanges binding the armature discs, or other masses of metal moving in a strong field. In fact, the effect of these might have been overlooked in the calculation. These should be cut down as far as is consistent with mechanical strength and stiffness, and kept as much as possible out of the path of the field. The first reason assigned I consider the most likely, and, as will readily be seen, it is difficult, if not impossible, to give a formula from which anything like correct results could be obtained.—EDDY.

Question No. 464.—Describe, in detail, a suitable resistance and other necessary gear for milking a weak cell from two hospital cells of same size. Normal charging current, 120 amperes; cell capacity, 900 ampere-hours.

Answer to No. 464 (*awarded* 7*s.* 6*d.*).—The best method for "Q. E. I." is to use a resistance frame such as is shown in Fig. 1. The resistance is made up of six loops of iron

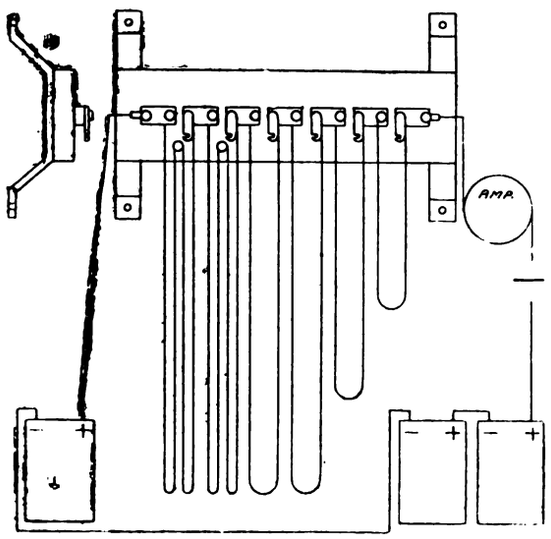


FIG. 1.

wire $\frac{5}{16}$in. in diameter. This will give a total resistance of about $\frac{1}{54}$th of an ohm. The lengths of loops, block to block, are: two of 8ft., two of 4ft., one of 3ft., and one of

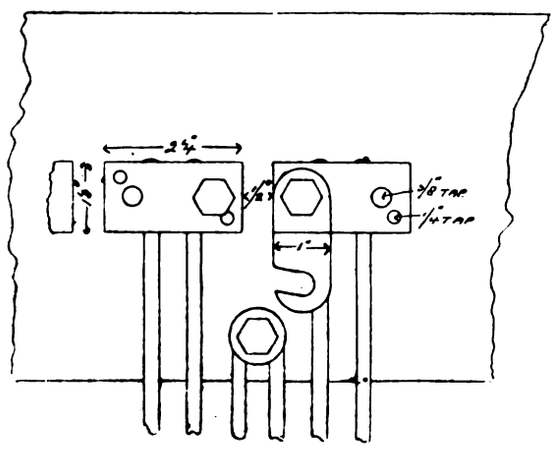


FIG. 2.

2ft. The blocks and connecting links may be made of iron or of gunmetal, but in either case should be well tinned. To fasten wire in blocks they should be drilled right through, the wire riveted over at top, and well sweated in. The slate base is 24in. by 6in. by 1¼in., to be fastened to wall by means of wrought-iron brackets. Fig. 2 is figured sketch showing manner of holding loop of the 8ft. lengths; a ¼in. bolt and washer will keep it in place. This frame will serve the purpose, and the wires will not require any other protection or fixing.

An alternative method is by fitting up a liquid resistance having two plates (Fig. 3) that may be raised and lowered

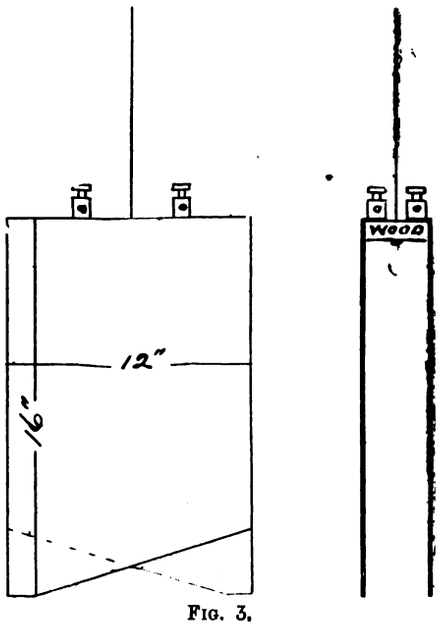
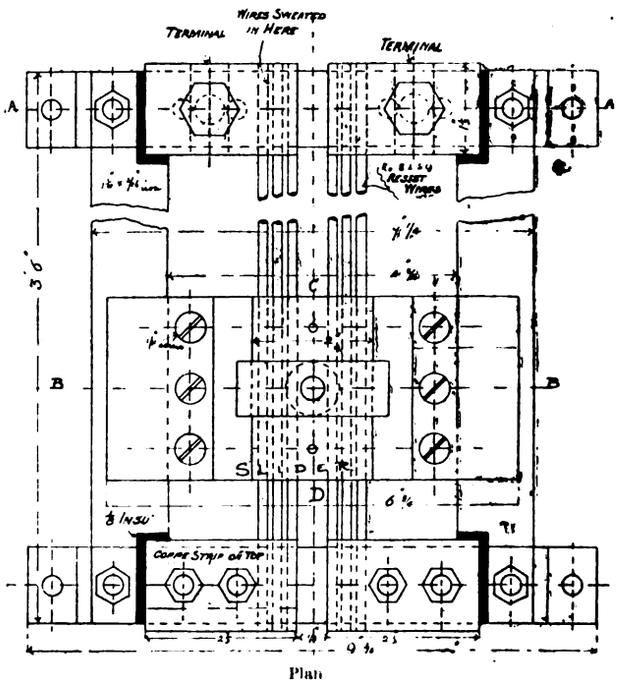


FIG. 3.

in a solution of sulphate of soda (Na_2SO_4). These plates are made of iron, have each a terminal, and are fastened to a strip of wood as per sketch. It is a good plan to cut off part of bottom of plates, so that on first touching the liquid there is a considerable resistance between them.—M. M.

Answer to No. 464 (*awarded* 7*s.* 6*d.*).—(*a*) The accompanying sketches *to scale* show dimensions and particulars of resistance for milking weak cell from two hospital cells. According to the manufacturer's list, Eureka resistance wire No. 8 L.S.G. has a resistance of 35·4 ohms per 1,000 yards = ·0128 ohm per foot; and when freely exposed to atmo-



Plan

sphere a current of 45·6 amperes will raise temperature to a blood heat—50 per cent. more current will raise temperature to 110deg. F. If we use three wires in parallel, with

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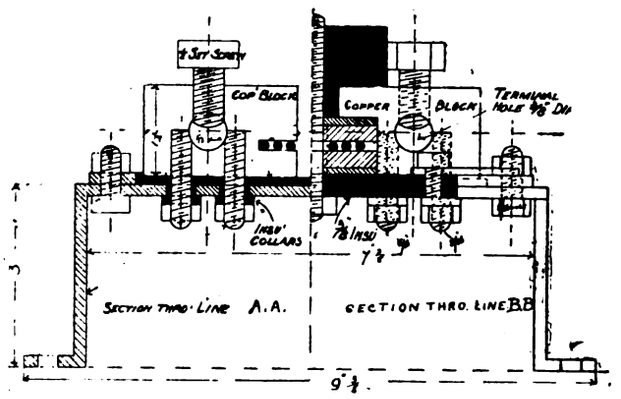
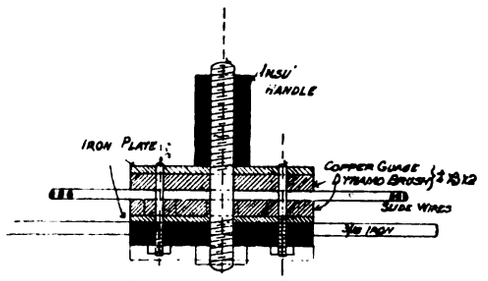
an air space between each, they should carry 120 amperes comfortably. With the working length of wire shown (about 6ft. 6in.) the highest resistance would be ·027 ohm, which would with a current of 120 amperes take up 3·2 volts—ample for regulating purposes. The resistance consists of three No. 8 Eureka resistance wires side by side, sweated into and stretched between copper blocks, as shown. The blocks themselves are fixed on a wrought-iron framework of $\frac{3}{16}$in. by 1¼in. iron, insulated from it by ⅛in. ebonite or fibre sheet, and held in position by $\frac{5}{16}$in. studs screwed into the blocks—insulated where they pass through iron, and held in position by nuts screwed on underneath iron, as shown. The two front blocks have each a ⅝in. hole drilled through and a ½in. hole tapped at right angles to the former for the terminals. In the back blocks these are omitted, but the $\frac{5}{16}$in. studs go right through, as shown. A strip of copper is slipped over them, the nuts on top holding it, and making a good connection between these two blocks, so that the circuit is never broken through the resistance; the slider simply shorts across the wires at the desired point. The regulating slider consists of two pieces of copper-gauze dynamo brush—above and below



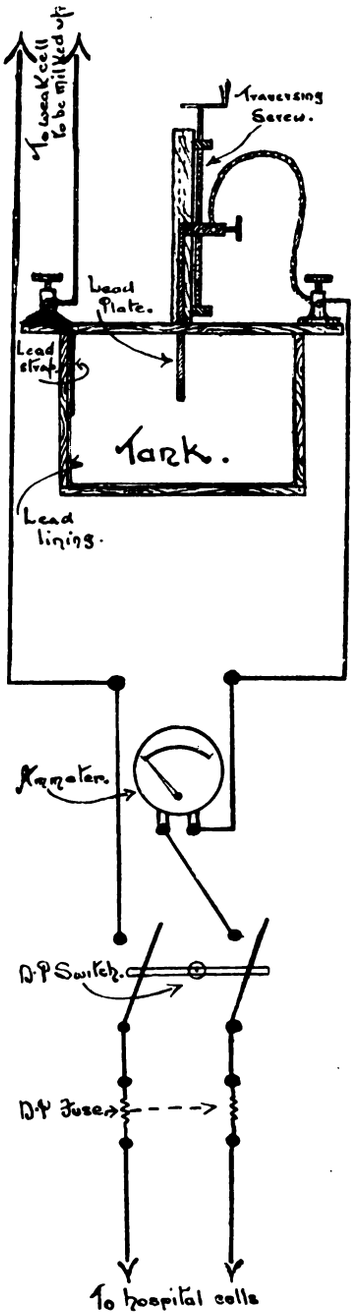


Section through C D.

the stretched wires—backed on top and bottom by a piece of ⅛in. iron plate; the whole is held together by a ⅜in. screwed iron rod with an insulated thumb-nut on the top end, for adjusting the pressure on the wires. Two ⅛in. steady pins are screwed into the bottom plate, to keep the copper-gauze pads and upper iron plate from slewing round when tightening up. The two copper-gauze pads and upper iron plate slip loosely over the screwed rod and steady pins. The bottom iron plate is held by nuts under the screwed rod and steady pins (described above) to a piece of ⅜in. fibre (or other suitable insulating material), which slides loosely between the parallel iron guides. Bearing plates of ⅛in. iron are fixed on each side of the fibre by three ¼in. screws, and serve to take the strain off the wires when sliding along or tightening up.

(*b*) The other gear necessary, besides above resistance, will be an ammeter reading up to 150 amperes, say, fuse and switch for the same current, four heavy flexible rubber-covered leads with clamps on one end, for clamping on to weak cell and hospital cells respectively. The whole would be coupled in series, and current adjusted by shifting position of resistance slider.—H. B. D.

Answer to No. 464 (*awarded* 5*s.*).—For battery-room use a liquid regulating resistance would be found very suitable for the above purpose. Instead of having cables lying about on the floor, which is usually the case when milking up bad cells, it is best to rig up a simple switchboard and make permanent connections from the hospital cells on to same, tappings being made from this board and carried to the cell to be milked up. If local conditions permit, hooked holdfasts could be driven into the walls or roof of the battery-room, and the milking leads hung up out of the way. The regulating resistance, described in sketch, is made box form of teak 1in. thick, 2ft. 6in. square by 2ft. deep. It is lined with sheet lead $\frac{1}{16}$in. thick, the lining forming one electrode and the other being made up of a sheet of lead 2ft. square by ½in. thick. The lead plate is fixed in a grooved wooden frame, made guillotine



fashion, fastened to the sides of the box, and by means of a traversing screw the plate can be adjusted to any depth in the box. The nut on the plate also serves as a terminal for same, a short piece of indiarubber-covered flexible cable being connected to this nut and fastened to a well-insulated binding post fixed to top of box. A substantial strap of lead is well burned on to the lead lining of the box, and connected to a similar binding post fixed well away from the plate connection. The box should be dovetailed together and no nails or screws used at all, and the outside should be given a coat or two of spirit varnish or anti-sulphuric enamel. Opinion differs greatly as to what is the best electrolyte to use in liquid regulating resistances, but the writer has found from experience that water with a little sulphuric acid of 1·200 specific gravity added gives every satisfaction.—S. L

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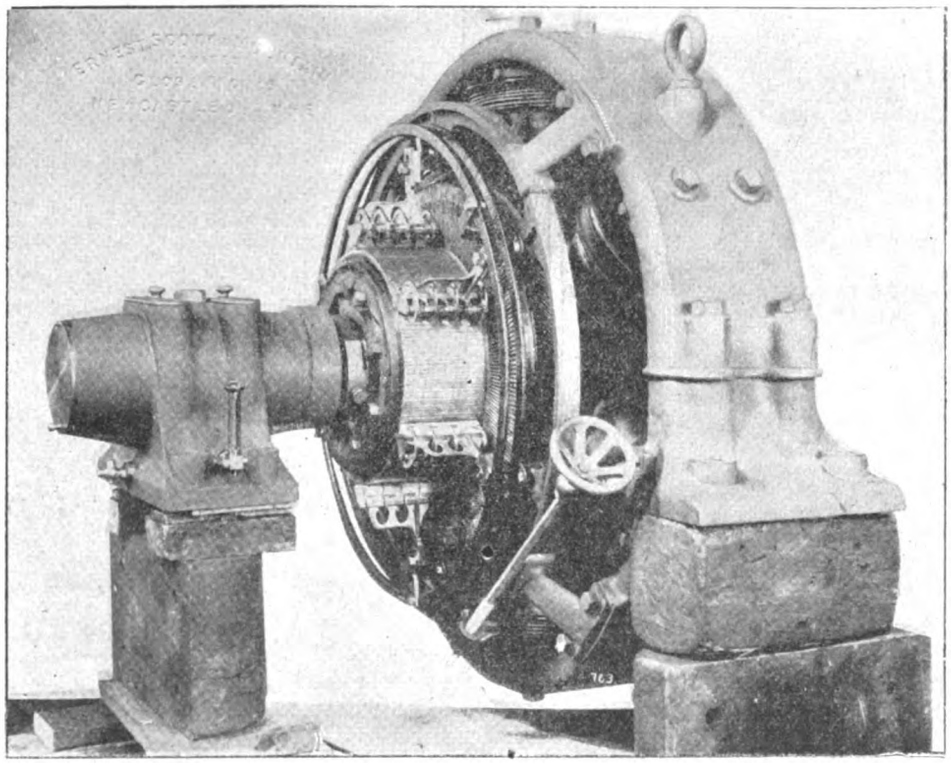
TRADE NOTICES AND NOVELTIES.

Ernest Scott and Mountain's Multipolar Dynamo.

The accompanying illustration is of one of the above firm's latest type of direct-current dynamo for direct coupling to either high or low speed engines. The armature is of the slotted-core drum-wound type. The embedded conductors are laid in the slots after being carefully insulated. The core is composed of steel plates of high magnetic permeability mounted upon a cast-iron centre with driving slots; cast-iron cramping plates are fitted at each side, which not only keep the core plates in position, but also support the ends of the armature conductors. The commutator is of hard-drawn copper, insulated with mica, and bolted direct to the armature core, so that the whole is positively driven, and the spindle can be removed if required. The magnet frame is of steel, with internal poles, and this type of machine is made with four poles in the small sizes, up to 16 poles in the larger sizes. The poles are cast separate from the yoke, so that they can be withdrawn sideways, and the magnet coils removed if required, the poles being secured to the yoke by turned steel bolts. The magnet frame is in halves, so that the top half can be removed to get at the armature. The brush gear is supported by brackets bolted to the yoke, and the ring supporting the brush-holders can be revolved in these brackets by means of a screw and hand wheel. The brush-holders are of special design to take carbon block brushes, and each are fitted with tension springs to vary the tension of the carbon block on the surface of the commutator, and also with vertical movement, so that any wear of the commutator can be taken up. These generators are designed so that the temperature rise after a run for six hours at full load will not exceed the temperature of the surrounding atmosphere by more than 70deg. F., and the machines are capable of withstanding an overload of 25 per cent. for two hours, or a temporary overload of 50 per cent. for short periods without adjustment of the lead of the brushes.



View of Ernest Scott and Mountain's Multipolar Dynamo.

Dia's Patent Cables.

We have recently received from the St. Helens Cable Company, Limited, Warrington, a copy of their new price list of Dia's "Impregnable" paper cables, of which they are the sole manufacturers and patentees. Low-tension single-conductor, concentric, triple-concentric, and three-core lead-covered cables of the Dia type are listed for working pressures up to 500 volts, also high-tension concentric and three-core cables for pressures up to 2,000 volts. Low-tension twin paper-insulated house wires for 500 volts are further included. Attention is called in the preface to Dia's patent waterproof cables, which the firm are now putting on the market at prices 5 per cent. in excess of those quoted for the "Impregnable" type cables. It is claimed that the system of manufacture adopted renders the paper insulation of these waterproof cables so impervious to moisture that they may be drawn into pipes or laid on the solid system without lead covering, should the engineer so desire. Every single length of the cable is tested, we are told, in water before lead covering. Together with the price list under notice, we received a copy of a report by Mr. C. H. Wordingham on Dia's patent waterproof cable. From this report we gather that the cable is insulated as follows: Next the core is placed a layer of paper lapped on in the usual way. This paper, which is of the best quality manilla, is somewhat thicker than is ordinarily used, and is impregnated before being applied to the cable. After the lapping is complete the covering is again impregnated, and is then taped. Over this tape is placed a layer of a waterproof material, to which the name of "Dialite" has been given. The "Dialite" is lapped with tape in the same manner as a rubber-covered cable, and is then vulcanised in steam. After vulcanisation is complete, the cable is finished with braiding treated with preservative compound in the usual way. The dimensions of the cable tested, which had been under water for several days, and for the 24 hours immediately preceding Mr. Wordingham's visit, gave a thickness of wall of 0·069in. for the paper and 0·094in. for the "Dialite." The length of the cable was 220 yards, and the core was composed of 19 strands of No. 16 S.W.G. The insulation resistance—measured by a battery giving about 600 volts—of the length of cable at the end of one, two, and three minutes' electrification was 1,265 megohms, 1,555 megohms, and 1,707 megohms re-pectively, or the equivalent respectively of 158, 194, and 213 megohms per mile. After this test the cable was earthed for 10 minutes and its capacity then determined, the result being 0·0988 microfarad for the length, which corresponds to 0·79 microfarad per mile. The temperature of the water in which the cable was immersed was 42deg. F. In subjecting the cable to a pressure test an alternating pressure of 5,000 volts, having a periodicity of about 80 per second, was applied to its whole length for half an hour without the cable showing any signs of breaking down. The pressure was next raised until the cable broke down, the dielectric being pierced at a pressure between 18,000 and 19,000 volts. The bending test to which the cable was subjected proved equally satisfactory, although very severe. A test made of a wire insulated entirely with Dialite showed this material to have a high dielectric strength as well as considerable insulation resistance. In concluding, Mr. Wordingham sums up the invention as a useful one. It is explained on a slip attached to the report that Dialite is a vulcanised substance of great durability made from bitumen, being purified by a special process on the latest scientific basis.

Water-Level Indicators and Tell-Tales.

From Messrs. Gent and Co., electrical engineers, Faraday Works, Leicester, we have recently received two illustrated catalogues. The first of these deals with the firm's patent water-level indicating apparatus, for indicating and registering at any distance the depth of water in reservoirs, impounding tanks, wells, rivers, docks, etc. The method of working is briefly as follows: Over or near the reservoir tank or well is fixed the transmitter, which, by means of a float and chain acting upon a spur wheel, makes an electrical contact for each 1in. rise or fall of the water, while at the pumping station, engineer's office, or other desired position is fixed the indicator or recorder, having a dial or cylinder, as the case may be, graduated in feet and inches to correspond with that of the transmitter. The instruments are connected together by means of an ordinary overhead or underground telegraph wire, and a battery is inserted in the circuit, whereby a change in the water level is automatically indicated at the receiving end as successive contacts corresponding to the rise or fall of the water are made. When desired, a number of indicators can be connected to one transmitter so as to register the rise or fall in two or more places simultaneously. A favourite plan, we are told, is to have an indicator in the engine-room and a recorder in the manager's office. A list of works is given at which the system described has been adopted. The second catalogue deals with Messrs. Gent and Co.'s watchman's clocks or electric tell-tales for checking the vigilance of night watchmen in warehouses, factories, mills, hotels, and similar establishments, or of nurses and attendants

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in asylums, hospitals, workhouses, and other institutions. The clock is fixed in the office of the manager or superintendent as may be required, while pushes or contacts are fixed in various parts of the premises where the attendants are watching or the watchman has to patrol. These contacts are each connected by an insulated wire with the clock, and a battery is arranged in circuit so that a clear and definite ink mark is made upon the record every time a contact is worked, thereby providing a check on the vigilance of the attendant or watchman. This system of checking has already been adopted, we are informed, in a large number of public institutions, and also in numerous factories, warehouses, etc.

Electric Wires and Cables.

From the Liverpool Electric Cable Company, Limited, 292, Vauxhall-road, Liverpool, we have received a copy of their new price list of electric wires and cables. Attention is called to the fact that in the vulcanised section the firm are supplying single wires and small strands with a "braiding" outside, and also that they have included a 1,000-megohm grade. The list is well arranged, the reference numbers, which are consecutive, giving at once the size of conductor and nature of insulation. At the end of the list the firm's patent clincher cable-clip is illustrated. This clip seems to be of ingenious and effective construction.

G.E.C. Progress Leaflet.

The progress leaflet issued by the General Electric Company, Limited, Queen Victoria-street, London, E.C., for March contains information relating to several of the firm's specialities, including "Geeko" telephones for connecting to existing electric bell wires and a patent rubber sleeve for lampholders. The latter has, we are told, been specially designed to protect lampholders from damp and other deleterious influences. It is of such length that it completely covers the lampholder and presses against the glass of the lamp, thus rendering the whole completely watertight.

NEW COMPANIES REGISTERED.

Gloucestershire Electric Power Syndicate, Limited.—Capital, £7,530. Objects: to carry on in the county of Gloucester the business of an electric power supply company, to construct power-generating stations, works, plant, apparatus, and machinery, cables, wires, lines, accumulators, pipes, lamps, for the supply of gas and electricity, and to adopt an agreement with T. N. A. Grove.

Dewhurst's Engineering Company, Limited.—Capital, £10,000. Objects: to acquire the business of mechanical and electrical engineers, colliery and general mill furnishers, etc.

Harbowne Electrical Manufacturing Company, Limited.—Capital, £1,000. Objects: to carry on the business of manufacturers of and dealers in electric fittings and fixtures of all kinds, and to acquire and turn to account any patents, etc.

Compagnie American Biograph Francaise, Limited.—Capital, £30,000. Objects: to acquire and carry on the Biograph and Mutoscope Company for France, Limited (old company), etc.

Batson's Patents Syndicate, Limited.—Capital, £1,000. Objects: to carry on the business of manufacturers of machines, articles and things of every description adapted for or capable of being used by engineers, manufacturers, motor and motorcar builders.

Automobile Components, Limited.—Capital, £2,000. Objects: to carry on the business of manufacturers of and dealers in cycles, motorcars, and vehicles of all kinds, etc.

Victoria Motor Company, Limited.—Capital, £2,000. Objects: to carry on the business of makers of and dealers in motors, motor-cycles, and cycle fittings, parts and accessories, electrical fittings, etc.

HUDDERSFIELD ELECTRICITY ACCOUNTS.

From the accounts of the Huddersfield electricity supply department just issued it appears that the total expenditure on capital account to Dec. 31, 1901, amounted to £154,356. Abstracts of the revenue account and general balance sheet are given herewith:

REVENUE ACCOUNT.

Dr.	Generation of Electricity.	£	s.	d.
Fuel	£2,499 0 11			
Oil, waste, water, and stores	327 2 9			
Wages at generating station	1,228 3 5			
Repairs and maintenance of buildings	61 15 3			
Repairs of boilers and engines	490 4 2			
Repairs and maintenance of plant, etc.	1,201 19 0			
		5,808	5	6
	Distribution of Electricity.			
Repairs, etc., of transformers, etc.	237 15 2			
Repairs, etc., of mains	338 10 5			
		576	5	7
Public lamps		216	19	6
Rents, rates, and taxes		854	1	11
Management expenses		1,294	5	0
Legal, etc., expenses		115	9	8
		8,865	7	2
Bad debts		44	12	8
Balance carried to net revenue account		10,851	10	4
		£19,761	10	2

Cr.	£	s.	d.
Sale of electricity by meter and meter rental	17,955	8	6
Public arc and incandescent lamps	803	5	6
Sundry contracts	265	13	6
Rent of meters	1,305	12	0
Hire of motors and other apparatus	130	10	2
Sale and repair of lamps	113	16	10
	20.574	6	6
Less discounts	938	2	4
	£19,636	4	2

BALANCE-SHEET.

Liabilities.	£	s.	d.
Mortgage debt	124,156	9	4
Floating liabilities	12.711	11	11
Depreciation and contingencies account	5,509	10	3
Excess of assets over liabilities	24,271	13	6
	£166,649	5	0

Assets.	£	s.	d.
Buildings	18,767	16	8
Machinery and boilers	50.C51	7	4
Cost of laying mains and services	57,143	17	3
Transformers, motors, etc.	11.735	6	4
Meters and fees for certifying	8,741	9	9
Electrical instruments, etc.	2,960	16	3
Discount on issue of 3 per cent. stock	4.439	10	0
Costs of obtaining provisional order, 1890	516	12	8
	154,356	16	3
Heating and power appliances	1,348	12	10
Mains and services	840	0	0
Stores on hand, Dec. 31, 1901	308	0	1
Sundry debtors	9,795	15	10
	£166,649	5	0

APPOINTMENTS VACANT.

Electrical Engineer, Wakefield Corporation, £300 per annum, April 8. Full particulars in our advertisement columns.

Superintendent of Tramways, Halifax Corporation, £150 a year.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Edinburgh.—The Corporation invite tenders for annual supplies from May 15 for the electric supply department.

Brisbane (Queensland).—The Postmaster-General invites tenders for a number of telephones. Tenders by April 14.

Alicante (Spain).—The Harbour Board require tenders for the supply of two movable cranes. Tenders by May 14.

Barcelona.—The Harbour Board invite tenders for an installation to supply electric light, power, and cranes. Tenders by April 7.

Maddaloni (Province of Caserta, Italy).—The Municipal Authorities require tenders for the electric lighting of the town. Tenders by April 8.

Madrid.—The Telegraph Department invite tenders for 30,000 zinc cylinders, estimated at £2,260. A deposit of 5 per cent. is required. Tenders by April 14.

Peterborough.—The Electricity Committee invite tenders for supplying 43 arc lamp pillars. Tenders by April 12. Details in our advertisement columns.

Madrid.—The Telegraph Department invite tenders for 40,000 porcelain insulators, estimated at £1,360. A deposit of 5 per cent. is required. Tenders by April 15.

Madrid.—The Postal Telegraph Department invite tenders for 12 tons 3mm. and 3 tons 1¼mm. bronze wire. Price per ton not to exceed 2,280 pesetas. Tenders by April 5.

Hartlepool.—The Corporation invite tenders for one 200-kw. to 250-kw. high-speed steam-engine, continuous-current dynamo, extension to switchboard panel, etc. Tenders by April 30.

Southampton.—The Corporation invite tenders for the construction of tramways in St. Deny's-road. Specification, etc., may be obtained at the Borough Engineer's Office, Southampton. Tenders by April 16.

Glasgow.—The Corporation invite tenders for the supply of 50 tons of tiebars. Specification, etc., can be obtained from Mr. John Young, general manager, 88, Renfield-street, Glasgow. Tenders by 10 a.m. on April 14.

Devonport.—The Corporation invite tenders for materials and work for about three miles of double tramway track. Specification, etc., may be obtained from Mr. C. Chadwell, 20, Victoria-street, Westminster. Tenders by April 16.

Hackney.—The Electric Lighting Committee invite tenders for the construction and erection of three water-tube boilers and accessories, and water-softening plant. Tenders by April 9. Details in our advertisement columns.

Rathmines.—The District Council invites tenders for supply and erection of engine-house plant, extension of switchboard and elec-

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tricity supply mains. Tenders by April 24. Full particulars in our advertisement columns.

Aylesbury.—The Urban District Council invite tenders for the public lighting of the urban district for one year from 8th inst. Tenders must be addressed to Mr. Percy A. Wright, clerk, Town Hall, Aylesbury, by 5th inst.

Warrington.—The Corporation invite tenders for a complete overhead tramway equipment. Specifications, etc., can be obtained from Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W. Tenders by April 9.

Madrid.—The Public Works Department invite tenders for extensions to the San Sebastian tramways and working the same for not more than 60 years. Particulars may be obtained from the Department. Tenders by April 5.

Bristol.—The Electrical Committee invite tenders for a 210-kw. dynamo (for immediate delivery). Particulars may be obtained from Mr. H. Faraday Proctor, city electrical engineer, Temple Back, Bristol. Tenders by April 7.

Swindon.—The Corporation invite tenders for the supply, delivery, and laying in the borough of Swindon (Wilts) of feeder and distributing cables, conduits, and accessories. Tenders by April 23. Details in our advertisement columns.

Glasgow.—The Parish Council invite tenders for electric wiring at the new general hospital, Stobhill. Specification, etc., can be obtained from the engineer, Mr. W. Arnot, 79, West Regent-street, Glasgow. Tenders by 10 a.m. on 7th inst.

Mansfield.—The Corporation invite tenders for the construction and erection of pipework, valves, and tanks, steam, exhaust, water, and other pipes, valves, tanks, foot-plates, and accessories. Tenders by May 1. Details in our advertisement columns.

Warrington.—The Electricity Committee invite tenders for supply of one 20-h.p. motor. Specifications and particulars can be obtained from Mr. William H. Grimsdale, borough electrical engineer, Electric Light Station, Howley, Warrington. Tenders by 12th inst.

Glasgow.—The Corporation invite tenders for the supply of concentric and single main cables, insulated with paper or fibre, impregnated with oil, bitumen, or other substance impervious to moisture, or with vulcanised bitumen. Tenders by April 21. Details in our advertisement columns.

Sydney.—The Municipal Council invite tenders for supply and erection of plant and machinery required for the complete equipment of their proposed electricity supply stations and sub-stations. Particulars may be obtained from Messrs. Preece and Cardew, Westminster. Tenders by May 7 at noon.

Edinburgh.—The Corporation invite tenders for the supply of the following materials for the electricity supply department for the year from May 15, 1902: cast-iron pipes, pavement and road box frames and covers, etc. Specifications, etc., can be obtained at the Resident Engineer's Office, 5, Dewar-place, Edinburgh. Tenders by April 12.

Southend-on-Sea.—The Corporation invite tenders for supply, delivery, and erection at their electricity works, London-road, Southend-on-Sea, of one balancer, two boosters, one motor-generator, two battery switches. Specification, etc., can be obtained from Mr. W. E. J. Heenan, M.I.E.E., borough electrical engineer, Southend-on-Sea. Tenders by April 8.

George Town (Penang).—The Municipal Commissioners invite tenders for the supply and delivery, f.o.b., of boilers, etc., ejector condenser, pumps, tanks, etc., pipes, steam dynamos and balancer boosters, switchboards, batteries, cables, junction boxes, &c., and arc and glow lamps, posts, and accessories. Tenders by April 28. Details in our advertisement columns.

London, W.—The Central Electric Supply Company, Limited, invite tenders for the supply, delivery, and erection of high and low tension switchboards at the company's generating station at Grove-road, St. John's Wood, N.W. Specification, etc., can be obtained from the General Manager of the Company, 19, Carnaby-street, Golden-square, W. Tenders by April 23.

Trowbridge.—The Trowbridge Urban District Council having obtained a provisional order for the supply of electricity in their district, are prepared to receive applications for a lease of their powers under the said order. A plan of the district can be seen at the offices of the Council. Applications to be sent to Mr. T. S. Hill, clerk, Council Offices, Town Hall, Trowbridge, by April 30.

Rotherham.—The Corporation invite tenders for the supply, delivery, and erection of rolling stock; overhead construction, with trolley wires, posts, switch pillars, etc.; and permanent-way construction, excavation, concrete foundations, steel rails, and special work, paving, etc. Specifications, etc., can be obtained from Mr. H. Hampton Copnall, town clerk. Tenders by April 23.

Burton-upon-Trent.—The Corporation invite tenders for the construction of about 5¾ miles of route length of tramways, constructed as single line with passing places. Specifications, etc., may be inspected and obtained at the office of the consulting engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, or at the Borough Engineer's Office, Town Hall, Burton-on-Trent. Tenders by April 22.

Bermondsey.—The Council invite tenders for the supply of the undermentioned articles up to March 31, 1903: arc lamp carbons, electricity meters, demand indicators, and main fuses, engine oils, incandescent lamps, indiarubber cables and jointing material, ironmongery and engine-room stores, lead-covered cables, and meter boards. Tenders by April 14. Details in our advertisement columns.

Falkirk.—The Corporation invite tenders for the supply and erection of the following: three 100-kw. steam dynamos (vertical enclosed high-speed engines); two dry-back marine-type boilers, with fittings; economiser, with dampers. Specifications, etc., can be inspected and all information obtained at the offices of Messrs. Burstall and Monkhouse, consulting engineers to the Corporation, 14, Old Queen-street, Westminster, S.W. Tenders by April 12.

London, S.W.—The London County Council invite tenders for the supply, delivery, and laying on the routes of the London County Council tramways (southern system) of (a) 48 miles of extra high-tension three-core lead-covered, paper-insulated cables; and (b) 87 miles of low-tension single, lead-covered, paper-insulated cables, and 14 miles of dry-core telephone cables. Specifications, etc., may be obtained from the County Hall, Spring-gardens, S.W. Tenders by April 22.

Oldham.—The Surveyor's and Tramways Committee invite tenders for the complete electrical equipment of new car depot at Wallshaw, within the borough boundary. The car depot is constructed to accommodate 70 cars, and contains eight tracks, laid the full length of the building. The work required to be done is approximately as follows: overhead equipment, lighting feeder and conduit from generating station to car depot, switchboards, car-shed lighting, motors, and telephones. Specification, etc., may be obtained from Mr. S. A. Pickering, A.M.I.C.E., borough surveyor, Town Hall, Oldham. Tenders by April 9.

Madrid.—The Secretary of State has received a dispatch from his Majesty's Ambassador at Madrid stating that tenders are invited by the Spanish naval authorities for the supply and installation of the photo-electrical material necessary for three gunboats. Tenders must be received before 11 a.m. on the 14th inst., and plans, etc., may be seen at the office of the Director of Material for the Navy (Direccion del Material, Ministerio de Marina) on all working days from 10 a.m. to 3 p.m. until April 14. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m.

Bexleyheath (Kent).—The Electric Lighting and Traction Committee invite tenders for the supply and delivery of tramway rails and accessories; also the supply, delivery, and erection of engines, alternators, dynamos, etc., under the following specifications: Specification No. 1 (Section A) tramway rails; (B) fishplates; (C) anchor plates; (D) tie-bars, bolts, etc. Specification No. 2 (Section A) engines; (B) alternators and exciters; (C) direct-current dynamos. Specifications, etc., may be obtained from the engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W. Tenders must reach Mr. T. G. Baynes, clerk, Public Hall, Bexleyheath, on or before the following dates: specification No. 1, April 21; specification No. 2, April 28.

RESULTS OF TENDERS.

St. Pancras.—The Borough Council have accepted the tender o Hitchen and Son for overhead travellers at £480.

Gloucester.—The Corporation have accepted the tender of Webb and Alexander to provide and fix a Weir feed pump at the electricity supply works at £86.

Aldershot.—The Town Council have accepted the following tenders for meters: Venner and Co., Westminster, S.W., ordinary meters; the Rochdale Electric Company, prepayment meters; and the Reason Manufacturing Company, Brighton, demand indicators.

Barking.—The following tenders have been accepted by the Council for extension to the electricity works: Messrs. Allen, 250-kw. steam dynamo (Siemens dynamo), £2,000 (119 tenders); Dick, Kerr, and Co., switchboard extensions, £340 (11 tenders); Glenfield and Kennedy, water-meters, £62. 2s. (three tenders); Babcock and Wilcox, economiser, £287.

Manchester.—The British Thomson-Houston Company, Rugby, have obtained the contract for 205 electrical equipments for the cars of the Manchester Corporation tramways. These 205 equipments represent 410 electrical motors, which are to be of the British Thomson-Houston Company's G E 52 and 54 type, the controllers being of the same company's B 3 type.

Southend-on-Sea.—The Corporation have received the following tenders for the supply and fixing complete of two storage batteries at their electric lighting station, London-road:

British Power Traction Company, York (accepted)	£1,511	14	0
Accumulatoren-werke (W. C. Horne and Sons, 5, Torrens-street, agents)	1,512	0	0
Kramer, Norfolk House, Norfolk-street, W.C.	1,680	0	0
Ashmore, Benson, Pease, and Co., Stockton-on-Tees ...	1,740	10	0
Electrical Power Storage Company, 4, Great Winchester-street, E.C.	1,807	1	6
Hart Accumulator Company, Marshgate-lane, Stratford	1,838	4	0
W. Rooper and Co., Victoria Works, Stafford	1,895	3	0
Tudor Accumulator Company, 16, Victoria-street, S.W.	1,906	0	0
Veritys Limited, King-street, Covent Garden.....	2,050	15	0
D.P. Battery Company, 11, Victoria-street S.W.....	2,130	19	0
Chloride Storage Company, Clifton Junction.....	2,714	11	0

Alexandra Park.—A strong feeling exists amongst the members of the Islington Borough Council on the subject of Mr. Henry Burt's proposals to give up the Alexandra Park for tramways and an electrical station, and the matter has been discussed by the Parliamentary and General Purposes Committee, who at their last meeting resolved to obtain counsel's opinion on the legality of the whole proceeding. This opinion has been given, and it is to the effect that both the tramways and the generating station would be contrary to the provisions of the Alexandra Park Act, and that the attempt to bring the building under Section 17 of that Act is only colourable, and cannot justify the action of the trustees.

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BUSINESS NOTES.

TRACTION.

Reddish.—Good progress is being made with the tramway construction at this place.

Mersey Railway.—It is anticipated that the electrification of this railway will be completed by the autumn.

Clacton and St. Osyth Light Railway.—A local enquiry will shortly be held with regard to this scheme.

South London Electric Railway.—This railway conveyed more than 250,000 passengers during the Easter holidays.

Speed Trials.—On Saturday last a number of motorcar speed trials took place at Gunton Park, Lord Suffield's place near Cromer.

Bournemouth.—The Board of Trade have refused the Corporation's application to construct an electric tramway along the Parkwood-road.

Leighton Buzzard.—It is stated that two gentlemen are about to come forward to finance the suggested light railway from Leighton Buzzard to Hitchin.

Poole.—Attention was called at the last meeting of the Town Council to the excessive speed of the tramcars on certain routes. No action was decided upon.

Oldham.—It was stated at the last meeting of the Town Council that the doubling of the tramway from Royton to Hathershaw is estimated to cost £11,346.

Wrexham.—Terms have been arranged by which the Corporation will supply the Wrexham and District Electric Tramways Company with current for working the tramcars.

London United Tramways.—On Good Friday and Easter Monday 405,200 passengers were carried on the West London electric tramways, an increase of 121,245 on the previous record.

Windsor and Maidenhead Light Railway.—The Light Railways Commissioners will open an enquiry at Windsor on April 8 into the application for an order to authorise the above scheme.

Birkdale.—The new electric tramway between the Southport boundary and Birkdale Station has been inspected by the Board of Trade officials, and a service of cars is now being provided over this route.

Tokio.—The General Electric Company, of United States of America, have recently received an order from Tokio, Japan, involving £150,000 for the erection of electric tramways on the overhead trolley system.

Wakering.—Some of the ratepayers are about to present a petition to the Corporation urging that the extension of the system of electric tramways from Southend to Great Wakering would be of very great service to the district.

Vale of Rheidol Light Railway.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order made by them authorising the construction of the Vale of Rheidol Light Railway.

Crewe.—The scheme of light railways which the Corporation have adopted, but which has been vetoed by a town's meeting, is for 2½ miles of line through the heart of the borough. It involves an estimated expenditure of £35,000.

Halifax.—Two men were knocked down by an electric car last week and would have been run over but for the lifeguard attached to the front of the car. As it was, both were severely crushed, and one of them afterwards died in hospital.

Potteries Light Railways.—The Board of Trade have confirmed the Potteries Light Railways (Extensions) Order, 1902, authorising the construction of light railways in the boroughs of Stoke-upon-Trent, Newcastle-under-Lyme, Longton, and Hanley.

Hull.—An accident happened on the Beverley-road tramway on Saturday evening, owing to one of the overhead trolley wires snapping. The mishap, which occurred opposite Melwood-grove, inconvenienced a large number of foot passengers, but no one was injured.

Nottingham.—The tramway traffic on Easter Monday was exceptionally heavy, constituting a record in regard to the number of passengers carried. No less than 137,000 persons rode on the cars, whereas the previous highest total for any one day was 106,000.

Wallasey.—The first week's running of the new electric trams has proved very successful. Sixty thousand passengers were carried, compared with about 24,000 the previous week on the old horse cars. On the Sunday the traffic was five times as much as on the previous Sunday.

Torquay.—At the last meeting of the Town Council the tramway question was discussed on the recommendation of the Electric Lighting Committee that steps should be taken to obtain powers for the construction of municipal tramways in the town. Eventually the proposal was adopted.

Rotherham.—Operations in connection with the construction of the electric tramways in the town are progressing so favourably that it is expected that some of the routes will be ready for the electric cars by October. The whole scheme will probably be completed by the early part of next year.

Rutherglen.—The electric tramways were inaugurated at this place on Wednesday. The first car ran from the municipal buildings at two o'clock in the afternoon, when the members of the Tramways Committee, and the provost, magistrates, and members of the Town Council of Rutherglen were passengers by it.

Calcutta.—The people of Calcutta, says *Indian Engineering*, are now within hailing distance of electric cars. The wires have been put up expeditiously, and without the slightest inconvenience to the public, and with the running of the first car a new era of prosperity will open for the Calcutta Tramways Company.

Isle of Man.—In connection with the liquidation of the Isle of Man Tramways and Electric Power Company, Limited, Mr. W. H. Walker, the liquidator, has been allowed as remuneration 2½ per cent. upon £304,000, the amount realised for the company's undertaking, or £7,600. The liquidation has been in operation since June, 1900.

Northampton.—A complete scheme has now been prepared for the conversion of the existing tramways to electric traction, and a long report by the Tramways Committee will be presented to the Town Council at their next meeting. The total cost of the scheme is estimated at £117,000. The overhead trolley system would be adopted.

Ilford.—The Works Committee have been asked to consider the advisability of diverting all vehicular traffic to the side roads so that the laying of the electric tramway in High-road may be expedited. The question of making a double line of rails on Ilford-hill, where only a single line is contemplated, has been referred to the Tramways Committee.

Buenos Ayres and Belgrano Electric Tramways Co.—The directors in their report for the year 1901 recommend a balance dividend of 3 per cent. on the "B" preference shares, making the full rate for the year, and also a dividend of 7 per cent. on account of arrears (leaving the arrears at 7½ per cent.), and carrying £1,976 forward.

Rawmarsh.—A long and exhaustive discussion took place at the last meeting of the District Council on the tramways question. The action of the chairman of the Tramways Committee was severely criticised in not placing before the committee some correspondence with the tramways company, and in consequence he announced his intention of resigning his office.

Croydon.—The completed Norwood section of the Croydon tramways has now been approved by the Board of Trade, and the electric trams have been running over the whole section this week. The full scheme has now been carried out in its entirety, and the electric cars are running on all routes. It is proposed to equip some of the electric cars with an improved lifeguard.

Cardiff.—Up to the present there have been eight miles of tramway track reconstructed. During the past four weeks the work has progressed at the rate of a mile a week. It is understood that the electric cars will run on the Roath Park section on May 1. Another successful trial of one of the new electric cars over a portion of the system which has been converted for electric traction has been made.

Leith.—The Corporation have received a communication from the British Westinghouse Company asking upon what conditions they would grant a lease of the tramlines to a company which would furnish the capital for converting the system into an electrical one, carry through the work of conversion, and operate the lines. The Corporation have decided to take no action on the communication.

Loughborough.—At a meeting of the General Purposes Committee last week it was agreed that the time given to the Loughborough and District Light Railway Syndicate to decide whether they will accept the transfer of the electrical powers of the Corporation on terms to be settled and subject to their carrying out concurrently their powers under the light railways order be extended to April 30 next.

Motor Service to Windsor.—It is reported that the management of a West-end hotel will commence a motorcar service between the West-end and Windsor and Kingston-on-Thames in the course of a fortnight. It is proposed to start with six motorcars of 10 h.p. each, and carrying 12 passengers. These vehicles will run six times daily during the spring, and perform the journey in about an hour.

Sheffield.—Last week a tramcar containing 34 passengers was standing at a terminus at the top of a long and steep incline, when, the driver being absent, the conductor released his brake to allow the vehicle to start. It ran down the hill 300 yards, and, gaining great speed, finally left the rails and dashed into the palisading surrounding a monumental mason's yard. No one was injured, although many were shaken.

Middlesex.—At the Westminster Palace Hotel last week a conference of West Middlesex local authorities, convened by the Heston and Isleworth District Council, was held, to consider the advisability of joint combination to oppose the Middlesex County Council's Bill in the House of Lords. It was unanimously agreed to recommend the various local authorities in Middlesex to oppose the Bill in the House of Lords.

Brighton.—The Corporation tram returns for Easter Monday show that over 63,000 fares were paid, constituting a record. The Town Council have received a letter from the promoters of the London and Brighton Electric Railway Bill, which recently failed to comply with Standing Orders of the House of Lords, stating that every endeavour will be made to pass the Bill successfully in the next session of Parliament.

West Bromwich.—The Corporation have now received the sanction of the Board of Trade to the borrowing of £86,350 and £34,650, making a total of £121,000, required in connection with the scheme for the reconstruction and electrical equipment of tramways within the borough. The Town Council have agreed to grant the South Staffordshire Tramways Company a further extension of time for nine months for the use of steam on their lines.

Salford.—It is anticipated that the electric cars will shortly be running on the Cross-lane and Weaste sections of the tramways. Arrangements are being made with the Board of Trade to inspect the new portions of the route in order that it may be opened with all speed. Mr. C. H. Chesters, traffic manager at the Weaste depôt, has been appointed traffic superintendent of the Corporation electric tramways. There were 105 applications for the position.

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Warrington.—The 9th of the present month is the date suggested by the Tramways Committee for inaugurating the municipal tramway system. Application has been made to the Board of Trade for an inspector to inspect the system, and in all probability there will be a trial run of one of the cars this week. The work of completing the car-sheds is being pushed rapidly forward, and the permanent way and overhead equipment at the sheds is practically complete.

Wolverhampton.—Fears have been entertained lately that the Corporation new electrical tramways would not be in readiness for the opening of the exhibition, owing to the delay in the dispatch from America of the surface contact boxes. A few days ago a number of these boxes arrived, and they are being put in position, and it is hoped that the route from Bilston-road to the exhibition entrance in New Hampton-road will be equipped with the boxes ere the month is out.

Light Railways.—The Board of Trade have recently confirmed the following light railway orders: (1) authorising the construction of light railways in the urban and rural districts of Dartford, in the county of Kent; (2) authorising the construction of light railways, in the county of Stafford, in the boroughs of Stoke-upon-Trent, Newcastle-under-Lyme, Longton, and Hanley; (3) authorising the construction of light railways from Tenterden to Headcorn, in the county of Kent, and at Robertsbridge, in the county of Sussex, and for other purposes.

St. Helens.—The dispute between the Corporation and the district tramways company upon the question of goods traffic on the tramways has not yet ended. At the last meeting of the Town Council a letter was received from the solicitors to the tramways company desiring to reopen negotiations with the Corporation, but the committee have decided not to reopen negotiations until previous letters from the company, in which they contended that their present powers enabled them to run goods traffic on the Corporation tramways, are absolutely withdrawn.

Aberdeen.—The Board of Trade inspector was expected in Aberdeen this week to inspect the Union-street tramway, and if, in his opinion, it is found satisfactory, it is expected that the Mannofield route, which has been already electrically equipped and sanctioned, will be opened for traffic at once, the cars to be run from Mannofield to Castle-street, and to the beach if necessary. The Commissioners under the Private Legislature Procedure (Scotland) Act are shortly expected to hold a local enquiry into the Aberdeen suburban tramways scheme.

Glasgow.—An electric car collision took place in Main-street, Maryhill, last week. A car was going down the steep incline at the canal bridge when the brakes failed to act. As a result the car dashed into a cart laden with coke belonging to the Gas Commissioners and smashed it up. The car was also badly damaged, and had to be taken to the depôt. At a meeting of representatives from various ward committees last week, a resolution was passed that the proposed increased 1d. distance should be divided into three ½d. stations and not four ½d. stations as suggested by the Tramways Sub-Committee.

Presentations.—On his retirement from the position of electrical engineer to the Corporation of Blackpool, the electrical staff and employés have presented Mr. R. C. Quin with a very handsome oak cabinet and secretaire combined, bearing a suitable inscription on a silver plate. Mr. J. W. Speight, who also retires from the post of chief assistant at the electrical works at Blackpool, has been presented with a beautiful marble clock and bronze figures. Both presentations were formally made last week; and Messrs. Quin and Speight will leave for London this week to take up their partnership as consulting engineers at Victoria-street, Westminster.

Bradford.—The Tramways Committee are still experimenting as to the best methods of providing rain-proof seats. Two hundred seats of a certain type are being given a prolonged trial. During the past 12 months the tramway receipts have rapidly increased, and the total for the financial year, which has just closed, represents a sum of about £67,000. Whetley Hill has proved the best paying section, the earnings per car mile working out at 13·40d., and on the Manningham-lane section, only recently opened for electric traction, the earnings have averaged 13·10d. per car mile. The Lidgett Green, Horton, and Manchester-road sections also show good returns.

Leeds-to-Bradford.—One of the local newspapers points out that in the course of a few days, should no unforeseen occurrence prevent, it will be possible to travel by tram from Leeds to Bradford, changing cars only at Stanningley. The electric equipment of the new route through Armley and Bramley is so far complete that members of the Leeds Corporation Tramways Committee have made a trial trip from end to end of the line—a distance of 5¼ miles from the Boar-lane terminus. At Stanningley the Bradford tramway system commences, but the gauges of the two lines are different, that of Leeds being 4ft. 8½in., and that of Bradford only 4ft., so that a change of cars is necessary.

Ayr.—The Easter tramway returns show that the number of passengers carried was 13,180, and that the drawings reached £50 odd, being £4 above the sum taken on Jan. 1, which was the previous record. The tramway system has now been in operation for six months, during which time the cars have run 117,949 miles and carried 1,099,833 passengers. The total drawings for the period have amounted to £3,554. 0s. 4d., or an average of £136. 13s. 5½d. per week, being at the rate of 7·231d. per car mile. The amount of current used was 98,842 units. The current is supplied by the electricity department of the Corporation at 1½d. per unit, and the cost works out at the low figure of £617. 15s. 3d.

Lancaster.—A letter was received at the last meeting of the Town Council from the tramway company to the effect that the directors are quite willing to recommend the company to dispose of their undertaking on reasonable terms, and if the Corporation are desirous of purchasing on reasonable terms, they suggest that the most likely way to arrive at a fair price will be for each party to appoint a qualified expert to value and negotiate, neither party being necessarily bound by the result of such value or negotiation. A letter has also been received from the secretary to the General Post Office, stating that he could not see his way to comply with the wishes of the Corporation to lay the telegraph wires in South-road underground.

Burnley.—Last week the new electric tramway system for Burnley, Nelson, Brierfield, and Padiham was formally opened. It will be remembered that last year the Burnley Corporation acquired the undertaking of the Burnley and District Tramway Company for £53,000, and proceeded to convert the system of traction from steam to electricity. New lines through the towns named, covering a distance of 7½ miles, have been constructed, the overhead trolley system having been adopted. It is expected that the cost of the undertaking, exclusive of the price paid for the old company's concern, will be about £110,000. Plans have been prepared for a number of branch lines in different parts of Burnley, but the Corporation have decided that this part of the scheme shall remain in abeyance until it is known whether the trunk line is a paying concern.

Manchester.—Work is going on vigorously in preparing various new tramway routes in the city for the introduction of electric traction. The Hyde-road and Stockport-road sections are almost completed, and they will be opened with a service of electric cars, as already arranged, in May next. The new line along Upper Brook-street, upon which horse cars were first introduced, has proved so successful that it has been decided to exchange the horse cars almost immediately for electric cars. The overhead equipment has already been provided, and the Electricity Committee hope to be in a position to supply the necessary current before the end of April. Preparations are now being made to deal with the Oldham-road, Ashton New-road, and Ashton Old-road sections. The relaying of these lines and the erection of the overhead equipment will, it is expected, be finished before the end of the year.

Manchester-to-Bolton.—There appears to be good prospect of an electric car service between Manchester and Bolton, and even further afield, to Horwich, in the near future. The whole length of the Kearsley line, from Unity Brook to Farnworth, has been opened, and negotiations are pending for the construction of the light railway from the latter point through the parish of Clifton. The Barton Rural Sanitary Authority, in whose district the parish named is situate, have approached the Salford Corporation, who have the control of the Swinton and Pendlebury tram service, but the Corporation have so far declined to take up the scheme. Overtures have been made by the Farnworth District Council, who run the electric cars to Kearsley as well as their own district, but the terms offered are far from satisfactory to the Barton Rural Sanitary Authority. The latter authority have three years in which to carry out the light railway scheme in Clifton, and seeing that the short length comprising the Clifton township is a valuable link in a through electric car service between Manchester and Bolton and Horwich, they are in no hurry to act. The light railway will involve an expense of nearly £20,000.

Darlington.—The Tramways Committee have now held a meeting at which the report of Messrs. Kennedy and Jenkin as to the form of electric tramway to be adopted, and the relative cost of the overhead and conduit system, was considered. On this report it was unanimously decided to recommend the adoption of the overhead system throughout the length of about five miles, one line to go from the Market-place to Cockerton, another through Northgate to Harrowgate-hill, a third to Eastbourne, and another to Haughton Bridge. The committee decided on a single line from Greenbank-road to Cockerton and from Burton-street to Haughton, the rest of the lines to be double, except 10 chains near the King's Head in Northgate, and a short length near St. John's Church at Bank Top. It was arranged that the single-line portion, supposing the sanction of the Board of Trade were obtained, should be so placed that in the event of it being afterwards decided to make a double line it would not be necessary to alter the position of or take up the single line. The estimated cost of the lines without allowing for old material, the existing car-shed, rolling-stock, horses, etc., and without including the purchase price of the old tramways—£7,500—would be about £90,000. If it were made a double line throughout under like conditions the cost would work out to about £99,000.

Watford.—We learn that the Light Railway Commissioners, who recently held a local enquiry into the proposal to establish light railways in Watford, Bushey, and Rickmansworth, have decided that the application of the Hertfordshire County Council as to the proposed county of Hertford (Bushey) No. 3 light railway should be granted. The Commissioners have also decided that the application of the Watford and District Tramways Company as to the proposed Watford and district light railways should be granted in respect of the railways (Nos. 1, 6, and 7) within the urban district of Watford, and should be rejected in respect of railways (Nos. 2, 3, 4, and 5) outside the district. With reference to the proposed line to Rickmansworth, having regard to the requirements of the Urban District Council of Rickmansworth as to road widenings and extensions through their district, and to the undertakings in that respect given to them by the promoters, the Commissioners consider it advisable that any such scheme should be presented to and considered by them as a whole. The result, therefore, is that Bushey and Watford urban districts will be provided with light railway accommodation, while the scheme for Watford, outside the limits of the urban district, is rejected; and in regard to the Rickmansworth scheme, the Commissioners desire further information.

LIGHTING AND GENERAL.

Gloucester.—The question of municipal telephones is being considered by the Corporation.

Bolton.—The charges recently adopted for supplying electricity to motors are to be reconsidered.

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Bridgend.—The District Council intend to apply for sanction to borrow £4,000 for electric lighting.

Worthing.—The Town Council propose to apply for sanction to borrow £7,850 for extension of electricity mains.

Uxbridge.—An agreement has been entered into by the Urban District Council and the local electric supply company.

Manchester.—Sanction has been obtained to the Corporation's application for a loan of £477,000 for electricity purposes.

Halifax.—It has been decided to invite tenders for the erection of additional plant in the electricity department at an estimated cost of £6,265.

St. Pancras.—The Borough Council are applying to the London County Council for a loan of £90,000 to extend their electricity undertaking in the borough.

Removal.—Messrs. Monté Callow and Co., agents of "Perfecta" resistance apparatus, etc., have removed from 39, Victoria-street, S.W., to 6, Ludgate-broadway, E.C.

Heaton Norris.—The Urban District Council are taking steps with a view to facilitating the introduction by the Manchester Corporation of the electric light into the district.

Edinburgh.—The Electric Lighting Committee received the following applications from Feb. 27 to March 27: lighting, 3,293; power, 972; heating, 140—total, 4,405 8 c.p.

Kendal.—The plant at the electricity station is being rapidly placed in position. There is a fair number of applicants for electric light, and the work is progressing satisfactorily.

Honley.—The Urban District Council have received applications aggregating 1,190 8-c.p. lamps, and will now apply for sanction to a loan of £2,000 to carry out their electric lighting scheme.

York.—The Electric Lighting Committee propose to make a charge of 3d. per unit for current supplied to consumers in connection with illuminations during the forthcoming Coronation festivities.

Llantarnam.—The Urban District Council have been considering the South Wales Electric Lighting Distribution Company's Bill, and are preparing clauses for protection *re* the proposed road to Forge Hammer.

Blyth.—The lighting installation at the new hippodrome and variety circus at Blyth includes several lamps of 4,500 c.p. each. These lamps are considered to be the most powerful in use in the North of England.

Middleton.—The Corporation's electricity works, which have just been erected under the superintendence of Messrs. Lacey, Clirehugh, and Sillar, will be opened by the chairman of the Electricity Committee on April 14.

Dorking.—A draft form has been prepared of an agreement with Edmundson's Electricity Corporation, Limited, for carrying out the electric lighting of Dorking, also a lease of the Council's undertaking for 25 years.

Stockton.—A Bill confirming a provisional order made by the Board of Trade under the Electric Lighting Acts of 1882 and 1888 relating to Stockton rural district and Thornaby-on-Tees has been read for the first time.

Night Telegraph.—An experiment recently tried in New Zealand of keeping telegraph offices open to midnight has, according to the last report of the Postmaster-General of that colony, proved a failure throughout the colony.

Professorship Vacant.—The Merchant Venturers' Technical College, Bristol, will shortly appoint a professor of electrical engineering at a salary of £400 a year. Further particulars appear in our advertisement columns.

Ballymahon.—A committee of the Town Council is conferring with a committee of the District Council with regard to the steps to be taken to put in force the Electric Lighting Act, 1882, so far as relates to the town of Ballymahon.

Barking.—The Council have applied for sanction to the borrowing of £7,570 for electricity works extensions, as per engineer's estimate, as follows: buildings, £375; generating plant, £4,712; distributing plant, £2 455; loan cost, etc., £28.

South Wales Power Distribution Bill.—This Bill, which should have come on Tuesday last week before the Standing Orders Committee of the House of Commons, was not considered owing to the committee's inability to obtain a quorum.

New Agency.—Messrs. Mackies, Limited, of Reading, makers of wrought-iron dynamo pulleys and fittings for other electrical work, have placed their London and district representation in the hands of Mr. J. E. Lawler, of 39, Lime-street, E.C.

New Branch.—The Electrical Company, Limited, Charing Cross-road, W.C., have opened a branch, with Mr. K. R. Stuart as manager, at 17, York-street, Sheffield. The telegraphic address is "Circuit, Sheffield," and the telephone number 3,435.

Aberdeen Telephones.—The circular issued by the town clerk, Aberdeen, with reference to the proposed municipal telephones, states that the rates proposed are, for unlimited service £6 per annum, and for restricted service £3. 10s. per annum.

London Gazette.—The hearing of the application for the discharge of L. J. Lawrence, trading as Lawrence and Butcher, electrical engineers, 5, Stafford-street, Old Bond-street, London, has been fixed for April 18, at 11 a.m., at Bankruptcy-buildings, Carey-street, W.C.

Belfast.—The National Telephone Company recently applied for a renewal of their lease with the Belfast Corporation. The Council, however, refused to consider such renewal unless the company first agreed to grant an unlimited service throughout the city for £5. 5s. a year.

Naval and Military.—Electricity is to be used in lighting the additional cells about to be built in the naval gaol at Lewes. Extensive electric lighting installations have also been carried out at Aldershot, Chatham, Portsmouth, and other naval and military centres.

Ilkeston.—The Chairman of the Tramways and Electricity Committee said at the last meeting of the Town Council that satisfactory progress was being made in regard to the work, the Derby and Nottingham Electric Supply Company having taken land adjoining Manners Colliery.

Cookham.—A scheme has been prepared for lighting the parish church with electricity. Mr. F. H. Headley's estimate has been approved, and £75 will be granted the churchwardens towards the cost of same, upon the understanding that the balance of £141 be raised by private subscription.

Branksome.—The Sanitary Committee have been corresponding respecting electric lighting with the electricity company, the Board of Trade, and the Poole Corporation, and have decided that sample lamps should be placed in the Ashley-road and estimates obtained, to be submitted to the Poole Corporation.

Blackpool.—The movement initiated by the Blackpool Tradesmen's Association in favour of a municipal telephone service is being pressed forward at every opportunity. The Lytham and Fleetwood Councils have expressed their willingness to co-operate in any endeavour to bring about a more economic and efficient service.

Frome.—At a special meeting of the Urban District Council last week the electric lighting scheme was discussed. A deputation attended and drew attention to the big schemes of electric power now being formed, which would be connected with areas extending over several hundred miles, one of which would have the Somerset coalfields as its base.

Walker.—It was reported at the last meeting of the Council that the Newcastle Electric Supply Company had stated their willingness to supply electricity for public lighting purposes within three months from the 14th ult. Messrs. Meldrum notified the Council of the firm's intention of making a start with the erection of the refuse destructor immediately after Easter.

Ripon.—The introduction of the electric light and the absence of any definite action by the Corporation to put in force the powers obtained under the provisional order, which will expire in July, 1903, is being discussed in the local Press. It is urged that as a municipal installation is probably impracticable, arrangements should be made for the purchase of electricity in bulk.

Salford.—The Electric Light Committee propose that from Oct. 1 the charges for electricity shall be reduced as follows: for lighting, 4d. per unit, with a minimum payment of 13s. 4d. per quarter on all bills; for power, 1½d. for consumers using over 5,000 units per quarter; and for consumers not using 5,000 units per quarter, 2d. for the first 2,500 units and 1½d. for the remainder.

Presentation.—Mr. J. Martin Carr, A.M.I.E.E., was presented last week with a handsome silver tea service on the occasion of his appointment as representative of the Samuel Barnes Electric Company (London) at 19, Waterloo-street, Glasgow. Mr. Carr has for the past 8½ years been associated with the electrical department of Wylie and Lochhead, Limited, Buchanan-street, where he was manager.

Mytholmroyd.—The Urban District Council have complained to the electricity department of the Halifax Corporation of bogus fire-alarms, caused by the interference of the Corporation's electric tramway wire with their fire-alarm wire. They ask for payment for attendance of firemen, etc., on the occasion of such false alarms. The electrical engineer has been deputed to enquire into the matter.

Heanor, Codnor, and Loscoe.—After hearing Mr. Barker, secretary to the Derbyshire and Notts Electric Lighting Company, last week on the projects of the company in the Heanor district in the matter of electric power and lighting, the Council decided to ask the company to send full particulars in writing for the Council's consideration. It was stated that 250,000 units could be supplied at 1½d. per unit.

Lightning.—The Lightning Research Committee, organised in January, 1901, by the Royal Institute of British Architects and the Surveyors' Institution, has prepared a record of 60 cases of the action of lightning strokes on buildings, 12 of which were fitted with some form of lightning conductor. Observers of lightning strokes and others interested in the subject may communicate with the secretary at 9, Conduit-street, W.

Eton.—At the last meeting of the Urban District Council the Clerk reported that he and the chairman had attended the enquiry held at the Board of Trade offices last week with reference to the application of Slough Urban District Council for a provisional order for the lighting of Datchet with electric light. He added that the order would not be granted without due consideration to the pecuniary interests of Datchet both now and in the future.

Whitby.—On Tuesday the Urban District Council decided to charge 5d. per unit for electric current supplied to all the churches and chapels in the town. The cost to private consumers is 6d. per unit. A resolution was also carried to the effect that the nine Bray lamps on the west pier be fitted with electric incandescent lamps of from 200 c.p. to 300 c.p. each. The estimate of the cost of replacing the present gas lamps of 80 c.p. with the incandescent lamps is between £150 to £200.

Macclesfield.—The Electricity Sub-Committee have decided to institute a canvass within the "prescribed area" of the electric lighting provisional order recently granted by the Board of Trade, asking for intimations as to who are prepared to use electricity for lighting or power, in the event of the Corporation undertaking the

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construction of works, or letting a company contract for them. Sixpence per unit was the price mentioned as that likely to be charged for lighting purposes.

Hendon.—At a recent special meeting of the District Council the following motion was discussed: "That in view of the decisions at the recent public meetings held in the parish in opposition to the installation of the electric light by the Council, the Council now determine not to proceed further with the application for the present loan." It was finally agreed to publish the proposed variations of the electric lighting scheme, and to take a poll of the parish thereon at the earliest possible date.

Stourbridge.—A special meeting of the Urban District Council will be held shortly to consider the whole subject of electric lighting and contingent matters. The Destructor and Electric Powers Committee have opened negotiations with the British Electric Traction Company for the purpose of endeavouring to obtain from them a proposal for taking over the Council's electric lighting order, and have been empowered to continue negotiations with the British Electric Traction Company or any other company.

Gravesend.—The engineer in his last report stated that as he found a saving could be effected by constructing the shaft of "Flettons" instead of the "picked stock facings," mentioned in the specification, he had ordered the contractors to substitute the former for the latter, and that the difference in the cost would be deducted from the contract price. The Town Council have resolved that the shaft be taken down to the stone coping and built up with "picked stocks" per specification, but that overhand pointing be allowed.

Crook.—The electric lighting question is before a committee. Messrs. Pease and Partners, Limited, who are at present putting down an extensive electric plant at their Bankfoot works, have been approached in regard to the street-lighting at Crook, and have replied that they could not consider it until their own requirements had been adequately met. The promoters of the Cleveland and South Durham power scheme have informed the Council that they hoped to decide in a week or two in which district to commence the erection of power stations.

Telegraphists for Africa.—Situations are offered by the Director of Military Telegraphs at Pretoria to men employed in the telegraph department of the Post Office who are willing to take service in the Transvaal. Candidates must be over 18 and under 25 years of age, unmarried, and prepared to sign an agreement to remain in the colony two years. They must join in all cases in the second class at £200 a year, rising by annual increments of £15 to £305. If promoted to the first class they will be paid £320 a year, rising by £20 yearly to £420. Service in the British Post Office will count towards their pension.

Cleveland and Durham Electric Power Co.—This Company are now making arrangements for putting up a large electric power station at Middlesbrough to supply works and shipyards in the neighbourhood. There are also other stations in the Durham district in contemplation. Mr. H. Graham Harris, of Messrs. Bramwell and Harris, London, has been appointed consulting engineer to the Company. An office has been opened in Darlington as being the central position in the district at 1, Victoria-road, and a branch office has also been opened at 13, Queen's-terrace, Middlesbrough, for local enquiries and business.

Electrical Power for South Wales.—The foundation stone of the generating station of the South Wales Electrical Power Distribution Company at Treforest will be laid on April 30. The excavations and the concrete foundations have been completed. The preliminary works are already being proceeded with for the construction of other large generating stations at Neath, Cwmbran, Bridgend, etc., where electrical power will be generated and distributed by mains throughout the various mining and manufacturing districts. The company propose to supply electric power at cheap rates to the local authorities for electric lighting and tramways.

Horsham.—At the last meeting of the Urban District Council it was stated, in reply to a letter asking how soon the Council would be able to supply electric current to Hurst-road and North-parade, that the tradesmen had responded nobly in taking up the electric light, and that private residents had also come forward, but unless private individuals in the area which was now supplied took the light, it would be at first some little loss. The matter, of course, was in the hands of the occupiers of houses as to whether they chose to pay for their own electric light or whether they would rather pay for the expenses of it through the rates. The letter was referred to the committee.

Aberdeen.—The new electric station, now in course of erection at Dee village, for the Corporation of Aberdeen, was inspected on Tuesday by the members of the Town Council. The engine-room is capable of containing about 6,000 h.p. or engines and dynamos together, with the necessary switchboards, condensing plant, etc. In connection with the works is a subway from the electric station to Union-street, *viâ* Crown-street. It is 2,480ft. long, is 7ft. 6in. in height by 4ft. 6in. in breadth, and is designed to carry cables suitable for 10,000 h.p., capable of extension to 15,000 h.p. The new station when completed will cost about £150,000, and it is expected to be finished in the course of a few months.

Brighton.—Colonel W. R. Slacke on Wednesday held an enquiry into the application of the Town Council to borrow £45,000 for the establishment of a municipal telephone system in Brighton and Hove; the urban districts of Burgess Hill, Portslade-by-Sea, Southwick, and New Shoreham; in the parishes of Clayton, Hurstpierpoint, and Pyecombe in the rural district of Cuckfield; the parishes of Ovingdean and Rottingdean in the rural district of Newhaven; the parishes of Patcham and Preston Rural in the rural district of Steyning East; and the parishes of Reeding, Bramber, Kingston-by-Sea, Old Shoreham, and Steyning, in the rural district of Steyning West. The Corporation propose to charge £5. 10s. per annum unlimited and £3. 10s. for a limited service with a 1d. call.

Mines Drainage.—From the report of the last meeting of the South Staffordshire Mines Drainage Commissioners it appears that a hitch has occurred in the electrical scheme. The Chairman stated that they had not been able to make arrangements for the supply of electricity for pumping purposes. The Electric Corporation for Power Supply asked for 1½d. per unit for surface and 1d. per unit in the mines. This price would work out very expensively, and if insisted upon it would pay them better to put down gas-engines for the generation of their own electricity, getting their supplies of gas from the local gas companies until such a time as Mond gas was available. They would not mind paying the price quoted for surface supply if they could get the current for the mines drainage at ½d. per unit.

Colchester.—The Tramways Committee have passed the following resolution in reference to a resolution previously passed by the Electric Light Committee: "That consideration be deferred until a future meeting, but that the Electric Light and Power Committee be informed it is intended that all current required for tramway purposes shall be taken from the Corporation." The electrical engineer, Mr. A. R. Sillar, in his last report states that the output of electricity in units in February, 1902, was 20,393, as compared with 12,500 in the same month of last year; the number of consumers at the end of February was 249, as compared with 164 in 1901 and 87 in 1900; whilst the total number of 8-c.p. lamps connected at the end of the month was 15,217, as against 10,266 in February of 1901, and 4,685 in 1900. The Council will borrow £5,000 from the Ecclesiastical Commissioners for the purposes of electric lighting, and the amount is to be repaid within 25 years with interest at £3. 12s. 6d. per annum.

Imperial Pacific Cable.—The subjoined telegram from the Postmaster of New Zealand to Mr. Chamberlain was received at the Colonial Office on Wednesday last week: "The first section of the Pacific cable, connecting New Zealand with Norfolk Island and Australia, finally completed to-day at Doubtless Bay. I have specially attended to be present at the landing of the cable. I send you the first message, and hope by the end of the year to have the satisfaction of cabling you *viâ* Vancouver. The work, when completed, will further weld another important link in the chain which binds the people of the British Empire." In reply Mr. Chamberlain cabled to the Governor of New Zealand, the Earl of Ranfurly, on the same day as follows: "Please thank Postmaster-General for telegram announcing landing of Pacific cable at Doubtless Bay. I appreciate the honour of receiving first message sent over Australasian section, and I share his hope for speedy completion of project of such importance and significance to whole Empire."

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Notting Hill Electric Lighting Company's further issue of 2,200 ordinary shares of £10 each, fully paid, Nos. 12,201 to 14,400. Application has also been made to the committee to allow the following securities to be quoted in the official list: Brisbane Electric Tramways Investment Company's £400,000 4½ per cent. first debenture stock (redeemable), in lieu of the provisional certificates now quoted; Notting Hill Electric Lighting Company's £50,000 4 per cent. first mortgage debentures of £100 each, Nos. 1 to 500 (registered): Willans and Robinson, Limited, further issue of 26,666 ordinary shares of £5 each fully paid, Nos. 90,001 to 116,666, and 16,666 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 125,001 to 141,666. Application has also been made to appoint a special settling day and to grant a quotation to the Electric Lighting and Traction Company of Australia, Limited, £75,000 5 per cent. debenture stock, and a further issue of 10,000 6 per cent cumulative preference shares of £5 each, fully paid, Nos. 20,001 to 30,000

Salford Enquiry.—The following report of the first meeting of the special committee appointed by the Town Council to hold an enquiry into the electricity affairs of the borough appeared in the *Salford Chronicle*: "When the matter was before the Council it was resolved 'that an enquiry be held by a committee to be appointed into the electricity department from the time of its inception in 1891 to the present date, and a report thereon presented to this Council as to the following: (1) as to the building, etc., of the Wallness works; (2) as to whether the aforesaid works could have been enlarged (so as to use the machinery at present contained therein) sufficiently to supply electric current for the necessary lighting, and to run the tramways at the present time and for the next five years; (3) as to the total power provided in the Wallness works and the new works, and if found to be in excess of the requirements for the next five years, to go thoroughly into the matter, and report to the Council as to who is responsible: and (4) as to any other matters that in their judgment should be enquired into, and report thereon, and they be empowered to go to any expense necessary to carry out this enquiry. It was also decided that the meeting should be open to the Press.' The committee selected by the General Purposes Committee consisted of the Mayor (Alderman S. Rudman), Aldermen W. Robinson, Holland, Snape, and Phillips, and Councillors Desquesnes, Muir, Kettle, Jackson, Barker, R. B. Robinson, Steele, and G. H. Jones. After the terms of reference had been submitted to the committee a letter was read from Mr. H. Hough, secretary of the Ratepayers' Committee, dated March 13, taking exception to the constitution of the committee, and urging that a legal gentleman—Judge Parry for preference—should be asked to conduct the enquiry, instead of the committee selected by the General Purposes Committee, and that the ratepayers might employ counsel at the expense of the Corporation to conduct the investigation on their behalf. This letter led to considerable discussion. It was ultimately proposed that, as the Ratepayers' Committee objected to certain gentlemen serving on the Enquiry Committee, they should be written to and asked to name the members of the committee they referred to, it being understood that these

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gentlemen would immediately withdraw. This proposal was not carried, however, and it was ultimately resolved to recommend the Council at its meeting in April to disband the committee, and to invite some legal gentleman to conduct the enquiry. It was understood that all evidence given at the enquiry should be given on oath, and that the meeting should be open to representatives of the Press." On Wednesday the Council decided that a legal gentleman to be named be appointed to hold the enquiry, and that so much of the resolution of March 5 as directed the enquiry to be held by a committee of the Council should be rescinded.

Scotch Shale Mines.—The Oakbank Company have just placed with the British Westinghouse Electric Company an order for a complete installation of electric machinery for their manufactory for shale oil. Seven alternate-current motors are to be installed at the works, the primary current being three phase of 3,300 voltage, and the total capacity of the generators 400 k.w. A 30-h.p. motor is to drive through gearing a shale breaker; another of equal power will operate a hauling gear for the removal of spent shale; a third, also of 30 h.p., will drive by belt an exhauster for drawing the gases from the retorts into the condensers. Two 10-h.p. motors will also be fitted, one to bring the raw shale by hauling gear to the retorts, and the other to work the shoot for the same material. The mechanics' shop tools will be worked electrically, as will also several hoists. In the shale mines proper, electricity will also be largely used, seven electric motors, varying from 150 h.p. downwards, having been ordered. One will serve for hauling the shale from the face to the upcast, its capacity being equal to taking a train of 100 tons up the steepest of inclines at a speed of 1½ miles per hour; another will pump 100 gallons of water per minute, a third will pump from the bottom to the surface at the rate of 8,000 gallons per hour against a head of 60ft., while three other centrifugals will deliver 4,000 gallons per hour against a head of 40ft. In addition to drainage, ventilation will also be done by electrically-propelled fans, these ranging up to 20 h.p. Although no actual mining implements are yet ordered, there will be no difficulty whatever in fitting them as occasion arises. The railway on the surface level will also be worked electrically, and for this and some other purposes the main alternating current will require to be transformed to a continuous current. At the oil refinery there will be four transformers of 75 kw. capacity to reduce the voltage from 3,300 to 440 volts for the motors used in this department. At the mine there will be four transformers of 100 kw. capacity to reduce the current here to the 440 volts at which it will work in the mines, while for the railway the transformer station will also have four machines of 37½ kw. capacity, reducing the current to 330 volts, and this will further be changed in a 100-kw. rotary converter into a continuous current of 500 volts for the railway running between the mines and the refinery works. The gauge will be 2ft. 6in., and two electric locomotives taking current from overhead wires will each be able to haul 85 tons at a speed of 10 miles per hour over the ordinary gradients. The overhead wire will also be used for conveying the current from the generating station at the refinery works to the mines. It is expected that the economy to be derived from this reconstruction of the works will have an important bearing on the future of the oil industry in Scotland, as frequently works are scattered over two miles and served at present by a number of inefficient steam systems, each attended by a separate staff of workers.

COMPANIES' MEETINGS AND REPORTS.

BRUSH ELECTRICAL ENGINEERING.

Directors: Lord Vaux of Harrowden (chairman); C. Shirreff B. Hilton; C. E. Hodgkin, A.M.I.E.E.; W. L. Madgen, A.M.I.E.E.; J. S. Raworth, M.I.C.E., M.I.E.E.; R. Percy Sellon, M.I.E.E.; G. F. M. Cornwallis-West. Consulting engineer: J. S. Raworth, M.I.C.E., M.I.E.E.

The report of the directors for the year ended Dec. 31, 1901, states that during the past year several changes have occurred in the constitution of the Board. Mr. E. A. Hopkins and Mr. Reginald Ryley retired at the last annual general meeting, and Lord Vaux of Harrowden and Mr. C. Shirreff B. Hilton were re-elected directors in their place. Mr. Reginald Ryley was subsequently elected as a director to fill the vacancy caused by the regretted death of Mr. J. Slater Lewis, but, unfortunately, he succumbed shortly afterwards to an illness contracted abroad. In November last Mr. J. B. Braithwaite, jun., as foreshadowed by him in his speech at the last annual general meeting, resigned his position as chairman and director of the Company. Lord Vaux of Harrowden has recently accepted the chairmanship of the Company, and Mr. G. F. M. Cornwallis-West and Mr. W. L. Madgen have lately been elected as directors to fill casual vacancies on the Board. The retiring directors are Mr. J. S. Raworth and Mr. G. F. M. Cornwallis-West, who, being eligible, offer themselves for re-election. The profit and loss account shows a gross profit of £61,054. 8s. 2d. After deducting general charges, maintenance, interest on debenture stock, bonus to employés under profit-sharing scheme, and amount placed to depreciation and general reserve funds, there remains a balance of net profit of £7,455. 8s. 11d. Of this sum £7,088. 17s. 6d. has been applied to the payment of the dividend on the preference shares at the rate of 6 per cent. per annum for the half-year ended June 30 last, leaving the balance of £366. 11s. 5d. to be carried forward to next account. The net profits would have been larger but for the fact that the directors have deemed it necessary to debit profit and loss account with the sum of £8,500 placed to a general reserve fund. Under Article 117, Sub-section 21, of the Company's articles of association, this reserve fund is available to meet contingencies, for equalising dividends, or for repairing, improving, and maintaining any of the property of the Company, and might be applied in payment of part of the preference dividend for the second half of the year 1901, but the directors are of opinion that it would not be prudent to do so. The auditors refer in their report to the patents and goodwill account, and to certain of the Company's investments. These matters, and the position generally, are receiving the careful consideration of the directors, but the Board having only lately been reconstituted cannot at present make any recommendation. The directors are confident that the economies and reforms which they are carrying out will produce improved results in the future. The share capital account has been increased during the year by £76,498, the proceeds of the issue of the remainder of the preference shares of the Company; and, in addition, the sum of £30,740 has been received from the British Electric Traction Company, Limited, as an advance in respect of an undertaking they have entered into to take up 25,000 of the £2 ordinary shares of the Company at par. A liability of £6,793. 13s. 8d. has been incurred in connection with these issues, of which £2,593. 13s. 8d. has been charged to the profit and loss account for the year. Capital expenditure to the extent of £15,536. 4s. 8d. has been incurred during the year on new plant and buildings. The remainder of the new capital has been applied to the discharge and reduction of the obligations and liabilities of the Company.

Dr. ABSTRACT OF BALANCE SHEET.	£	s.	d.
Authorised capital—150,000 6 per cent. preference shares of £2 each	300,000	0	0
180,000 ordinary shares of £2 each	360,000	0	0
	660,000	0	0
Capital issued—150,000 6 per cent. preference shares of £2 each	300,000	0	0
105,731 ordinary shares of £2 each	211,462	0	0
	511,462	0	0
Advance from British Electric Traction Company	30,740	0	0
4½ per cent. perpetual first debenture stock	125,000	0	0
4½ per cent. perpetual second debenture stock	125 000	0	0
Loan from bankers	25,000	0	0
Sundry creditors and bills payable	49,936	10	0
General reserve fund	8,500	0	0
Depreciation reserve fund	25,606	18	1
Workmen's Compensation Act insurance fund	1,000	0	0
Profit and loss account, less interim dividend	366	11	5
	£902,611	19	6

Cr.	£	s.	d.
Property and plant	280,895	4	1
Patents and goodwill, as per last account	181,397	8	9
Stock in hand and in progress	139,486	10	8
Sundry debtors and bills receivable	117,103	17	1
Balance of commission payable	4,200	0	0
Cash at bankers and in hand	10,534	17	8
Shares and debentures at or below cost price	148,461	16	10
Depreciation reserve fund invested in consols	20,532	4	5
	£902,611	19	6

Dr. ABSTRACT OF PROFIT AND LOSS ACCOUNT.	£	s.	d.
Directors' fees	2,500	0	0
Auditors' fee	150	0	0
Salaries	6,870	8	7
Law charges	540	7	4
Insurance	1,402	14	1
Expenditure under Workmen's Compensation Act	213	15	10
Postage, stationery, and printing	696	14	8
Rent, rates, and taxes	1,841	12	6
Advertising and London office expenses	2,507	13	2
Debenture stock, trustees' fees and expenses	204	1	4
	16,927	7	6
Maintenance of buildings and plant	5,529	19	3
Maintenance of patents	293	13	5
Interest on perpetual first debenture stock	5,625	0	0
Interest on perpetual second debenture stock	5,625	0	0
Proportion of expenses of new share issues	2,593	13	8
Cost of making good damage to buildings, plant, etc.	888	2	8
Remainder of cost of redeeming £16,290 redeemable second debenture stock	407	5	0
Bonus payable to employés under profit-sharing scheme	708	17	9
Amount carried to depreciation reserve fund	6,500	0	0
Amount carried to general reserve fund	8,500	0	0
Balance carried to balance-sheet	7,455	8	11
	£61,054	8	2

Cr.	£	s.	d.
Balance brought forward from last account	1,502	6	10
Gross profit on trading	52,142	0	5
Profit realised from sale of an undertaking, and interest on securities	7,303	15	11
Transfer fees	106	5	0
	£61,054	8	2

EDWARDS'S AIR-PUMP.

The directors in their report for the year ending Dec. 31, 1901, state that the royalties booked during that period show an increase of over 10 per cent. on the previous year. The revenue from this source for

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1899 amounted to £3,219, for 1900 to £4,266, and for 1901 to £4,734. The expenditure of the year shows a slight increase of £95. The steady expansion of the business of the Syndicate continues both in respect to marine pumps and pumps for land installations, the former representing 58 per cent. and the latter 42 per cent. of the total number of pumps booked. A very satisfactory feature of the past year has been the large increase in the number of pumps built under license abroad. The pump has fully maintained its reputation amongst consulting, mechanical, and electrical engineers, and has now been fitted for the condensing plants of over 60 of the most important electrical stations in the United Kingdom. The directors confidently expect a considerable increase of business as the result of appointments of foreign agencies. The balance on the revenue account for the year amounts to £2,171. 9s. 10d., which together with the balance carried forward from last year (£375. 10s. 1d.) gives a total of £2,456. 19s. 2d. The directors propose applying this balance as follows: to sinking fund account for redemption of cost of acquiring patents, £1,250; to pay a dividend of 5 per cent. on the called-up capital, £1,049. 16s. 3d., leaving to be carried forward the sum of £247. 2s. 11d.

MERSEY RAILWAY.

The report of the directors for the half-year ended Dec. 31 last, to be submitted to the meeting on the 26th inst., states that the management of the Company's affairs was not vested in the Board until Aug. 7, 1901, since which time only have they had control of them. The total receipts from all sources for the half-year have been £34,395, as compared with £39,049 for the corresponding period of 1900. The directors regret the decrease in the traffic receipts, which is due to the opening of the Birkenhead electric tramway system, and which they believe will continue until the railway is worked by electricity. The contract with the British Westinghouse Electric and Manufacturing Company, Limited, provides for payment of the interest on the redeemable first, also the Mersey Railway new first perpetual debenture stocks until the railway throughout shall be available for public traffic worked by electrical power. The electrical works are in course of construction, and substantial progress has already been made. The system of electric traction adopted by the Company has since been selected by the Board of Trade after an exhaustive enquiry before an arbitrator appointed by them as the system to be adopted on the Metropolitan and the Metropolitan District Railways.

FERRANTI LIMITED.

The report of the directors for the year ended Dec. 31, 1901, states that the gross profits (including dividends on British Insulated Wire Company shares, £4,299. 15s.) amount to £49,821. 8s. 7d. From this has to be deducted the total cost of administration, patent fees, and experimental expenses, £15,104. 11s. 4d.; and repairs, renewals, and depreciation, £9,556. 15s. 8d.; leaving a net profit of £25,160. 1s. 7d. The directors consider this result satisfactory. The plant and machinery has been kept in a high state of efficiency. Nine thousand nine hundred and fifty-six pounds, as shown above, has been charged against revenue for upkeep and depreciation. Of the above balance £8,215. 12s. 4d. is payable to the liquidator of the old company as interest on the purchase price, in accordance with the contract for sale; income tax and directors' fees amount to £944. 8s. 6d.; debenture interest and interest on loans, £4,434. 11s. 11d.; dividends on preference shares calculated from dates of payments of calls, £1,091. 9s.; leaving to be dealt with £10,473. 19s. 10d. In accordance with the articles of association, the sum of £2,500 will be applied to the reduction of patents account, and it is proposed to write £1,100 off the formation expenses. In view of the amount of interest mentioned above, it is proposed to pay £1,784. 7s. 8d. only as dividend on ordinary shares. Of the balance of profit—*i.e.*, £5,089. 12s.—£3,000 will be transferred to reserve account, and £2,089. 12s. 2d. carried forward. The directors hope to finally dispose during the current year of the expenditure on old engines, to meet which the sum of £14,000 was reserved at the formation of the new company. In view of the unexpected depreciation since the issue of the prospectus in the quoted value of British Insulated Wire Company's shares which were taken over from the old company, Mr. Ferranti has executed an agreement undertaking to meet the deficit (if any) upon the sale of these shares, and has given security. They have, therefore, not been written down in the books. The orders in hand are over £60,000 greater in value than at this date last year. To meet the rapid increase in business, it has been found necessary to lease additional premises close to the existing works, which are being equipped as a switchworks, the present accommodation for this branch of the business being quite inadequate. Amongst the orders recently obtained are important contracts for the London County Council, Manchester Corporation, and Capetown Municipality.

MERSEY RAILWAY.

Mr. James Falconer presided over the half-yearly general meeting of the shareholders in this Company held at Worcester House, Walbrook, E.C., on the 26th ult.

In moving the adoption of the report, the **Chairman** referred to the arrangement concluded with the British Westinghouse Company for the electrical equipment of the line. He hoped that by the time the corresponding meeting next year was held they would have the public being carried under the improved conditions. At the last half-yearly meeting a question was raised as to whether the Company ought not to adopt another system known as the Ganz system. The Board considered that question very carefully when they entered into the contract, and came to the conclusion that the system was not suited to the circumstances of the Company. With regard to the accounts, there was only one matter to which it was necessary to refer—the effect of the opening of the Birkenhead electrical tramways. The result had been to take away a certain amount of traffic that had hitherto travelled by the tunnel. This was one of the strong reasons which showed that it was essential for the Company to abandon steam and take to electric traction on their undertaking.

Mr. S. G. Sheppard seconded the motion, which was adopted.

GUILDFORD ELECTRICITY SUPPLY.

The annual general meeting of this Company was held at Guildford on the 26th ult., Dr. F. R. Russell presiding.

The directors' report drew attention to the greatly improved position of the Company. Not only had there been a gain in gross revenue of £515, but a decrease of no less than £377 in expenditure, notwithstanding an increased output of over 20 per cent. The total gross profit was £960. 19s. 3d., which was equivalent to 4 per cent. on the total capital of the Company, including loans in use during the year. Considerable improvements had been made to the machinery during the year, chiefly in the direction of fuel-saving apparatus. All the temporary sheds had now been removed and substantial and well-lighted buildings erected, which would hold all the machinery the Company was likely to want for some years to come. The retiring director was Mr. Baring-Gould, who offered himself for re-election.

The **Chairman**, in proposing the adoption of the report, said they would be very pleased to see the great improvement there was on the previous year, both in the amount they had received for current and also in the expenses, and how very much the coal bill had diminished, both through the coal itself being cheaper, and also because of the present very excellent cells they had got in, which had been a great saving to the Company. They had now got in condensers and other coal-saving machinery, which he hoped would further reduce the price of the coal. The Board had decided not to raise the price of current this year. They were going to make an attempt for another year at the present price. They felt that a dividend should be paid on the ordinary shares. They had had to raise capital by debentures at a very high rate of interest, but they thought it better to struggle on for another year and see how the Company went, and he hoped that, with increased custom, they would be able to show a still better balance-sheet next year.

Mr. Asher seconded the motion.

In the subsequent discussion it was pointed out by a shareholder that only in the case of one other company were such bad results obtained as at Guildford.

Replying, the **Chairman** said the reason they had not paid a dividend was because they started with insufficient capital. It was only a question of time for the Company to pay, and pay handsomely. They had earned a dividend of 4 per cent., and had the shareholders come forward and subscribed the whole of that capital they would undoubtedly have received a 4 per cent. dividend.

Ultimately the resolution was adopted.

FOLKESTONE ELECTRICITY SUPPLY.

The annual general meeting of this Company was held at Folkestone on the 27th ult., under the presidency of Mr. George Spurgeon.

The report of the directors stated that the Company continued to make satisfactory progress. Up to Dec. 31, 1900, the equivalent of 24,190 8-c.p. lamps was being supplied, whilst up to Dec. 31, 1901, the equivalent of 32,532 8-c.p. lamps was being supplied. There is a profit on the revenue account of £4,074. 12s. 7d., which, with the sum of £345. 2s. 4d. brought forward from last year's accounts, and after allowing for interest on debenture stock and bank charges on overdraft, shows a net balance for distribution of £2,960. 19s. 10d. Out of this the directors recommended the payment of a dividend at the rate of 4½ per cent., which required £2,250, and the placing of £400 to the reserve fund, thus leaving a balance of £290. 19s. 10d., which it was proposed to carry forward. The Company had expended a large sum during the year for additional plant, etc., and to meet the cost of same a further issue of £25,000 debenture stock was made in September last on the same terms as the previous issue, and the directors were pleased to report that the issue was entirely successful. A Stock Exchange quotation had now been granted in respect of this stock. The directors considered the profit shown on the year's working was very satisfactory.

The **Chairman,** in submitting the above report for adoption, said the shareholders had every reason to be well satisfied with the progress of the Company during the past year. In addition to the number of 8-c.p. lamps mentioned in the report the Company had received applications for 1,196 lamps since December. The increase of capital during the year was £1,838, and 82,616 units of electricity had been supplied, an increase of 21 per cent. on last year. The average charge for this supply worked out at 4¾d. per unit, ¼d. cheaper than Dover. The Company had had many difficulties to contend with in regard to the high price of fuel, which had at one time reached 33s. 3d. He thought in future, however, that they would be able to maintain the position they had held, so long as they were able to purchase their fuel on the same terms they were then paying. In regard to the working of the Company, the engineer and his staff had done all they possibly could to maintain the high reputation of the Company, and the electric light was becoming very popular in the neighbourhood. In reply to a shareholder, the chairman pointed out that 170,328 units of electricity entered as not accounted for were entered as such in accordance with the Board of Trade regulations, and represented power lost in the cables.

The motion was adopted unanimously.

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BROMLEY ELECTRIC LIGHT AND POWER.

The annual general meeting of the shareholders in this Company was held at Bromley, Kent, on the 24th ult., Mr. T. E. Gripper in the chair.

The report of the directors showed that the progress made by the Company during the year had been satisfactory, the lamp connections in Bromley having increased from 13,395 to 20,125, whilst 6,691 were being supplied to Chislehurst. Applications for 2,000 additional lamps had already been received this year. The sale of current had increased from £4,044 to £5,756. The result of the year's trading, including the £122. 7s. 10d. brought forward from last year, showed a profit of £3,461. 0s. 5d., and after payment of debenture and loan interest amounting to £2,525. 2s. 2d., the amount available for dividend was £935. 18s. 3d. The directors recommended the payment of a dividend at the rate of 4½ per cent. for the year, and that £400 be placed to a reserve fund for the renewal of plant, leaving a balance of £65. 8s. 5d. to be carried forward to the next account. Extensions to the plant, which had been completed during the year, had enabled considerable economy to be effected in the working of the station. It was proposed to submit a resolution authorising the directors to acquire an interest in the Chislehurst Electric Supply Company, Limited, by subscribing for the whole or part of the share capital of that company. Also a resolution authorising an increase of the debenture issue to £50,000, and a resolution to increase the number of directors to six, by the appointment of Mr. Edmund Charrington and Mr. John Cuthbert Wigham. One of the directors, Mr. Daniel Grinsted, retired by rotation, and, being eligible, offered himself for re-election.

The **Chairman** formally moved the adoption of the report.

Mr. Medhurst seconded, and the motion was carried unanimously.

Afterwards a resolution was carried authorising the directors to increase the debenture issue of the Company to £50,000.

GATESHEAD TRAMWAYS.

Mr. C. R. Greene, presiding over the annual meeting of the shareholders in this Company, held in London last week, said the working of the electric cars had been very successful, and the takings were increasing. When all the lines were working, he thought the Company would be able to pay a fair dividend. He regretted that the Company had not been able to induce the Corporation to allow the Company to abolish ½d. fares on certain sections. He predicted that the Company would prove a sound commercial concern. He moved the adoption of the report, and the motion was carried unanimously.

A dividend of 2½ per cent. on the ordinary shares was afterwards declared.

WILLANS AND ROBINSON.

On the 26th ult. the ordinary general meeting of the shareholders in this Company was held at the Cannon-street Hotel. Mr. Mark Robinson presided.

The **Chairman** moved the adoption of the report (which appeared in our last issue), and in doing so expressed the directors' satisfaction at the results which had been attained in the Company's present transition state. Larger profits than ever before were shown, and, though the unavoidable burden of capital which as yet earned nothing precluded the Board from repeating the bonus of the last two years, yet they maintained a rate of dividend—10 per cent. per annum—which at one time they felt very proud to declare. The Rugby extensions were coming into beneficial use, though there was much still to do, and the progress of everything had suffered from the almost unaccountable delays of the cranemakers and toolmakers generally. At Queen's Ferry the boiler works had made good though much less rapid progress than the directors had hoped. Steel had been manufactured at intervals upon a commercial scale, sufficiently to prove that the Company could make steel of excellent quality for their purposes. The superintendent of the tube shop expected to begin drawing tubes in July, and the directors saw no reason why the Company should not be erecting boilers before the end of the year. The directors had asked the shareholders' permission to increase the debenture debt from £100,000 to £250,000. The Company's financial position a week ago was this — orders had been given, or in principle approved, for buildings; plant, etc., upon which there would be to pay, when the work was done, a further sum of £92,733. Against this there was money on deposit or otherwise (but, of course, not counting the reserves and cash actually in hand for current needs) amounting to £48,516. There was, therefore, already a potential need for £44,217. Beyond this, money was required for further plant at Queen's Ferry and for some at Rugby. There must be a margin to enable improvements to be made if these should be found desirable, and there must be working capital for the new as well as for the old business. Further, as past experience taught, a large margin under this head must be provided for the tendency to an increased lock-up in stock, book debts, etc., which a growing business entailed. For all these services, as far as the directors could see at present, £150,000 additional was not too much. When the existing issue of £100,000 was made, the net assets of the Company, after deducting debts, amounted to £204,100, excluding goodwill. Now, to secure the proposed issue of £250,000, the Company had on Dec. 31 last—and they had more now—net assets of £938,868. The present assets include neither goodwill nor patents, both having been written off completely.

Mr. G. W. Anderson seconded the motion, which was carried unanimously, as was also a resolution authorising the directors to borrow the additional amount mentioned by the issue of debenture stock.

SALISBURY ELECTRIC LIGHT.

The annual general meeting of the shareholders in this Company was held at Salisbury on the 25th ult., Mr. W. M. Hammick presiding.

The report of the directors stated that the progress made by the Company during the year had been satisfactory. The number of consumers had increased from 210 with 9,795 lamps connected, to 259 with 12,176 lamps connected, and over 2,500 additional lamps had been applied for which were not yet ready for connection. During the year the buildings had been extended, and large additions had been made to the plant. The profit on the year's working, including £21. 10s. 1d. brought forward from last account, amounted to £2,044. 12s. 11d., and after payment of £1,598. 6s. 10d. interest on debentures and loans, there remained a balance of £446. 6s. 1d. available for dividend. The directors recommended that a dividend be paid at the rate of 4 per cent. per annum, that £200 be written off the preliminary expenses account, leaving a balance of £50. 2s. 1d. to be carried forward to next account.

The **Chairman,** in moving the adoption of the report, said they were adding to the plant and machinery every day and building up the business. The Company was progressing most satisfactorily. The balance of the ordinary shares, which amounted to something over £11,000, had been taken up. The price per unit to the consumer had been reduced from 5d. to 4½d., and they had sold 150,000 units, as compared with 112,000 last year. During the year they had added a 200-h.p. engine and boiler to their machinery. This boiler was fitted with a patent chain grate stoker, which was a very excellent thing. In the past their neighbours had complained of the smoke from their shaft, but the chain grate stoker had practically remedied that difficulty, and the Company had given orders for the other engines to be fitted with this patent. In order to meet increasing demands a 350-h.p. engine had been ordered. The Company had entered into a contract with the London and South-Western Railway Company to light their new station. That was a big thing. The wiring of the station, which contract he was also happy to say was in the hands of the Company, amounted to no less a sum than £3,400. The lights at the station would include 90 arc lamps. Having regard to these facts he thought the shareholders might be satisfied that the directors had done their best to look after their interests, and that the manager, Mr. Randall, had proved an excellent servant. The Free Wiring Company had ceased work in Salisbury, and this branch of the business, which was a profitable one, had been taken over by the Company. The directors had the greatest pleasure in recommending a dividend of 4 per cent as compared with 3 per cent. last year.

Mr. Gripper seconded the motion, which was agreed to *nem. con.*

DOVER ELECTRICITY SUPPLY.

The annual general meeting of the shareholders in this Company was held at the offices on the 26th ult., Sir W. H. Crundall in the chair.

The report of the directors stated that a very material increase had taken place in the profits during the year as compared with the previous 12 months, this being partly due to increased output and partly to reduction in cost of coal, etc. During the year 3,350 8-c.p. lamps had been added to the company's mains, besides motors and numerous temporary lights. The additional lights represented a greater increase than in any previous year. There was an increased output over the combined private supply of 1900 equal to 54 per cent. In order to stimulate the increase the directors had given notice some months since to reduce the price of current to 5d. per unit. The profits for the year amounted to £4,729, and after payment of debenture and other interest the directors recommended payment of a 5 per cent. dividend on the ordinary shares, a balance of £278 being carried forward. The directors reported a definite offer from the Dover Corporation to purchase the undertaking for £142,228, which would allow of a distribution of £8. 10s. to each holder of a £5 share. They recommended the acceptance of the offer.

The **Chairman** expressed the view that the shareholders would be fairly satisfied with the result of the past year's working. He had no hesitation in saying that on this year's working they would pay a minimum dividend of 7½ per cent. They had made a very favourable coal contract, extending over the whole of the ensuing year, which in itself would mean more than a 1 per cent. dividend, owing to the difference in the cost of coal as compared with last year. Then they had to take into account the economies they had made in the working, on which they would save from 1 to 1½ per cent. at the very least, to say nothing of the increased number of customers they would get in the year, many having been secured during the last three or four months. He next referred to the death of Mr. Bagshawe, a director, and announced that Mr. Henry Hobday had been appointed to fill the vacancy on the Board. Remarking on the fact that there were only 400 customers for electric lighting in Dover out of some 8,000 houses, he thought that Dover people would soon emerge from the prejudices they had had with regard to electricity, and would seize the opportunity of installing it at the cheap price current was now being offered at. With regard to the future he mentioned that they had connected up the Prince of Wales's Pier for lighting and power. They had also lighted up the Admiralty Pier, and were now about to lay a power cable there to supply electric cranes, which would bring in a fairly large income. As to the sale of the undertaking to the Corporation, the directors had decided to recommend the shareholders to accept the low price of £8. 10s. for their ordinary shares, and the premium that the shareholders had paid for the preference shares and debentures. The payment to be made meant a total profit to the ordinary shareholders of £35,000. He considered the Corporation would have a magnificent bargain, and he wa

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confident in saying they would earn sufficient money on this year's working to pay the interest on that £142,000 which they were going to pay for the concern. He moved the adoption of the report and accounts, with a dividend of 5 per cent. on the year's working. .

Mr. Hobday seconded, and the motion was carried.

A resolution was afterwards carried: "That the contract of sale of the undertaking to the Corporation be approved, and the seal of the Company be affixed thereto."

IMPERIAL TRAMWAYS.

The report of the directors for the year ended Dec. 31 last states that the gross receipts of the Middlesbrough, Stockton, and Thornaby electric tramways amounted to £48,772. 17s. 1d., and the number of passengers carried to 9,141,183, compared with totals of £47,218. 17s. 9d. and 8,782,970 in the preceding year. The extension to Clarence Ferry was opened for public traffic in August last, and the additional accommodation is much appreciated by the public of Middlesbrough. The net profits for the year show that the return of 6¾ per cent. is maintained upon the increased capital expenditure. With regard to the Corris Railway Company, the operations of the year resulted in a dividend at the rate of 5 per cent. on the share capital, the whole of which is held by this Company. During the past year the London United Company has made very great progress, the feature of the year having been the introduction of electric traction on their system. Some of the lines were opened in April and others in July, when the public ceremony of inaugurating the first electric tramways in the Metropolis was performed by the Right Hon. the Lord Rothschild, supported by the Right Hon. A. J. Balfour, M.P., and other Cabinet Ministers, as well as the leading representatives of the financial, engineering, and scientific world. The undertaking launched under such unique auspices has from the first been attended with the most gratifying public success, and the profitable results of its operation have more than justified the directors' anticipations. The revenue derived from the shares in the London United Company held by this Company amounted to £25,530 for the past year. At the close of that period the undertaking was sold to a new company—the London United Tramways (1901), Limited—upon terms which will give the Imperial Company a substantial profit. In respect of its holding of 29,000 6 per cent. preference shares and 6,000 ordinary shares in the old company, it will receive 34,800 5 per cent. preference shares and 12,000 ordinary shares in the new company, together with about £58,000 in cash. As the affairs of the old company are not yet closed up, none of the benefit of this transaction is included in the Imperial accounts now submitted, but will accrue during the current year. The directors, however, contemplate distributing in specie some of the ordinary shares of the new London United Company amongst the holders of Imperial ordinary shares by way of interim dividend, and the necessary formal addition to the Imperial Company's articles of association will be proposed at the forthcoming meeting. Since the last report arrangements have been concluded by which the tramways at Reading and Darlington have been transferred to the respective Corporations, and the revenue accounts are brought down to the dates of handing over in each case. The proceeds of sale have been credited to the capital account, and the difference between the profit on Darlington and the loss on Reading charged against the reserve fund for contingencies. It will be seen that the Company's net revenue account for the year shows an available balance of £43,846. 2s. 6d., and after payment of interest on the debenture stock for the whole year and interim dividends on the preference and ordinary shares in respect of the half-year to June 30 last, amounting together to £25,371. 10s. 8d., it is proposed to appropriate the balance as follows: dividend at 6 per cent. per annum on the preference capital (paid on Jan. 1 last), £5,702. 12s. 11d.; final dividend at 11½ per cent. per annum (making 10 per cent. for the year) on the ordinary capital, £11,500; to add to the dividends equalisation fund, £1,000; and to carry forward to the next account the remaining sum, £271. 18s. 11d. The reserve funds will then be increased from £72,789 to £92,470.

The ordinary general meeting of this Company was held at Bristol on the 26th ult.

Mr. George White presided, and in moving the adoption of the report said he thought it would be received by the shareholders with considerable gratification. There had been progress in every direction. Referring to the more important undertaking in which the Company were interested—viz., the London United Tramways—he remarked that this concern had made great strides during the year. The traffic returns showed each week an ever-increasing volume of traffic, and when the extension of the system was opened to Twickenham, Richmond, Hampton Court, Kingston-on-Thames, Surbiton, and other well-known London resorts, he believed that the anticipations of the directors, which had already been published, would be more than fulfilled. In connection with the sale of the London United undertaking to their new company, they, the Imperial Company, in respect of their holding of 29,000 6 per cent. preference shares in the old company, received 34,800 5 per cent. preference shares, which was the equivalent capitalisation, and represented an issue of shares to the full amount of the cost to their Company of the old 6 per cent. shares. These 5 per cent. preferences were quoted in the market at £1 premium, and, therefore, they showed thus already a profit of nearly £35,000, which, however, they had not taken into account. In respect of the 6,000 old ordinary shares, they would receive a sum in cash estimated at £58,000 and 12,000 ordinary shares of the new company, so that after allowing for reinstating in their capital account the full cost at which these investments stood in their books there will remain over 10,600 of the ordinary shares coming from the new company, and these represented the profit on the transaction and belonged to the ordinary shareholders whether distributed amongst them or not. They believed the desire on the part of their shareholders to have a personal holding in the ordinary share capital of the London United was universal, and they had, therefore, determined that 5,000 of these profit shares should be distributed amongst the Imperial ordinary shareholders without calling upon them for any payment in respect of the shares. When the new London United Company was brought out some ordinary capital was reserved for future issue, and it had been arranged that the Imperial Company should be permitted to at once subscribe at par for their due proportion of those unissued shares. That would run to 4,500 shares, and therefore they would see that the Imperial Company would still retain in its possession 11,500 London United ordinary, which would yield such a return as to put it beyond question that the Imperial Company would in future be able to pay a minimum dividend of 10 per cent. on its ordinary shares.

Mr. J. Clifton Robinson seconded the motion, which was carried.

At a special meeting subsequently held, an addition was made to the articles of association to provide for dealing with the money receivable from the new company.

TYNEMOUTH AND DISTRICT ELECTRIC TRACTION.

Directors: W. J. Greer (chairman); C. S. Drummond; Emile Garcke, M.I.E.E.; E. A. Paris; J. H. Robinson; J. B. Williamson. Secretary: G. E. Medhurst.

The report of the directors for the year ended Dec. 31, 1901, states that the capital expenditure during the year amounted to £26,130. 9s. 5d., the total capital outlay on the construction, reconstruction, and electrical equipment of the lines being £78,434. 9s. 9d. (including £5,089. 19s. 5d. on the old line). The subscribed share capital is now £40,000 in ordinary shares of £5 each, and £30,000 in 5 per cent. cumulative preference shares of £5 each. The total revenue from March 18 (the date of opening for traffic by electric traction) to Dec. 31 amounts to £11,069. 6s. 10d., and the expenditure to £5,700. 16s. 9d., leaving a net profit of £5,368. 10s. 1d., which, added to the amount of £55. 6s. 11d. brought forward from last account, makes an available balance of £5,423. 17s., which the directors recommend should be applied as follows: amount to be placed to depreciation and reserve fund, £1,000; dividend at the rate of 5 per cent. per annum on the cumulative preference shares for the year, £900; dividend at the rate of 7 per cent. on the ordinary shares for the year, £2,800; to be carried forward to next account, £723. 17s. The enquiry respecting the Company's application for a light railway order for the extension from the present terminus at Whitley to Whitley Sands, a distance of four furlongs three chains, was held on Feb. 24, 1902, and the order (which was unopposed) has been passed by the Light Railway Commissioners subject to confirmation by the Board of Trade. The lines, as constructed and equipped for electrical traction, were inspected by the Board of Trade inspector on Feb. 13, 1901, and were opened for traffic on March 18 following. In order to provide for increased services, the directors have given instructions for the doubling of the track along the Grand-parade, Tynemouth, and the work will, it is hoped, be completed before the coming holiday season. Messrs. Emile Garcke and C. S. Drummond are the directors retiring by rotation, and are eligible for re-election.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Power and running expenses	4,460	12	3
Repairs and maintenance	416	11	0
Administration and general expenses	747	7	5
Interest	76	6	1
Balance carried to balance sheet	5,368	10	1
	£11,069	6	10
Cr.	£	s.	d.
Traffic receipts	10,903	8	11
Advertising receipts	139	8	7
Sundry receipts	26	9	4
	£11,069	6	10

The ordinary general meeting of the shareholders in this Company was held on Thursday, March 27, at the offices, Donington House, Norfolk-street, Strand, Mr. W. J. Greer presiding.

The **Chairman**, in moving the adoption of the report, pointed out that this was the first annual general meeting of the members since the electrical equipment of the line, and he thought the shareholders had cause to congratulate themselves on the result of the nine months' working from March 18 (the date of the opening) to Dec. 31 last. At the time of the opening they commenced running with only six cars, whereas at the end of 1901 they had 22 in stock. The receipts per passenger averaged 1·51d., against which they had to set off an expenditure of ·78d., the ratio being 51 per cent., which he thought you will agree was low. After dealing with the accounts, he referred to their application for a light railway order for an extension from the present terminus at Whitley to Whitley Sands, a distance of a little over half a mile. The enquiry regarding the application was held at North Shields on Feb. 24 last, and the order (which was unopposed) had been passed by the Light Railway Commissioners, and would be submitted to the Board of Trade for confirmation. He was glad to say that the relations existing between the Company and its employés were satisfactory. Steps were being taken to form a branch of the British Electrical Friendly Society—a society from which the men would derive very considerable benefits in the shape of weekly contributions while disabled—and he felt confident that the shareholders would heartily endorse the action taken by the directors in contributing to the funds of that society. Then, again, there was the British Electrical Superannuation Fund, which, however, only affected the salaried officers of this and other companies associated with the British Electric Traction Company.

Mr. Drummond having seconded the motion, it was carried unanimously.

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PROVISIONAL PATENTS, 1902.

MARCH 19.

6684. Improvements in incandescent electric lamps. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

6686. Improvements relating to "switches" for electric motors. Richard James Appleton and Joseph Oulton, 2, Market-street, Bradford.

6695. Improvements in frictionless trolley wheels for electric trams. Charles Alfred Palmer and Edward Brice, Castle-green, Bristol.

6699. Improvements in or relating to electrical apparatus for signalling. Maunsell Mercier, 57, Barton-arcade, Manchester.

6726. Improvements in and relating to incandescent electric lamps for decorative and other purposes. Theodor Wohlmuth, 45, Southampton-buildings, Chancery-lane, London.

6733. Improved apparatus for the regulation of electrical circuits in heating devices. Willie Dickson Kilroy, 1, Queen Victoria-street, London.

6734. Improvements relating to alternators. The Honourable Charles Algernon Parsons, 18, Southampton-buildings, Chancery-lane, London.

6760. Improvements in the production of fluid-tight joints for electrical and other purposes, and in centering. William McLellan, 46, Lincoln's-inn-fields, London.

MARCH 20.

6766. Improvements connected with series traction. James Swinburne, 82, Victoria-street, London.

6815. Marine telephone, the application of the telephone on board steamers. Sid Arclau, 13, Samuel-street, Woolwich.

6817. Improvements in telephone sets. John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Bell Telephone Manufacturing Company, Belgium.)

6818. Improvements in flexible conducting cords applicable especially for use in the plug circuits of telephone switchboards. John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States.)

6850. Improvement connected with ceiling roses for electric incandescent lighting. Eduard Schulz, 173, Fleet-street, London.

6854. An improved system of electrical distribution. Philip Arthur Newton, 6, Breams-buildings, Chancery-lane, London. (Bliss Electric Car Lighting Company, United States.) (Complete specification.)

6855. Improvements in brush mechanism for dynamos. Philip Arthur Newton, 6, Breams-buildings, Chancery-lane, London. (Bliss Electric Car Lighting Company, United States.) (Complete specification.)

6880. Improvements in electrical heating devices. George Croydon Marks, 18, Southampton-buildings, Chancery-lane, London. (George Ludwig Dengier, United States.)

6884. Improvements in telephonic apparatus. Alfred Graham, 46, Lincoln's-inn-fields, London.

MARCH 21.

6897. An automatic combined lifeguard and brake attachment applicable to electrical tramcars. William Pickering, Samuel Albert Pickering, and James Bromley, 4, St. Ann's-square, Manchester.

6898. An automatic safety device applicable to the trolley arm used in connection with electrical tramways. William Pickering, Samuel Albert Pickering, and James Bromley, 4, St. Ann's-square, Manchester.

6946. Improvements in covers for the junction boxes of telegraph cables and the like. Callender's Cable and Construction Company, Limited, and Harold Hastings, 24, Southampton-buildings, Chancery-lane, London.

6947. Improvements in connections for electric cables. Callender's Cable and Construction Company, Limited, and Harold Hastings, 24, Southampton-buildings, Chancery-lane, London.

6948. Improvements in the "feeder pillars" used in connection with electric supply mains. Callender's Cable and Construction Company, Limited, and Theodor Petersen, 24, Southampton-buildings, Chancery-lane, London.

15475A. Improvements in synchronising dynamo-electric machines or motors or for producing and maintaining synchronous motion between two or more rotating or vibrating bodies. Philip Middleton Justice, 55, Chancery-lane, London. (The Rowland Telegraphic Company, United States.) (Date claimed under Patents Rule 19, July 30, 1901.)

MARCH 22.

7003. Improvements in incandescent electric lamps. Noel Cleminson, John Wilfrid Butterworth, and Alexander Morrison, 5, John Dalton-street, Manchester.

7062. Improvements in or relating to overhead trolleys for electric vehicles. Fritz Häller and Romain Noiset, 111, Hatton-garden, London. (Complete specification.)

7039. Improvements in electric fuses. Sebastian Ziani de Ferranti, 18, Southampton-buildings, Chancery-lane, London.

7075. Improvements in multiplex telephony, telegraphy, and the transmission of electrical impulses and vibrations. George Lewis Hogan, 27, Chancery-lane, London.

7080. An improved electromagnetic instrument. William Mundell Thornton, 18, Buckingham-street, Strand, London.

MARCH 24.

7111. Improved double-pole electrical joint-box. John Grant Roy, 121, West George-street, Glasgow.

7121. Life-saving guard for electric motor, steam, or cable cars. John Carr, 63, Constable-street, Hessle-road, Hull.

7125. Improved electrical ozonising and circuit breaking apparatus. Philip Kossuth Stern, 130, Fulton-street borough of Manhattan, New York.

7149. Improvements in watt-hour meters. The British Thomson-Houston Company, Limited, and Frank Holden, 83, Cannon-street, London.

7150. Improvements in methods of forming coils for electrical apparatus. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Julius W. Lundskog, United States.) (Complete specification.)

7151. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Walter C. Fish, United States.) (Complete specification.)

7152. Improvements in electrical steering gear. The British Thomson Houston Company, Limited, 83, Cannon-street, London. (Maxwell W. Day, United States.) (Complete specification.)

7188. Improvements in means for the control of electrically-driven reversible roller mills. Carl Ilgner, 1, Queen Victoria-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published April 17.

1901.

1122. Automatic telephone systems applicable generally to step-by-step mechanism driven or controlled by electrical impulses. Janney.

4017. Electrolytic bleaching of cotton and other textile materials and apparatus for use in connection therewith. Vogelsang.

5728. Electric switch operating apparatus applicable to illuminating, advertising, or other electric lighting purposes. Mushet and Eggar.

6004. Means or apparatus for driving dynamos on railway and other vehicles from the axles thereof, and for connecting such dynamos and batteries to lighting, heating, or other circuits on such vehicles. Beaumont and Still.

6041. Apparatus for use in connection with lifts, arc lamps, and other movable bodies for taking up and paying out electrical conductors. William Joseph Brown.

6352. Electric accumulators. Drake and Gorham.

6353. Electrically-driven rotary pumps. Drake and Gorham.

6460. Electrical signalling appliances for steam, electric, and other railways. Bartelmus.

6723. Means for applying the active material to the plates of secondary batteries. Pescatore and Tudor Accumulator Company, Limited.

8437. Manufacture of vulcanised electric cables. Claremont.

8890. Printing electric telegraphs. Heimerdinger.

8906. Transmission of electric currents. Maiche.

9193. Gear for actuating the electric switches of cranes, capstans, and the like. Sir W. G. Armstrong, Whitworth, and Co., Limited, and Honner.

9595. Apparatus for securing telegraph, telephone, or other wires. Austen.

10735. Electric circuit breakers. British Thomson-Houston Company, Limited. (Stewart.)

10756. Magnet coils or solenoids. Drake, Garrard, Ram, and Nernst Electric Light, Limited.

10879. Voltaic cells. Dickson.

10971. Controllers for electric railway and like vehicles. Lake. (Tice.)

12186. Electrolytic production of lead dioxide. Johnson. (Chemische Fabrik Griesheim-Elektron.)

17132. Construction of insulators for electrically separating sections of overhead trolley line and the like. Quin.

17801. Transmitting telegraph keys. Shirley and Skirrow. (Date applied for under International Convention, Aug. 6, 1901.)

1902.

999. Electrically-controlled railway switches. De Pass. (Cheatham Electric Switching Device Company.)

3416. Switches for electric light circuits and the like. Jones and Jones, jun.

3657. Insulated electrical conductors. Cummings.

3894. Use of electric glow lamps for occasional illumination. Brown.

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3953. Telegraphic and telephonic apparatus. Lake. (Aktiesels-kabet "Progress.")

4521. Storage batteries. Apple.

4608. Receptacle for watches in connection with a source of electric light. Arnold.

4754. Field magnets for dynamo-electric machines or electric motors. Lundell.

4755. Incandescent electric lamps. McOuat.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	Mar. 29	545	523	+ 22	30,810	28,691
Birmingham Tramways	—	—	—	—	—	—
Blackburn Corporation	,, 21	655	551	+ 104	6,861	6,188
Blackpool Corporation	,, 29	415	147	+ 268	2,351	1,883
Blackpool-Fleetwood Tramways	,, 22	212	162	+ 50	1,936	1,736
Bolton Corporation	,, 23	1,342	1,238	- 104	14,775	13,738
Bradford Corporation	,, 16	2.784	826	+ 1,958	19,732	8,367
Bristol Tramways Company	,, 28	4,210	3,581	+ 629	—	—
Carlisle Tramways Company	,, 15	122	123	- 1	1,282	1,192
Central London Railway	,, 29	6,121	6,228	- 107	85,840	79,235
City and South London Railway	,, 30	2,655	2,122	+ 1,533	38,941	26,437
Cork E. T. and L. Company	,, 27	388	339	+ 49	4,339	4,240
Darwen Corporation	,, 22	169	154	+ 15	1,961	1,844
Darwen-Hoddlesden	,, 14	26	—	—	—	—
Dover Corporation	,, 29	234	153	+ 81	2,185	1,998
Dublin & Lucan Electric Railway	,, 30	101	79	+ 22	1,105	936
Dublin U. T., electric cars	,, 28	3,415	2,929	+ 1,486	—	—
Dublin S. District, Electric	,, 28	731	620	+ 111	—	—
Dundee Tramways Company	,, 26	611	532	+ 79	—	—
Glasgow Corporation	,, 29	10,952	7,999	+ 2,953	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 29	1,682	1,543	+ 139	87,401	72,809
Liverpool Corporation	,, 22	9,515	7,749	+ 1,766	104,805	93,654
Liverpool Overhead Railway	,, 30	1,418	1,462	- 44	17,869	19,206
Newcastle-on-Tyne Corporation	,, 29	2,065	—	—	—	—
Portsmouth Corporation	,, 22	1,160	472	+ 688	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 30	3,824	—	—	—	—
Southampton Corporation	,, 27	775	537	+ 238	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £301 decrease.

Barcelona Ensanche y Gracia, £11 increase. Barcelona, £147 increase.

Brisbane, £173 increase (month of Feb., £1,341 increase).

Buenos Ayres and Belgrano Electric (month of March, receipts £12,184; decrease £647), £126 decrease.

Calcutta, £20 decrease.

Cape Town (month of Feb.), receipts, £15,896; expenditure, £6,780.

La Capital Traction and Electric, Buenos Ayres (month of Dec.), £1,394 increase.

Mexico Electric (month of Feb.), receipts, £16,500; expenditure, £9,800.

Perth Electric, £215 increase.

Port Elizabeth (month of Feb.), receipts, £3,559; expenditure, £1,784.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Tramways.—	£	£
Anglo-Argentine, 1-260,007	5	4-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100	124-127
Blackpool and Fleetwood Tramroad	10	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	2¾-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¾-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	6¾-7¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	9¼-9¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	102-104 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	13-14
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12¼-12¾
—— 5 per cent. Perpetual Debenture Stock	100	124-127 xd
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1⅛-1¼
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5¼-5¾
—— 5 per cent. Deb. Stock, Red.	100	103-106
—— Prov. Cert., all paid	100	97-100
Cape Electric Tramways, Nos. 1-400,000	1	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	11-12
—— 6 per cent. Pref., Nos. within 1-60,000	10	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	96-99 xd
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14¼-15¼
—— 4½ per cent. Deb. Stock	100	112-114
Kidderminster and District Lighting and Traction, Pref.	5	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100	102-104
New General Traction, Ordinary	5	2¼-3¼
—— 6 per cent. Cum. Pref.	10	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10	10¼-10¾
—— 5 per cent. Cum. Pref.	10	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	99-102
Potteries Electric Traction, Ordinary, 26,667-40,000	10	9¼-10¼ xd
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	10s.	¼
—— £50,000 ,, ,,	1	1
—— £500,000 4½ per cent. Debenture Stock	50 p.c.	50 p.c.
Commercial and Industrial.—		
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	⅝-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1	⅛-¼
—— Ordinary, 1-125,000	1	⅛-¼
British Insulated Wire, Ord., 1-70,000	5	9½-10½
—— 6 per cent. Cum. Pref., 1-40,000	5	5¾-6¼
—— 5 per cent. Mortgage Debentures	100	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	5¼-6
Brush Electrical Engineering, Ordinary	2	½-1
—— Nos. 90,001-105,731	2	½-1
—— Non. Cum., 6 per cent. Pref.	2	1-1¼
—— 4½ per cent. Debenture Stock	100	101-104
—— 4½ per cent. 2nd Debenture Stock	100	97-100
Callender's Cable, Debentures	100	111-115
—— Ordinary	5	17-18
—— 5 per cent. Pref.	5	5¼-6
Crompton and Co.	3	⅜-3½
—— 5 per cent. Debentures	—	100-105 p.c.
Edison and Swan United, Ordinary	3	⅛-⅜
—— 5 per cent. Debentures	5	2-3
—— 4 per cent. Deb. Stock, Red.	100	78-83
—— 5 per cent. Second Deb. Stk. Prov. Crts.	—	82-87 xd
Electric Construction, Limited, Nos. 1 to 112,100	2	1⅜-1⅞
—— 7 per cent. Cumulative Pref.	2	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	97-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10	9⅜-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	98-101 xd
W. T. Henley's Telegraph Works, Ordinary	5	17-18
—— 4½ per cent. Preference	5	5¼-6
—— 4½ per cent. Debentures	100	111-115
India Rubber, Gutta Percha, and Telegraph Works	10	21-22
—— 4 per cent. Debentures	100	99-102 xd
Parker, Thos., Limited, Ordinary	10	15¼-16½
Telegraph Construction and Maintenance	12	35-38
—— 5 per cent. Bonds	100	102-105
Telegraph Manufacturing, Ordinary	5	10¼-11½
—— 5 per cent. Cum. Pref.	5	5¼-6 xd
Willans and Robinson, Ordinary, 1-30,000	5	9-10
—— 6 per cent. Cum. Pref., 30,001-60,000	5	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	105-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1	⅜-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	98-103 xd
Bournemouth and Poole, Ordinary	10	11-12 xd
—— 4½ per cent. Cum. Pref.	10	9¼-10¼
—— Debenture Stock, Red.	100	103-106
Brompton and Kensington, Ordinary	5	8¾-9¼
—— 7 per cent. Preference	5	8¾-9¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	8¼-9¼
—— Nos. 20,001-30,000	5	8-9
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14½ xd
—— ,, ,, £10 Ord.	6	10¾ xd
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	106-108
Charing Cross and Strand	5	9-10
—— 4½ per cent. Cum. Pref.	5	5¼-5¾
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	105-107
Chelsea Electricity Supply	5	5-5⅛
—— 40,501-50,936	5	5-5¼
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	8-9
—— 6 per cent. Cumulative Pref.	10	12-13
—— 5 per cent. Debenture Stock	100	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	102-105
County of London and Brush Provincial, Ordinary	10	8¼-9¼ xd
—— 6 per cent. Cum. Pref.	10	12-13 xd
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	6-6¼
—— 6 per cent. Cum. Pref.	5	6-6¼
—— 4½ per cent. First Mort. Deb.	100	106-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	4-4¼
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	5¼-6
—— 4½ per cent. First Deb. Stock, Red.	100	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	10-11
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	103-106 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9¾-10¼
London Electric, Ordinary	3	1¼-2
—— 6 per cent. Pref.	5	4-5 xd
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	95-100
Metropolitan, Ordinary	10	14¼-15¼ xd
—— 4½ per cent. First Mortgage Debenture Stock	100	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9¼
—— Preference	4	6¼-6¾
Notting Hill Electric Lighting	10	14¼-15¼
Oriental, 1879	1	1¼-1¾
—— £5 Shares	5	7¼-8
—— £4½ Shares, New	4½	6¾-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6
—— 4 per cent. Debenture Stock	100	98-101
River Plate Electric Light and Traction, Deb.	100	65-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	102-104 xd
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	1¾-2¼
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	2-2½
St. James's and Pall Mall, Ordinary, 101-20,080	5	14-15
—— 7 per cent. Pref.	5	8-9
—— 3½ per cent. Deb.	100	98-101
Westminster, Ordinary	5	11¼-12¾
Electric Railways.—		
Central London, Ordinary	100	101-104
—— 4 per cent. Pref.	100	103-106
—— ,, ,, deferred	100	97-100
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	116-118
City and South London, Consolidated Ordinary	100	65-68
—— Ordinary	10	—
—— Nos. 60,001-70,000	10	—
—— 4 per cent. Debenture Stock	100	112-116
—— 5 per cent. Pref. Stock '91	100	128-133
—— ,, ,, '96	100	123-126
Liverpool Overhead, 5 per cent. Pref.	—	13-13¼
—— Ordinary, 1-50,000	—	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	92-95
Telephones.—		
National Telephone, Preferred	100	95-99
—— Deferred Stock	100	60-64
—— 6 per cent. Cum. First Pref.	10	13-15
—— Preferred, 590,001-790,000	3½	3¼-3⅜
—— 6 per cent. Cum. Second Pref.	10	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	4¼-5⅛
—— 4 per cent. Deb. Stock, Red.	100	93-96
—— 3½ per cent. Deb. Stock, Red.	100	101-105
Oriental Telephone and Electric Company	1	¾-1

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NOTES.

South Australia.—We beg to acknowledge the receipt of a copy of the report of the Board of Governors of the Public Library, Museum, and Art Gallery of South Australia, covering the year 1900-1901.

British Association. — We understand that the Mayor and Corporation of Cheltenham are sending an invitation to the British Association for the Advancement of Science to hold their annual congress there two years hence. The British Association had previously been approached on the subject, and there is every likelihood that the invitation will be accepted.

Parliamentary Telephones.—Two Post Office telephones were on Monday opened for the first time in the central lobby of the House of Commons. We understand that they will in future be available for both members of Parliament and the public having business in the parliamentary buildings at a uniform charge of 2d. for three minutes' conversation within the metropolitan area.

Science and Art Examinations. — Candidates desiring to sit at the evening examinations of the Board of Education in Science and Art within the county of London should, unless they are attending classes as registered students, apply at once to the special local secretary, 116, St. Martin's-lane, W.C., for forms of applications and particulars as to fees, etc. All application forms must be returned not later than Monday, April 28.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on the 7th inst., Sir James Crichton-Browne, treasurer and vice-president, in the chair. Mr. W. A. Bailey, Mr. J. M. Barr, Mr. C. W. Darley, Mr. W. E. L. Gaine, Mr. Carl Hentschel, Mr. J. C. Inglis, Mr. G. Northcroft, Mr. H. C. Plimmer, Mr. F. E. Robertson, and Mr. G. A. Wilson were elected members. The special thanks of the members were returned to Dr. Francis Elgar, F.R.S., for a donation of £50 to the fund for the promotion of experimental research at low temperatures.

An Electrical Time Recorder.—We note that electricity is being called into practice in motor racing for obtaining exact records, as in the case of the recent speed trials at Lord Suffield's seat near Cromer. An electric cable was specially laid from the house to the starting and finishing points of the mile course, and also to the intermediate stations. The wire was placed across the roadway, and as soon as the wheels of a car passed over it a signal was automatically given at all the points, so that the precise time at which each car crossed the line was accurately recorded by the official. The device is reported to have been very successful at the trials in question.

Electricity in Canada.—A proposal is before the Ontario Legislature to authorise Canadian municipalities of over 100,000 population to purchase, transmit, and distribute electrical energy for heat, light, and power. If the measure is passed into law, its scope of operation will be distinctly limited for the present at least, as Toronto is now the only municipality with a population of over 100,000. One of the chief objects of the Bill, however, is to give to that city the right to obtain current from Niagara Falls, and it will accordingly meet with strenuous opposition from the supporters of private enterprise in that part of the Empire. The Toronto scheme would entail an outlay of between £60,000 and £80,000.

An American Marconi Company.—As on the European Continent, a company has been formed in New York to secure the American patent rights of Marconi's Wireless Telegraph Company, of London. The new company, promoted by Mr. J. Pierpont Morgan's interests, is to be styled the Wireless Telegraph Company of America, and will have a capital of £1,230,000. Its first work will be to establish wireless communication between Key West and Havanna, where it will have a monopoly. If this proves successful, the system will next be exploited in the Philippines, Hawaii, Porto Rico, the Danish West Indies, and Alaska. It is further stated that the English company will receive for its rights and patents £50,000 in cash and shares in the American company, which represent a controlling interest. The parent company also will receive a further sum in cash for its stations already erected in the United States.

Influence of Hydrogen on Iron.—A series of experiments have recently been made by Mr. R. Heyn in the Charlottenburg technical laboratory concerning the influence of hydrogen upon iron. It seems that the gas is allowed to act upon iron at red heat, and it is found that the latter is considerably affected. In the first experiments the author found that iron heated to redness and plunged in an atmosphere of hydrogen, then tempered in water, became brittle, and that this brittleness is especially remarked in the trials of cold bending. On the other hand, if the iron be again heated at a rather low temperature in a water or oil bath it becomes much less brittle, or even retains its original state. The same phenomenon is observed when the pieces are allowed to remain in the open air at the ordinary temperature. The time required for the iron to come back to the normal state varies with its constitution.

German Telephones. — Statistics show that the reduction of the telephone tariff two years ago by the German Postal and Telegraph Department has had good results, and it has been remarked that the use of the telephone by the public has become greatly extended since that took place. The total number of urban systems at present installed in Germany is 2,157, an increase of 381 per cent. over the figures for 1895. It is also a noteworthy fact that in 1900 as many as 52,009 new telephone stations, or double the number for the two years preceding, have been established. It is remarked also that the interurban lines are becoming more frequently used, and the number of conversations is constantly on the increase. Germany is now among the foremost in the use of the telephone on the Continent, and recent figures show that there is one subscriber for every 185 inhabitants, while in 1899 the ratio was 1 in 217—a very appreciable increase.

Electrical Bills in Parliament.—A report has been issued by the Board of Trade showing the total number of Railway, Canal, Tramway, Electricity, Gas, and Water Bills before Parliament. There are altogether 185 Bills relating to these matters, as compared with 190 of the session of 1901, so that from this standpoint the trend of progress is not very marked. Of this total 45 Bills are for tramway powers, the aggregate length of the proposed lines being 337 miles. The capital expenditure entailed for these purposes is nearly eight millions sterling. As compared with 1901, the number of Tramway Bills this session show an increase of six, and the capital proposed an increase of £3,359,833. Forty-four of them relate to tramways in England and Wales, and one to a tramway in Ireland. There are 12 Bills affecting the supply of electrical energy, the moneys proposed to be raised on this account amounting to a total of £3,933,999. In many cases procedure for powers for the supply of electrical energy is by provisional order under the Electric Lighting Acts; but in the majority

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of these Bills the powers sought are beyond the scope of those Acts.

An Early Transformer.—A note headed as above in the issue of the *Electrical World* for March 29 announces the fact that a patent was granted on the 18th ult. to Prof. Elihu Thomson and Mr. Edwin J. Houston for a transformer. The application for this patent was filed as long ago as Feb. 19, 1887, and from the abbreviated description in our contemporary it is for a transformer which in many details is not unlike a commercial transformer of the present day. How far the claims in this patent will prevent manufacturers manufacturing at the present time without paying royalties is one question, but the enormous interval of 15 years between the application for the patent and the issue is another instance of the absurd way in which the Patent Office in the United States is worked. There is no information given as to why the granting of the patent has been deferred for this length of time, but its life, of course, only counts from the date of issue. The result is likely to be an injustice to the electrical industry, as the patent may be acquired by one of the large trusts, and used for a considerable number of years to hamper rival manufacturers.

Automobile Restrictions.—In view of the recent agitation in connection with the restrictions to be placed on automobilists using the public highways in this country, it is instructive to see what they are doing in the States in the matter. The capital city is taking the lead over there, and we learn that a Bill is pending before Congress providing for the registration of all vehicles propelled by steam or electricity on the streets of Washington. Every such car would then have a number, which would be placed upon the lamps at the rear of the vehicle in such manner as might be officially prescribed. This seems to be a far more sensible proposal than that brought forward in this country—that every automobile should carry its registered number upon a suspended plate, after the style of our hackney carriages. One obvious advantage of inscribing the number on the lamps of the car is that it would be as legible at night as in the daytime. The Bill above referred to provides for a fine of £2 for every violation of its provisions. On the question of speed, it is proposed by the measure to limit this to 12 miles an hour over the streets of Washington.

Lightning Discharge on Birds in Mid-Air.—An interesting communication is published in the March number of the Institution *Journal* from Mr. Leonard Joseph, in which is related a curious effect of lightning discharge during a heavy thunderstorm in December last year at Zechliner Hütte, in Germany. The author observed in one of the passages of the storm a wild goose, which fell through the air, and with a thud buried itself fairly deep in the sand. On the abatement of the storm, at a distance approximately just under a mile from the point at which the bird referred to was picked up, another dead wild goose was found. On examination of the two birds, it was discovered that the only wounds upon them were "a narrow but direct opening about 3cm. long' on the back of the neck of the first-found bird, and a small puncture "at a point where the neck joins the body" on the second bird. Excepting in the immediate neighbourhood of these wounds, the bodies and feathers of the birds were uninjured. During the storm five flashes of lightning only were observed. Judged by the position in which the birds were found, Mr. Joseph is of opinion that their flight was in opposite directions, the wounds in each instance being instantaneously fatal.

Institution "Journal."—The March number of the *Journal* of the Institution of Electrical Engineers is now issued. It contains some of the papers which have been read this session before the parent Institution as well as the more important of those presented to the local sections—viz.: "Some Principles Underlying the Profitable Sale of Electricity," by Mr. Arthur Wright; the reports of committees on the Institution visit to Germany in 1900, on traction, light and power distribution, on manufacturing, and on telegraphs and telephones; "Earth Currents Derived from Distributing Systems," by Mr. E. B. Wedmore; "An Account of the Visit of the Institution of Electrical Engineers to Germany, June, 1901," by Mr. P. S. Sheardown (Dublin Section); "Note on Alternate-Current Diagrams" and "The Testing of Motor Losses," by Dr. W. E. Sumpner (Birmingham Section); "The Breaking of Shafts in Direct-Coupled Units due to Oscillations set up at Critical Speeds," by Messrs. J. Frith and Ernest H. Lamb (Manchester Section); "Electrical Car Equipments and their Maintenance," by Mr. A. W. Wigram (Newcastle. Section); and a "Note on an Observed Effect of Lightning Discharge on Birds in Mid-Air," communicated by Mr. L. Joseph.

Glasgow Exhibition.—The organising work connected with any department of a large exhibition such as that held in Glasgow last year involves an enormous amount of detailed work, and, as a rule, such services are not duly appreciated by the exhibitors. We are pleased to note that in connection with the electrical department of the Glasgow Exhibition this has not been the case. An illuminated address and gold watch have been presented to Mr. C. A. Ward, who so ably superintended the electrical installation at the exhibition. The address—a photograph of which has been sent to us—contains the names of all the prominent electrical firms who exhibited, and comments on the successful way in which Mr. Ward overcame the difficulties attending such a large under taking. The address was presented at Edinburgh on Tuesday, April 1, after a dinner, at which Mr. W. A. Chamen presided. Mr. Pickstone, of Messrs. D. B. Peebles and Co., made the presentation on behalf of the contractors. We had the pleasure of being shown round the generating department of the exhibition by Mr. Ward last year, and commented in an article on the excellent arrangements made by him for securing continuity in the supply, although the current had to be drawn from such a large variety of generators.

An Electric Car Sprinkler.—The electric car sprinkler is little known in this country in practice, and this is all the more astonishing seeing that the Americans are finding it of great service in keeping their tramway tracks and adjacent roadways clean. Our attention is called to the subject by an excellent illustration which appears in an American contemporary showing the latest type of sprinkler in use on the Colorado Springs and suburban lines. It is known as the Studebaker wide-spraying electric car, the sprays from which emanate from the car sides and cover a distance of 60ft. each way, and this while travelling at a speed of about 10 miles an hour The "sprinkler," which in the illustration before us has the appearance of an ordinary passenger car, carries a 2,600-gallon steel water-tank. The spray is thrown from two sprinkling heads on either side of the car. A third sprinkling head is located in front for the flushing of the tramway tracks. The water is forced from these heads by two individual force pumps, run by a 30-h.p. motor which is located at the rear of the car. The volume of water thrown is governed by levers. Current for working the car is obtained in the ordinary way from the overhead trolley lines. The cost of watering must be much reduced by this power apparatus, which should have the attention of our borough engineers.

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Depreciation of Plant.—The system of accounting which is adopted by the Aberdeen Corporation electricity department is one which might well be imitated with advantage by other corporations who at present do not pay sufficient attention to the important question of depreciation. Besides the efficient maintenance of plant and the usual sinking fund for wiping off the capital expenditure and interest, it seems that the Aberdeen Corporation are allowing for depreciation at their Cotton-street station at the rate of 1 per cent. on buildings, 5 per cent. on machinery, and 5 per cent. on accumulators. They are also allowing 5 per cent. for depreciation on meters, 1½ per cent. on mains, and 2½ per cent. on electrical equipment, and in addition are keeping up their plant in full working order out of revenue. Thus, for depreciation of plant of the value of £102,833 at the Cotton-street station last year, the large sum of £10,547 was put aside, the sinking fund at that time amounting to £6,892 and the reserve fund to £4,844. This healthy state of affairs reflects great credit on those at the head of the department in Aberdeen, and if the same policy be pursued with regard to the new generating station, now nearing completion, which the Corporation are erecting at Dee village, it is easy to foretell what the result will be. Perhaps, however, the depreciation may be carried too far, and thus keep up the price of current unduly.

Vibration on Tube Railways.—A parliamentary paper has been issued containing the appendices to the report of the committee appointed by the Board of Trade to enquire into the vibration trouble on the Central London Railway. The memorandum of Mr. A. Mallock is especially interesting, as he offers a new and plausible explanation of the causes of vibration on tube railways. He first points out that, as in the case of the Central London Railway, the rails are not absolutely level and that wheels wear irregularly, the consequence of which is the creation of waves which spread in all directions. He agrees that objectionable vibrations could certainly be avoided by reducing the non-spring-borne load on each axle to something under two tons in the case of a train running at speeds up to 30 miles an hour and on rails laid in any of the usual ways, and no doubt at present this is much the simplest procedure. Mr. Mallock's theory is, however, that if the surface of the rail could be made nearly smooth and with only very long and gentle irregularities, much heavier non-spring-borne loads might be used without inconvenience, and he thinks this possibility should not be lost sight of, since if train speeds of 100 miles an hour or more ever become common, it is almost certain that more care will have to be taken in making the surface of the track more uniform than is at present called for From the committee's report we gather that these irregularities are due to the imperfect straightening of the rails after rolling.

High-Tension Switchgear.—The question is often raised in connection with large power distribution schemes using abnormally high voltages, as to whether any switchgear should be employed. A number of authorities in the west of the United States hold that these power circuits should never be suddenly interrupted, owing to damage which is likely to ensue both to the switchgear and also to the generating plant. That it is possible, however, to design a switch which can open one of these power circuits without damage to itself, is proved by some recent experiments made in the Coalgate power-house of the Bay Counties Power Company, California. A single-pole switch designed by Mr. J. Nelson Kelman, the superintendent of that division of the company's work, has been tried on a 40,000-volt circuit. The circuit was supplied by generators of 7,500 kw. capacity through transformers. The switch was opened and closed 10 times in two minutes, and it also opened a dead short-circuit on the line without causing any damage either to itself or to the generators and transformers. This information we gather from the *Electrical World*, but no particulars are given as to the design of the switch in question. Experiments afterwards conducted on the same instrument showed that it was quite capable of breaking the circuit when there was some 240 miles of line wire between it and the transformers. Experiments on this gigantic scale cannot be tried in this country, but we presume that the miles of line wire were of the overhead construction, which is much less likely to cause resonance trouble than if underground cables were employed.

Water Power in British Columbia.—After nearly two years continuous labour, the development of 3,000 h.p. on the Kettle River at Cascade, in British Columbia, is now almost an accomplished fact. The electrical energy to be generated from this source will be conveyed to the various mining districts within a certain area from the power-house, where it is expected it will find extensive use in connection with the mining operations. A short description of the water power available on the Kettle River at Cascade has appeared in several of our American contemporaries, from which we gather that at this point there is a natural fall of 121ft. A dam 400ft. long and 50ft. high has been constructed at the head of the rocky gorge through which the water of the river rushes for a distance of half a mile, and this dam raises the water 36ft. above the natural level, thus giving a working head of 156ft. at low water. Provision has been made to control the water level during the periods of high water, by a series of sluice-ways, 12 in number, which can be opened to a depth of 12ft. below the normal level, giving an area of about 2,000 square feet of waterway through which to pass the flood water. From the dam the water is to be conveyed to the power-house, first by an open cut 225ft. long, thence through a tunnel in the solid rock a distance of 410ft., and again by an open cut in the rocks for a distance of 500ft. From this point, where a concrete bulkhead will be built, the water will be conveyed through a circular flume, 12ft. in diameter, to the power-house. This building, which is now nearing completion, is situate 2,000ft. away from the dam. It will contain electrical machinery of the most approved pattern, the plant including six turbine wheels of the horizontal type. At the outset the horse-power developed will be 3,000, but later it is expected a maximum of 9,000 h.p. will be reached. The first place to which power will be transmitted when the works are complete is Phœnix, a distance of 21 miles from Cascade, ordinary copper conductors being used.

Magnetic Traction.—The possibility of increasing the tractive power of electric locomotives and tramcars by means of magnetism has been taken up by numerous inventors in the States, some of whose devices have recently been subjected to experiment. The *Street Railway Review* for March 15 records a device invented by Mr. A. A. Honey, with which very successful results are said to have been obtained, the increase in tractive effort on an electric car equipped with the same having amounted to over 300 per cent. Around the axle of each wheel was wound a coil of wire, through which current was passed by means of a switch. The car was equipped with two motors of 40 h.p. each, and during the tests stood on the rails of an experimental line at Seattle, Wash. One end of the car was attached by means of a cable to a dynamometer which registered the tractive power of the motors. This dynamometer was capable of registering the pull in tenths and twentieths of a ton. Several distinct tests were made

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both with and without the magnetic device. In the latter case the dynamometer showed the pull of the car to be less than half a ton, while after the application of the current to the magnetic device the pull increased to somewhat over two tons, and in one test to as high as 2¼ tons. We understand from our contemporary that Mr. Honey is preparing another similar device for test, but in this case, instead of using the driving wheels as magnetic poles, he proposes to employ an independent magnet constructed with small wheels about 1ft. in diameter to run on the rails as close as possible to the driving wheels. The device would close the magnetic circuit through the rails, driving wheels and axles, and giving an uninterrupted metallic circuit. This magnetic means of increasing adhesion between the wheel and the track need, of course, only be applied on up grades where a slip is likely to take place, but it would be interesting to learn if the power required to drive the train or car is not also increased by the device. We should imagine that at reasonable speeds there would be a considerable amount of eddy-current loss both in the wheels and in the track.

Iron and Steel Institute.—The annual meeting of this institute will be held at the Institution of Civil Engineers, Great George-street, Westminster, on Wednesday and Thursday, May 7 and 8, 1902, commencing each day at 10.30 o'clock a.m. On the opening day a general meeting of members is arranged for, at which the council will submit their report for the year 1901, and the Bessemer gold medal for 1902 will be presented to his Excellency F. A. Krupp, of Essen. A selection of papers will also be read and discussed. In the evening the annual dinner of the institute will take place in the grand hall of the Hotel Cecil, at 7.30. The succeeding day will be given over entirely to the reading and discussion of papers, of which the following is the full list: Report by the committee appointed to investigate the nomenclature of metallography; "On a New Vacuum Tuyere for Blast Furnaces," by Mr. Horace Allen, London; "On the Microstructure of Hardened Steel," by Prof. J. O. Arnold, and Mr. A. McWilliam, Sheffield; "On the Compression of Fuel before Coking," by Mr. J. H. Darby, Brymbo; "On Gas from Wood for Use in the Manufacture of Steel," by Dr. James Douglas, New York; "On a Combined Blast-Furnace and Open-Hearth Process," by Mr. P. Eyermann, Benrath, near Düsseldorf; "On the Physical and Chemical Properties of Carbon in the Hearth of the Blast Furnace," by Mr. W. J. Foster, Darlaston; "On the Sulphur Contents of Slags and Other Metallurgical Products," by Baron H. von Jüptner, Donawitz, Austria; "On the Elimination of Silicon in the Acid Open-Hearth Furnace," by Mr. A. McWilliam, Sheffield, and Mr. W. H. Hatfield, Sheffield; "Report on Research Work carried out during the past year," by Dr. J. A. Mathews, New York (Andrew Carnegie Research Scholar); "On the Iron Ore of Brazil," by Mr. H. Kilburn Scott, Rio de Janeiro; "On the Recovery of By-Products in Coking," by Mr. J. Thiry, London; "On Brinell's Researches on the Influence of Chemical Composition on the Soundness of Steel Ingots," by Mr. Axel Wahlberg, Stockholm. The autumn meeting of the institute will be held in Düsseldorf on Sept. 2 and following days.

Telegraphic Interruptions.—The great sleet storm which so completely disorganised telegraphic and telephonic communication between London and the North of England and Scotland this winter was not confined to our shores alone, and we find that the damage inflicted upon overhead wires of every description in the States about the same time by the abnormally severe weather was, if anything, more complete than in our own case. Thus, Philadelphia was completely isolated, so far as telegraphic communication went, for several days, and Baltimore was in nearly the same condition. New York, too, was severely crippled in its telegraphic communication with the rest of the country. The havoc caused by the storm among the telegraph and telephone wires and poles required several days' labour before the services could be resumed with anything like satisfaction. The electric light wires, being generally larger, it seems, suffered less, and trolley wires least of all, except where broken trees and poles fell across the road. Discussing this state of things editorially, the *Electrical World* naturally raises the question whether, in view of the enormous cost of restringing the destroyed lines of wire, it would pay to put the wires in the open country underground, and it is forced to the conclusion, as the Postmaster-General in this country has been compelled to decide, that financial considerations forbid the wholesale burying of these wires. Apart from the fact that there is enormous expense entailed in making and laying underground lines, and relatively large expense in repairing them, although the repairs may be less frequent, there is always the objection that transmission by underground cables is very much slower than by the overhead wires. It is quite conceivable, however, that it would be worth the increased cost to place some of the more important trunk wires underground, as we are doing in this country, for the dispatch of urgent messages in times of breakdown, and our contemporary takes the same view as regards New York, Philadelphia, Baltimore, and Washington, so that the telegraph and telephone lines connecting these important cities would be proof against weather disturbances. For a general solution of the difficulty, however, we must look to improvements in the existing methods of overhead construction.

Electrical Manufacture of Barium Compounds. The manufacture of soluble barium compounds from barytes in the electric furnace was described in a recent paper by Mr. Chas. B. Jacobs before the American Society of Chemical Industry. It seems that the electrical process is based upon a discovery which brought to light a new chemical reaction, this taking place beyond the range of temperature attainable in combustion furnaces. The furnace charge is made up of a mixture of ground barytes and coke in the proportions of four molecular equivalents of barium sulphate to four molecular equivalents of carbon. When this mixture is heated there is an immediate reaction between the carbon and the barium sulphate, in which one part in every four of the latter is reduced to barium sulphide, and a mixture is produced containing approximately three molecular equivalents of barium sulphate and one molecular equivalent of barium sulphide. Under the high temperature of the electric furnace these react such that not more than 2 or 3 per cent. of unconverted sulphate is left in the charge, the other product being barium hydrate and a small amount of sulphide. The furnaces used in the process are a new type of continuous electric furnaces of the tapping variety. They are tapped periodically, as in the case of iron blast furnaces, and have a maximum power consumption of 500 kw. and a maximum output of eight tons of furnace product every 24 hours. The product tapped from the furnace is dissolved in hot water, and the insoluble impurities filtered off, these latter consisting of a saturated solution of barium hydrate containing a small amount of barium sulphydrate. The barium hydrate is crystalled out by cooling, and the sulphydrate remaining is carbonated or converted into some of the acid salts of barium. The barium hydrate crystals are freed from the last traces of sulphydrate liquor by washing with a

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spray of cold water, and after drying are melted, and the fused mass poured into thin iron drums, where it solidifies on cooling into a solid shape of crystallised hydrate weighing about 500lb., and containing less than 1 per cent. of impurities. The demand for barium hydrate has very rapidly increased of late. It finds its chief uses in the sugar industry for the recovery of sugar remaining uncrystallised, in the purification of water for steam-boilers, and in tanning works.

The Glasgow Tramways.—We desire to heartily endorse the action of the Glasgow Corporation in deciding to extend the long-distance stages on the city tramways rather than to give a longer ride for the already very nominal charge of ½d. As matters have now been agreed upon, these ½d. stages will remain as before, and the new conditions will only apply to those passengers who pay a minimum of 1d. Thus, those of the travelling public in Glasgow who have hitherto paid 1½d. will pay 1d., and instead of being carried 1¾ miles will be carried 2⅓ miles for the lesser charge. The 1½d. fare then will extend over six stations, and the maximum charge of 2d. over eight stations. The meeting of the City Council at which these things were approved was held at the end of last week, when those advocating the extension of the long-distance journey were in a majority of about two to one. It was pointed out that if the ½d. stage were increased those persons who at present paid 1d. would be reduced to the lower fare, and would be carried considerably over a mile for ½d. On the other hand, it was argued by the opposition that the suggested arrangement did not affect the ratepayers equitably, as advantages were given to those outside the city at the expense of those inside. In the face of this, however, it is satisfactory to note that the committee's proposals as mentioned above were adopted by 44 to 20 votes. At the same meeting the question of dry seats on the tramcars was brought up for consideration. A large number of corporations are at present experimenting with different devices in an endeavour to decide the problem of keeping the outside seats free from rain, but we have not yet heard of any complete successes in this direction. In some cases the question has been shelved for a time pending a more perfect solution of the difficulty. This course has been adopted by the Glasgow Corporation, and the general manager of the tramways has been instructed to gather further information on the subject in the meantime. Of the many devices which inventors have brought out lately having the object mentioned in view, one is being tried at Glasgow, which is also engaging the attention of several other corporations, notably those of Leeds, Bradford, and Manchester. In this contrivance the working of the seat centres round a spiral spring enclosed in a tube, which runs along the whole length of the back. To this spring flaps are attached at the front and rear by strong pins. When wet weather prevails, these flaps are pulled down on top of the ordinary seat, which is said to be not interfered with in the least by the device. At the top of the back is a groove, which is intended to catch all the water falling over the top rail, and to carry it away from the dry flaps to the floor of the car. This arrangement seems rather complicated, but before expressing any opinion upon its merits, it is well to await the results of the experiments which we understand are now being made with it.

Electrolysis of Alkali Chlorides with Carbon Anodes.—A full abstract of a paper by Mr. L. Sprocsser on this subject appears in the issue of the *Journal* of the Chemical Society for April. In the paper, the nature, extent, and causes of the deterioration of carbon anodes of different kinds when used in the electrolysis of solutions of alkali chlorides are investigated very fully. Cells with and without diaphragms were used, and the solution always contained more or less chlorate and hypochlorite. The attack of the carbon is mainly due to oxidation, chlorination occurs sometimes with carbons containing volatile matter, but it is in general of very little importance. The principal oxidation product is carbon dioxide; considerable disintegration of the carbon always occurs, the loss due to which may exceed that due to the chemical action. The difference between the results of experiments with and without diaphragms is one of degree, the concentration of the hypochlorite and the oxidation being smaller in the former case. In sulphuric acid (about 20 per cent. H_2SO_4), more than 90 per cent. of the oxygen separated at the anode is used in oxidation of the carbon, about half of it yielding carbon dioxide, and the remainder, probably colloidal, humus-like substances which colour the acid brown (the same products are formed with the other electrolytes although in different proportions). The mechanical disintegration of the carbon is very marked. With a 16 per cent. solution of sodium hydroxide, both oxidation and disintegration are less than with sulphuric acid, and different specimens of carbon behave differently, which was not the case with the acid. There is no direct relation between the behaviour of carbon in the different solutions. Rise of temperature always accelerates the destruction of the carbon. The author explains the characteristic behaviour of the carbon anodes by their porous nature. When a solution of an alkali chloride is electrolysed, the Cl ions within the pores of the carbon are soon discharged, and since they cannot be rapidly replaced by diffusion, a point is soon reached at which OH ions are discharged. This only occurs within the pores, because the circulation of the electrolyte at the surface of the anode keeps up a sufficient supply of Cl ions there. The carbon is therefore oxidised mainly within the pores, which explains the disintegration observed. The disintegration is not due to the escape of gas, because a carbon cathode does not disintegrate. In similar circumstances, much more oxygen is evolved from a carbon anode than from one of platinum, a fact readily explained by the author's hypothesis. This is strikingly exemplified by a series of experiments with hydrochloric acid, in which the quantity of oxygen evolved increases with the porosity of the carbon anode used. That the concentration of hypochlorite attainable at a carbon anode is much smaller than at one of platinum is also in agreement with the theory, because for each OH ion discharged a H ion must remain in solution. This is equivalent to the formation of a molecule of hydrogen chloride, which decomposes an equivalent quantity of hypochlorite. A carbon anode undergoes great disintegration in sulphuric acid of moderate concentration, but it is very little disintegrated in concentrated acid; since the discharge of SO_4 ions within the pores of the carbon increases the strength of the acid contained in them, it will be a better or worse conductor than the main body of the acid according as this is weaker or stronger than the acid of maximum conductivity. The pores will therefore be more exposed to attack in weak acid and less exposed in strong acid. The formation of hydrogen chloride at carbon anodes may be explained by the reaction $2HOCl + C = 2HCl + CO_2$. The author shows that this change really occurs with considerable velocity, but inclines to the view that his own hypothesis is preferable as being more generally applicable. Generally speaking, the less porous a carbon the more suitable it is for use in the electrolysis of solutions of alkali chlorides, but the only satisfactory test of the suitability of a carbon is a prolonged experiment with it under working conditions.

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MONTMORENCY FALLS DOUBLE-CURRENT PLANT.

BY FRANK C. PERKINS.

The development of the power transmission at Montmorency Falls, which are seen in Fig. 1, is of particular interest, on account of the introduction in this plant of single machines supplying both direct and alternating currents at the same time. The Quebec Light and Power Company have in operation in this plant alternators of the inductor type, manufactured by the Royal Electric Company, of Montreal, Canada, as well as the double-current machines of the Westinghouse Electric and Manufacturing Company, which supply a two-phase current from one side and a 500-volt direct current from the other side of the machine. The total drop from the falls is 275ft. before reaching the St. Lawrence River, while there is an available head of 200ft. at the power-house, shown in the accompanying illustration (Fig. 2). This building is 150ft. long and 40ft. wide, and is constructed of stone.

The interior of the power-house (shown in the illustration, Fig. 3) is equipped with five turbines in all, each having a capacity of 1,000 h.p., and each being direct coupled to a single generator. In addition to the double-current machine, there are in operation four Stanley two-phase alternators of the inductor type, generating currents of 5,000 volts, and having a frequency of 66 cycles per second. These machines have capacities of 600 kw. and 700 kw. The Westinghouse double-current generator is shown in Fig. 3 This generator is a 600-kw. machine, and supplies a 500-volt continuous current to the local railway feeders from the direct-current side, and a 400-volt two-phase current from the alternating side. The frequency of this current is 66 cycles per second the armature having a speed of 286 revolutions per minute. This generator is directly connected to a 54in. Victor turbine, which develops 1,000 h.p. at an available head of about 200ft. The turbines and governors were installed by the Stilwell-Bierce and Smith-Vaile Company. The switchboards seen in the accompanying illustration (Fig. 4) are equipped with circuit breakers and the many measuring instruments required in the power-house for the various circuits. The two-phase alternating current, after passing the switchboard from the double-current machine, is increased in potential by static step-up transformers to 11,000 volts, and is conducted to a sub-station at St. Anne's de Beaupre, which is over 12 miles distant, where rotary converters are employed for changing the two-phase alternating current to a direct current for supplying the railway feeders radiating from this point.

The speed regulation of the turbines in this plant is secured by the use of Geissler waterwheel governors, one type of which is shown in Fig. 3. The variation is kept within 10 revolutions under the heaviest changes of load, while ordinary variations of load do not affect the speed by more than five revolutions. The mechanism used for turning the waterwheel gate shaft consists of two worms and worm gears, a double-ended flat friction plate, and a set of epicyclic gearing. The worm gears are said to reduce the noise to a minimum, while the face frictions are employed to start and stop quickly, the epicyclic gears securing a reverse motion for opening and closing the gate. This is an electromagnetic governor, and the double friction plate

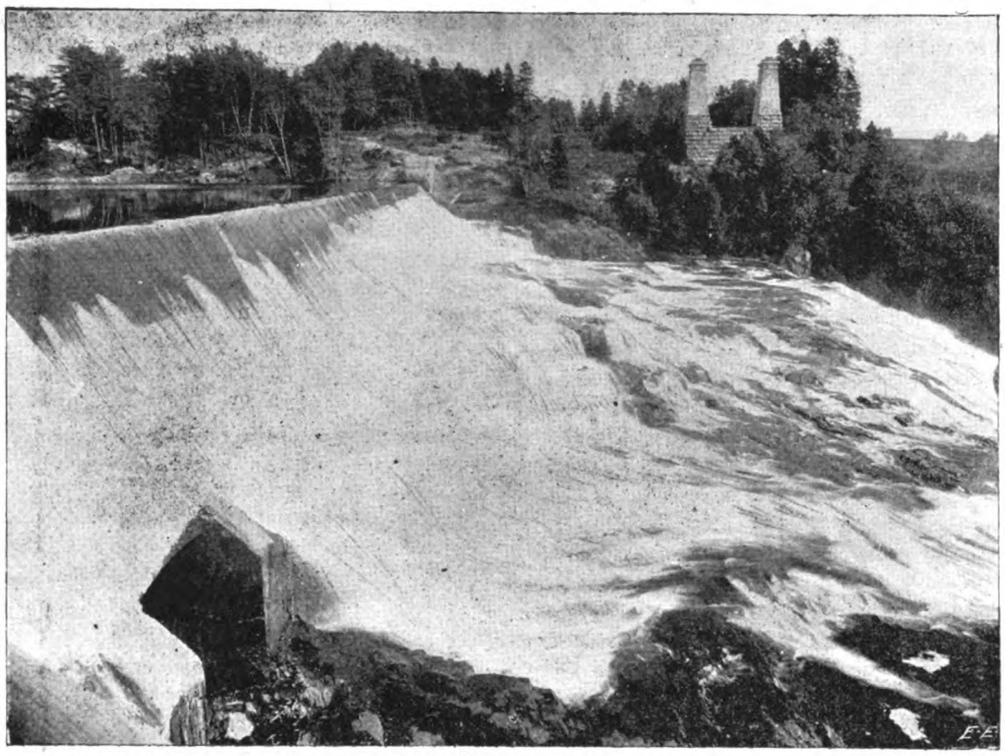

FIG. 1.—Montmorency Falls.

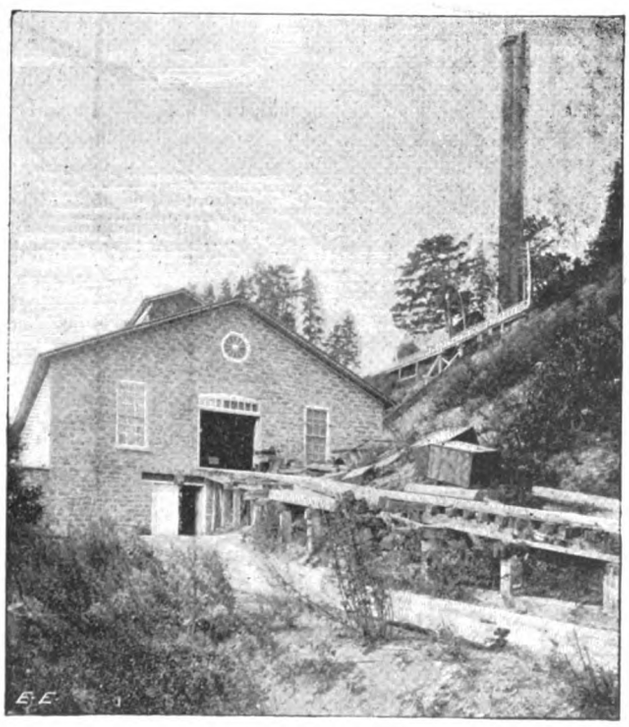

FIG. 2.—Power House, Montmorency Falls.

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is connected with two automatic stops. One is set when the waterwheel gate is fully open; the pull of the magnet is neutralised, so that no further opening of the gate may occur. The other is set so that the magnets are neutralised when the waterwheel is running at full speed, but without load. This stop is essential, and in case of a sudden relief of load, caused by the blowing out of fuses or from any other cause, the governor will shut down to a normal speed, and keep it there until the operator can close down the waterwheel by hand or by power.

It is considered by some engineers an entirely useless proceeding to instal double-current generators when rotary converters have been brought to such a state of perfection as to supply the necessary direct current with so little inconvenience and expense. It will therefore be interesting to note any new additions which may be made from time to time to this class of apparatus in plants now in process of construction or under consideration. The double-current machine is undoubtedly used to good advantage when a direct current is necessary for low-voltage lighting in the locality of the power station, and when alternating currents are required for supplying current to suburban points, while this method will also no doubt have many adherents where local street railway and suburban feeders must be supplied from a single station.

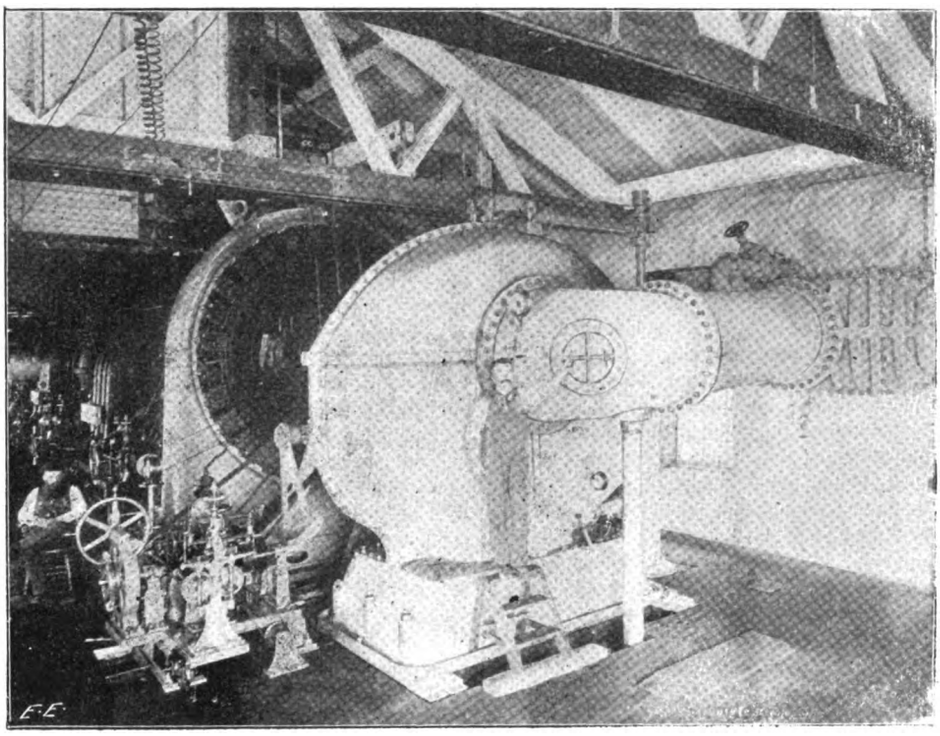

FIG. 3.—Westinghouse Double-Current Generator, Montmorency Falls Power House.

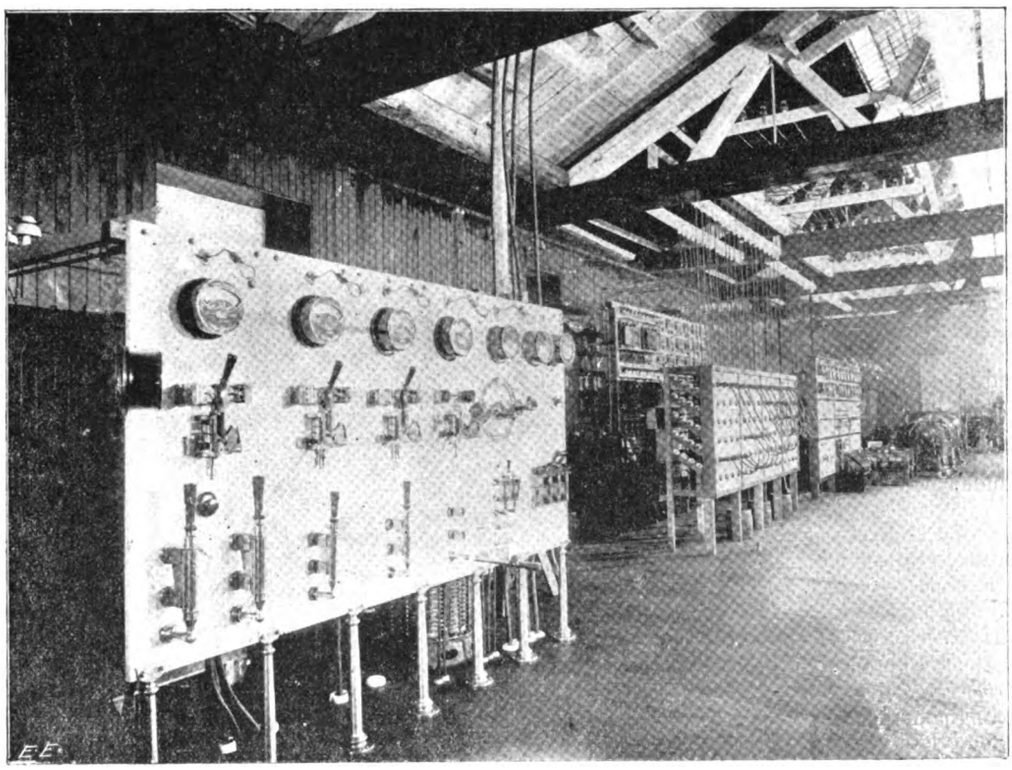

FIG. 4.—Direct-Current and Alternating-Current Switchboards, Montmorency Falls Power Plant

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ELECTROLYTIC TRADES IN AND AROUND BIRMINGHAM.

[FROM OUR OWN CORRESPONDENT.]

The city of Birmingham, including its sphere for influence, is not dependent upon any one staple industry for its prosperity, but is noted for the great variety of its manufactures—from a tin tack to an iron bridge. With regard to electrolysis, or the chemical changes produced in a solution by the passage of an electric current, the city may claim to have been the first to apply these principles to practical uses more than 60 years ago, when Messrs. Elkington obtained a patent for electro-plating and gilding by means of cyanide of potassium solutions of gold and silver. During all the progress of later years in other branches of the electrolytic industries there has been very little change in this. The solutions as patented by Elkington, are identical with those in use at the present day. This solitary application of electro-chemistry to industry was all that Birmingham was content to use until the last few years, although some enterprising Birmingham firms were early in the field of copper refining in other districts. The case is now very different, as many old methods are being gradually replaced by the newer electrolytic ones. Electro-plating and gilding still occupies the first place, but is well seconded by the industry of copper refining, which is perhaps the most extensive and most important of all electro-chemical applications. In this method we are sadly handicapped in the absence of water power, and the necessity of importing our ores from foreign countries, which is an immense disadvantage compared with the Americans, for example, who now smelt and refine their own copper *in situ*. Nevertheless, we still manage to turn out enormous quantities of electrolytic copper from our large copper works. Fortunately, the power required is small, and therefore not vital, so that with skilful arrangements and the use of large depositing tanks for a given output, the cost of power, even when coal is used to produce it, is not the chief item in the total cost of the process. Hence this is one of the electrolytic industries that it is possible to carry on successfully in a city like Birmingham with a total absence of natural water power. The production of electrolytic copper has been largely created by the increasing demand for pure copper for electrical purposes, and is another striking illustration of a new industry creating a demand for a high quality of a standard article for its own consumption, as well as enormously increasing the demand, for over 60 per cent. of the total output of copper is utilised in electrical engineering. For many purposes connected with this new profession the copper need not be chemically pure, but must be practically free from certain injurious elements, such as bismuth, which so greatly diminishes its strength and conductivity; hence the deposition may be conducted at a fairly rapid rate. If perfectly pure copper is aimed at, the rate of deposition must be slow, as any attempt to hasten the process causes the simultaneous deposition of any injurious constituents that may be present. Where time is of essential importance, that rate of deposition is raised to the highest possible limit. Of course this increased rate is not obtained for nothing: the price to be paid is the use of a higher voltage, and therefore extra power. But considerable gain in speed may be obtained by taking proper advantage of the help that is given by working at a higher temperature, and employing a highly metallised solution of low specific resistance, coupled with the use of means for obtaining rapid diffusion of the electrolyte at the cathode surface. As these principles become more widely known, the advantages of electrolytic deposition will become more widely appreciated.

Another Birmingham industry which has increased by leaps and bounds of late years is that of *nickel plating*, for which we are largely indebted to the ubiquitous bicycle. Hundreds of hands are daily employed in this extensive trade, plating and polishing, who only a few years ago were absolutely innocent of any knowledge of such a metal as nickel, and considerable numbers of men are yearly being initiated into the mysteries and principles of nickel plating in the great municipal technical school. The power required for nickel deposition is approximately the same as for copper, but nickel plating is almost entirely applied to iron and steel articles, which have to be highly polished and carefully prepared, thus greatly adding to the total cost. In fact, the cost of actual deposition is insignificant compared with the mechanical preparation and finishing.

The refining of crude nickel is carried on by Birmingham firms, but whether they conduct the processes actually at the Birmingham works or at their outside works we are not able to say. There is no difficulty in depositing nickel in thin films, as in nickel plating, but to obtain sheets of moderate thickness is another matter. The details of the process are jealously guarded, but the principles are doubtless the same as those laid down by Dr. F. Foerster. From his investigations he found that in order to obtain thick coherent plates the electrolyte must be kept at a temperature of about 70deg. C. The electrolyte contains 145 grm. of commercial nickel sulphate per litre, or 30 grm. of metallic nickel per litre. The concentration of this solution is kept constant, and continuously agitated. A nickel anode, enclosed in parchment paper to retain the sludge, is used, and a thin nickel plate, from which the deposited metal can be easily detached, forms the cathode. It was found that with a current density of 0·5 to 2·5 ampere per square decimetre and at the above-mentioned temperature good coherent deposits can be made. The nickel thus deposited is very tough. Of the usual impurities, only iron and cobalt are deposited with the nickel, and as the former is the only objectionable ingredient, it may be prevented by adding to the electrolyte a little tartaric acid and electrolysing with a low current density, which causes the iron to be deposited first. On increasing the current density to upwards of one ampere per square decimetre the nickel is deposited.

Zinc is another metal that is now deposited on iron by an electrolytic process in the Birmingham district. Zinc, as is well known, is largely used as an excellent protective coating for iron and steel goods. It has the advantage over tin that it is electro-positive to iron, and is attacked in preference to iron when the two metals are exposed to corrosion. This revival of the original process for galvanising is interesting and instructive, and tends to show that what are termed obsolete methods may be again revived, and become highly productive when new conditions, adapted to modern requirements, are grasped. The usual method is to dip previously pickled iron goods in a bath of molten zinc, which must be kept at a temperature of above 420deg. C. In the case of hard steel goods, this so tempers them that they lose a part of their tenacity. Also the alloy of zinc and iron on the surface has a low tenacity, and may be a serious diminution of the total strength in articles of small section, such as wire, cables, and bolts. Hence the demand for a coating of zinc which can be applied at the ordinary temperature. These conditions are fulfilled by the process of electro-deposition. The objects to be coated are made the cathode in a 10 per cent. solution of crystallised zinc sulphate, which must be kept nearly neutral, for if the solution becomes too basic the zinc is deposited in a spongy state. A fairly high current density is necessary, say about 15 amperes per square foot of surface. The electro-deposited goods have a duller lustre than the ordinary dipped goods, which exercises a prejudice against them.

The electro method is carried out near Birmingham by the Cowper-Coles process. He reckons that to cover steel plates of an average thickness of $\frac{5}{16}$in. with zinc at the rate of 1oz. per square foot will cost £2. 8s. 6d. per ton of plate coated. This is probably higher than the dipping method, but has advantages in being deposited cold instead of hot. Further, to heat uniformly a large finished article, such as a riveted tank, is costly in consequence of the large quantity of zinc which has to be kept in stock, while a solution to do the same work would be comparatively of slight cost, and much less injurious to the iron. It may be interesting in connection with this process to mention the admirable adoption of that extremely effective instrument known as the "sand blast" for thoroughly cleaning such parts as the inside of tubes, which have to be galvanised by the Cowper-Coles process. The ordinary method of simple pickling is often very defective, leaving

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bits of scale, which are not removed, and therefore parts which are not subsequently galvanised. Such defective parts become centres of rapid corrosion when the tubes are in use, and cause holes to be formed. Such corrosive centres do not remain alone, but spread contamination to the surrounding metal.

The electro-deposition of iron as a facing material for electrotypes and similar soft metals in order to impart hardness to the surface, and thus to enable the metal to resist wear, is another important Birmingham industry. It is commonly termed "steel facing" or "acier type." It is used for all kinds of copper type and engraved plates. It has a most extensive application in the potteries. The plate is first of all thoroughly well cleaned, so as to free it from all grease before placing in the solution. The depositing solution is acid ferrous sulphate, made nearly neutral with ammonia. The prepared plate is first put in a cold solution, and "struck" with a strong current so as to get a coating of iron all over as quickly as possible, and then transferred to a similar solution, kept at about 80deg. C. by means of hot pipes running round the inside of the vat. The current now used is about 0·8 volt and about 10 amperes per square foot of cathode surface. About one hour is sufficient to give an effective coating without destroying the sharpness of the engraving or type. On removing the plate from the vat it is well swilled in water, and then in boiling water, so that on removal the metal rapidly dries. A coating of vaseline protects the iron from rusting. After a time the iron wears off in patches, and it becomes necessary to recoat it. The whole of the old coating must be completely removed by immersion in dilute sulphuric acid, when the plate, after being cleaned with finely powdered pumice stone, is swilled, dipped in potash, swilled again, and is then ready for recoating.

An interesting application of electrolysis is carried out by Messrs. Chance for producing mirrors for searchlights. This is an adoption of electrotyping on a glass mould. The glass base is properly prepared with a conducting surface, and surrounded with a copper ring. This is then suspended in an acid copper sulphate bath, and left until a deposit of sufficient thickness is obtained. The mould is kept constantly in rotation during the deposition. In order to remove the deposit from the mould the whole is placed in water, and the temperature raised to 120deg. F., when the metal reflector will leave the glass mould, on account of the unequal expansion of the two. This deposit has the same brilliant polish as that of the mould, and is then ready for plating with palladium. This metal can be deposited bright to any desired thickness. It is a silver-white metal and possesses the very important property of resisting tarnishing, even when exposed to the intense heat of the electric arc.

The electrolytic production of alkalies and bleach is now in successful operation in the Birmingham district, and although this method of production is only in its infancy, large quantities of caustic potash, caustic soda, bleaching powder, and potassium chlorate are manufactured here. The Castner-Kellner is, we understand, the particular method adopted. The electrolysing bath consists of a shallow trough, divided into three compartments. The bottom is covered with mercury, which fills two gutters in the bottom, and thus effectually separates the compartments from each other. The middle chamber contains water, and the two outer ones contain brine. In the middle chamber is placed a cathode of iron, and in the brine an anode of carbon. The whole apparatus is made to rock up and down during the electrolysis, each end compartment being thus alternately raised, and when in this position being empty of mercury. During this time the current passes from the carbon anode in the other end compartment through the brine to the iron cathode. The current thus decomposes the brine, liberating chlorine gas, which is led away to chambers for making bleaching powder, and the sodium amalgamates with the mercury. When the chamber rocks over the other way the mercury shifts, and the amalgam coming in contact with water, the sodium is dissolved out, forming caustic soda, while fresh sodium is being reduced and amalgamated with mercury in the opposite end compartment. In the electrolytic production of chlorate of potash a solution of potassium chloride is electrolysed, the products being chlorine and potassium, the latter with water forming caustic potash. The latter is then fed into the anode chambers, where it absorbs chlorine and forms hypochlorite, which readily decomposes into potassium chloride and chlorate.

The recovery of tin from waste tin-plate scrap by an electrolytic method is another Birmingham industry which has sprung into existence during the past few years. We have examined this process and made some analyses of the products during the initial stages, but cannot divulge the practical details. The tin is not pure, and requires to be refined in the ordinary way. The clean iron is sold as best scrap. The power is supplied by a dynamo, driven by a gas-engine, producing 1,000 amperes at about one to two volts. The usual copper conductors are used, and the solution is either a chloride or a sulphate. In about half an hour after switching on the current the tin is dissolved off the scrap and deposited as a sponge on the cathode with a considerable quantity which falls to the bottom of the vats in the form of mud, while some of the spongy deposit is detached and floats on the top of the bath. The electrolyte requires to be kept at a certain strength and requires replenishing at intervals. The current density is about 10 to 15 amperes per square foot of cathode surface. The tin sponge may be refined electrolytically by placing it in a canvas bag, which forms the anode in a hydrochloric acid solution containing tin salt, using tinned sheet iron as cathodes. The tin is then deposited practically pure, leaving the impurities in the bag and in the solution.

The electrolytic production of phosphorus is also carried out near Birmingham, but the details of procedure and the practical methods adopted are jealously guarded as a trade secret. The process is probably similar to that of the Diel process, lately patented in Germany. The electrolyte is a mixture of a strong solution of phosphoric acid with about one-quarter its weight of charcoal, which reduces the phosphorus and volatilises it, suitable means being provided for its escape and condensation. An enormous current is required, probably 100 to 150 amperes at 120 volts.

It will be seen from the brief descriptions of the above processes that the great Midland metropolis is well to the fore in the practical application of the extremely powerful and important agent "electricity," and we may confidently expect to see in the near future a considerable advance in its multifarious ramifications.

BOILERS AND WATER SUPPLY.

BY F. G. ANSELL.

(Concluded from page 485.)

There are two substances which contain a large quantity of oxygen in the solid form and can part with it very easily. They are nitrate and chlorate of potash, both of which are used in the manufacture of explosives, and are dangerous when in the presence of bodies which are easily oxidised. In making this experiment we work with grains instead of pounds, and we do not require the furnace. In fact, we want a calorimeter, which in the present case may be described as the same as the previous apparatus, but minus its furnace. As we are going to work with very small quantities we must be exceedingly careful, and must take our sample of coal with very great care, or we shall not get a fair and useful result—in fact, the experiment will have been made in vain. These and other similar considerations make the author prefer "Count" Rumford's apparatus. However, the manipulations are now given for those who are able to use them. The sample of coal should be about 20 or 30 grains, carefully dried and very accurately weighed on a good balance. We will suppose 25 grains taken for the experiment. The combustion mixture should be composed of three parts chlorate of potash and one part nitrate of potash, well powdered, thoroughly mixed together, and carefully dried at a temperature of about 100deg. F. or 120deg. F. The 25 grains of coal powder must now be carefully and thoroughly well mixed,

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but not rubbed, with 10 or 12 times its weight of the combustion powder. Rubbing the coal and combustion mixture together might sometimes cause an explosion, and should, therefore, be avoided, especially whilst the ingredients are warm. The mixing being complete, the powder must be put into the combustion tube of the calorimeter, a short fuse applied and lighted in the usual way, and the door of the apparatus tightly closed to prevent the escape of heat, as the burning of the coal will be very violent and rapid; in fact, almost, if not quite, explosive. Allowance for the absorption of heat by the apparatus must be made as before, and the calculations will be

25 × 966 = 24,150 grains of water.
Deduct, say 2,450 grains of water, the amount represented by the apparatus.
21,700 grains of water put into the apparatus.

Now, every 1deg. F. which the temperature of the water gains by the combustion represents the number of pounds of water which 1lb. of the coal will evaporate at 212deg. F., since the proportion would be the same if we could have used pounds instead of grains of coal and water in this experiment.

Boiler Fittings, Adjuncts, etc.

No steam-boiler should be left entirely in the hands of any one person, no matter how careful he may be, but a good stoker should always be appointed, and he should be carefully impressed with the responsibility of his position, which is very important. No boiler is safe in the hands of a careless stoker. Good stoking will keep good clean fires and constant steam pressure, the fires being regulated according to the demands put upon the boiler Bad stoking leads to dirty fires, half stifled with clinkers and ashes, irregular water-level, steam blowing off at the safety valves, and the general neglect of idleness, which should never be tolerated. Therefore, in addition to a good stoker, some intelligent man of careful habits should be charged with the duty of seeing that the boiler is well and properly attended to, and that the various valves and fittings are all in good working order.

In addition to the above two persons, the boiler should be thoroughly inspected by a competent experienced man every few months inside and out. Perhaps the best way to effect this is to insure the boiler with a good company, who will keep it well looked after for their own sake as well as the sake of the owner. A boiler explosion is a terrible calamity, and should be carefully avoided at all cost. No flaw of any sort should be allowed to remain in any part of a boiler, and no boiler should be uninsured. The cost of the insurance is very little, and the advantages derived from that small payment are very great. The periodical inspection is alone worth more than the premium paid for the insurance. It discovers flaws and slight damage before they have had time to do any serious harm; it makes those in charge of the boiler careful, and realise their responsibility; it gives a guarantee to the owner as to the true state of his boiler, and in many cases leads to valuable suggestions and economy in working.

The safety valve should be kept under constant observation, and occasionally gently lifted to make certain that it has not stuck; it should always blow off when the hand of the pressure gauge points to the limiting pressure, and under no circumstances whatever should any weight, no matter how small, ever be added to the weight or spring of the safety valve. Many years ago stokers could be found who would hang shovels or fire-irons on to the safety valves to prevent them from making a noise, but we will hope nobody could now be found so reckless. It is most dangerous and reprehensible. If the safety valve makes a noise, the noise is a sign that the valve is doing its duty, and the proper way to stop the noise is to let the fire down, to use more steam, or pump cold water into the boiler. A common practice is to open the fire-door, but when the fire is very hot the sudden admission of cold air to the furnace crown is apt to damage it, as previously pointed out. In addition to the safety valve, which is often in duplicate, there is in many boilers a valve which opens when the water in the boiler gets low. Its action is simple, and depends upon the well-known fact that a weight suspended from a point does not hang so heavily when submerged in water as it does when in the air. In other words, the water buoys the weight up, and consequently relieves the point of suspension of part of its load. This knowledge is thus applied: A safety valve is fixed as usual, but to the bottom side of the valve an iron rod is fixed, and this goes inside the boiler a few inches. To this vertical rod a horizontal lever is connected. The fulcrum of the lever is at its middle point, and at the other end of the lever is hung by means of a rod or a chain a flat weight such as an iron plate or a paving stone, which is under the surface of the water when the boiler has it proper quantity of water in it. But if the water get low, then the end of the lever has to support the entire weight of this flat piece of iron or stone, and, of course, the extra weight thus added draws this end of the lever down and so forces the other end up and relieves the valve of part of the weight or force which was holding it down, and allows steam to escape. The noise of this escaping steam attracts attention, and then more water must be put into the boiler immediately. This low-water safety valve acts well, and is a valuable addition to any stationary boiler. If, however, the gauge glasses are properly observed and kept in good order, this valve should not often be called into action. The gauge glasses are attached to the boiler at top and bottom by means of brass unions and taps. There is also a third tap to each placed at the bottom of the glass tube, so that water may be let out. We may speak of each of these three taps as follows: the top tap, which when open should let steam only pass; the water-tap, which controls the flow of water; and the drain tap, which when open allows the inside of the glass tube to communicate with the air. If the water-tap is shut, and the steam and drain taps open, steam should blow out into the air, showing that the steam-tap is in order. If the steam-tap is shut, and the water and drain taps open, water should escape into the air, showing that the waterway is not blocked by lime or other deposit, or dirt inside the boiler. When the gauge glass is in good working order, and it is wished to make certain that its indications are correct, shut the water-tap, open the drain tap, and empty the glass by blowing steam through, then shut the drain tap, leave the steam-tap open, and also open the water-tap, when the water should flow easily and quickly up inside the glass to the same level as the surface of the water inside the boiler. Obviously, any pressure inside the boiler is the same on the top and on the bottom of the column of water inside the glass, provided the steam and water taps are open, so that this column of water is counterbalanced by the water inside the boiler and nothing else. It is very necessary to check the reading of the gauge glass at least once a day, because the taps may and often do get choked by an accumulation of the deposit of lime and other salts, which form the "scale" or "fur" on the inside of the boiler. The following considerations will show how a gauge glass may give false indications. We will suppose the water-tap blocked, but the other two in good order. Of course, opening and shutting the tap which is blocked will make no difference to the glass. Shutting the drain tap and moving the handle of the water-tap will not now have any immediate effect on the glass, but the steam-tap being open, steam will condense in the tube slowly as it cools, and so clear water will rise slowly in the tube. This clear water will rise up to the top of the glass, and so the gauge may be said to give a false indication, although the slowness with which the water has risen really should have drawn attention to the true state of affairs. In many cases a further indication would also be the clearness of the water, because very often the water inside the boiler is turbid. Of course, the fact of the water-tap being blocked should be known by the non-appearance of water when the water-tap is opened, the drain tap open, and the steam-tap shut, but often to avoid steam and mess in the stoke-hole the drain tap of the gauge glass is connected to a small pipe, which conducts the steam and water away completely out of sight. This is not altogether a good and satisfactory arrangement, as it hides too much. There is another fault which might occur—viz., the steam-tap or its

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tube might get choked through "priming," scum, excessive ebullition, or neglect, and in this case the water-tap being closed, and the other two open, no steam would blow out, and supposing this not noticed, the effect of the stoppage would be that water might rise slowly in the glass, when the drain tap is closed and the water-tap open, because the air confined in the glass would be compressed by the pressure of steam in the boiler, and so a false reading obtained. This fault might be caused by the glass being placed too high in the top socket, and so having its end closed. A few observations may show failure in the correctness of the gauge—viz., the water lying too still in the tube, its exceptional clearness or loss of the usual turbidity, rising too slowly after opening the water-tap, rising to the top of the tube with the water-tap shut and the steam-tap open. The level should rise when water is pumped into the boiler, and should fall while the boiler is giving steam and not receiving fresh water. The level should fall more rapidly as more steam is used, and as more fire is required. No gauge glass should ever be scraped with a knife, and iron wire should never be put inside the tube, as both these operations are very apt to cause a crack and breakage of the tube the next time it has any pressure in it Occasionally it may be observed, especially in slanting tubes, that the inside of the tube is corroded or eaten away on its lower side. This is caused by the chemical action of the lime and other alkaline salts contained in the water trickling down the inside of the tube, and dissolving away a portion of its substance. In time this will so weaken the tube that it will no longer be able to withstand the steam pressure.

In addition to two gauge glasses, many boilers are fitted with small taps at different heights. These may be turned one at a time until the level of the water is ascertained, and so the indication of the gauge glass verified. The top one of these taps is often provided with a screw thread, so that the boiler inspector may attach his own pressure gauge to the boiler, and thus check the reading of the ordinary pressure gauge. The author prefers Bourdon's tube pressure gauge to all others he has met with. All boilers are now fitted with a plug, made of metal which is easily melted, in the top of the furnace. Under normal conditions this is always covered with water which keeps it well below its melting point, but if the water gets too low, then the plug gets hotter and melts, so opening a hole in the boiler and letting all pressure down. This has the further advantage of blowing some water on to the fire, and so putting it out more or less according to circumstances. All valves should be kept in thoroughly good order, so that they may be opened or shut at will.

A good donkey pump should be provided in places where very hard or hot water has to be pumped into the boiler. Direct-acting pumps are preferable to all others; they take up less room and have fewer parts, the absence of a flywheel being an advantage. Where the quality and temperature of the water are favourable, a good injector is the best means of putting water into the boiler, but a duplicate injector should always be at hand in case of emergency. If circumstances will allow the injector to be worked with exhaust steam, a considerable economy can be effected. Steam-traps are useful and economical in many places, especially where steam is used for heating. It is a greater assistance to a boiler than many people imagine to have steam-pipes plenty large enough for the work they have to do, and to avoid sharp bends as far as possible. The pipes should also be laid free from dips, and so that water cannot accumulate in them. Water so collected is often blown about with great violence, and, besides making an unpleasant noise, its blows may often break the joints in the pipe. Pipes should always be laid to drain, if possible, back to the boiler. If dips in the pipe are unavoidable, some means of escape must be provided—such as a steam-trap. Where pipes are exposed to frost, this is very necessary. The covering or "lagging" of the pipes prevents unnecessary condensation, and so is a great economy. When starting work, it is advisable to turn steam on very gently, as the cold pipes must cause a lot of condensation, and the water so formed should have plenty of time allowed to drain to a place of safety, or it may blow about violently inside the pipe and so break the joints. Remarks as to the fire, the furnace doors, dampers, etc., have been given previously.

General Economy.

As steam-boilers are great consumers of fuel, water, and labour, great attention should be paid to the general economy, or serious and avoidable losses may occur. For instance, the top of the boiler should be carefully and thoroughly covered with some non-heat conducting material, and so should all steam-pipes as far as possible to prevent condensation, which is really loss of steam and waste of heat. Long flues leading from the furnaces to a distant chimney stack should be avoided if possible, because the heat of the chimney is of great importance to the draught, and the heat of the gases in the chimney should under no circumstances fall below 600deg. F., or they will lose their proper buoyancy, and so the draught will suffer. In putting up new chimneys it should be remembered that the efficiency is in proportion to the square of the diameter of the sectional area of the flue, and only in proportion to the square root of the height of the chimney. Chimneys should be built of non-heat conducting material, such as brick, and steam should not be turned into a brick chimney unless it is lined internally with sheet iron, and even then it is not advisable, as the steam greatly aids decay, and will very materially shorten the durability of the chimney. All chimneys should be provided with thoroughly efficient lightning conductors, made of strip copper, actually in contact with the material of the chimney. This is best done by copper clamps nailed to the brickwork by copper nails. The top of the chimney should be surrounded by the strip, and if the diameter of the chimney is at all considerable, three or four sets of gilt or platinised copper points should be well riveted to the strip, and the strip must be led down the outside of the chimney. A lightning conductor led down the inside of the chimney would most likely be quite useless. The bottom of the strip must be well riveted by copper rivets to a plate of copper in not less than three places, and then properly buried in moist earth. The copper plate should not be less than 2ft. long, 1ft. broad, and $\frac{1}{16}$in. thick, and it should be surrounded by coke and buried in earth which is always moist. The electrical resistance of the whole conductor, including the earth connection or contact, should not be more than ·1 or ·2 ohm in any case. This should be properly tested by an electrician.

The waste heat of the furnace gases may with advantage be utilised, provided the heat of the gases when entering the chimney is not reduced below 600deg. F. A chamber is often built between the furnace and the chimney for superheating steam, and also for heating the boiler feed water. The heat of any exhaust steam, whether from the engines or elsewhere, should be utilised. It will warm a very large quantity of water daily, and this can be used for many purposes. It would be much more economical to warm offices and buildings with it than to let it go to waste.

With regard to the best material for covering steam-pipes, etc., in order to prevent loss of heat, opinion may differ slightly and circumstances must be considered. Asbestos is absolutely non-inflammable; cow-hair is practically safe, and is probably a better non-conductor of heat, while felt is often used with success. It must be borne in mind that steam at 50lb. pressure will char wood to a serious extent, and make it dry enough to be dangerously inflammable.

TESTS ON THE NERNST LAMP.

A paper by Mr. R. P. Hulse, Bowen Scholar, Birmingham University, read before the Birmingham Local Section of the Institution of Electrical Engineers on the 19th ult., adds considerably to our knowledge of the value of the Nernst lamp. The following is an abbreviation: It has been known for a long time that certain materials which insulate at ordinary temperatures will conduct fairly well when strongly heated. About four years ago Dr. Nernst applied this principle in the construction of his lamps, and used material for their manufacture very similar to that used in Welsbach mantles. Owing to the fact that the melting point is very high, a much higher temperature can be maintained than with a carbon filament, and a higher-efficiency lamp is the result; and also, the material bein

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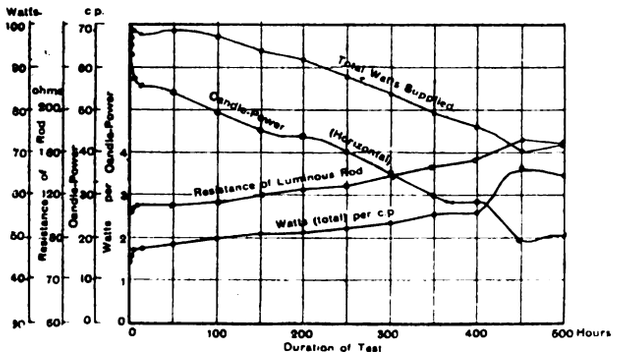
non-oxidisable, no vacuum is necessary. The materials used for the illuminating rod require to be heated up in order to start the current flowing; but when once heated the rod conducts, and need no longer be heated by external means. The "1902 model" of the Nernst lamp now being put on the market forms the subject of the tests described below. These tests comprise the measurement on a direct-current circuit of life, candle-power, and watts under the following conditions: continuous run at normal pressure; continuous run at a pressure above normal; continuous run at a pressure below normal; continuous run with constant current; continuous run with constant watts expended in rod; test with varying volts (increasing till burner is destroyed); resistance tests on the iron regulating resistance; heating effect of coil. In each case 100-watt 110-volt "burners" were employed. The candle-power of the lamps was ascertained by comparison with standard Ediswan incandescent lamps.

The author here proceeds to describe the means taken to ensure reliable results. As a battery of accumulators was used to supply the current, a very much more steady pressure was maintained than would have been possible with the mains, the excess volts when charging the battery being cut down by a regulating resistance. The average variation in pressure for any long time was certainly not more than half a volt, and generally less, and it will be seen later that since that under perfectly steady conditions the lamp itself varies 2 to 3 per cent., sometimes more, a steadier run was hardly required. The life was in all cases, unless otherwise stated, perfectly continuous, only one break occurring in the circuit during the seven weeks during which the tests lasted, and that for but a few seconds.

Life Tests.

In every life test made there was a very considerable falling off in candle-power, in the first half-hour amounting to 25 per cent. in the over-run lamp*, but only about 10 per cent. when on normal volts. After this we get a much slower drop until 20 hours is reached; then, as a rule, there was a slight recovery, followed by a period in which the variations depended on the conditions under which the lamp was run.



CURVE I.—Life Tests at Normal Voltage.

1. *Tests at Normal Voltage.*—Three lamps, each marked 100-watt 110 volts, were tested on 109·5 volts. These three lamps were substantially the same, the big decrease and slight recovery being shown in each; and after this a steady diminution of candle-power until 400 hours, the efficiency during this part also diminishing (see Curve I.). After 400 hours there was another sudden drop, and then the state of the rod seemed to change, for there was a slight rise in efficiency and candle-power up to the point where the burner broke down.

TABLE I.—Life Tests on Normal Volts (109·5). Mean Values from Curves representing Three Separate Tests.

Hours after start.	Current.	Watts absorbed. Total in lamp.	Per cent. on rod only.	Candle-power.	Watts per C.P. Total.	Rod only	Resistance of rod.
	Amperes						Ohms.
0	·917	100·5	88·4	66·8	1·51	1·33	105·6
1	·913	100	89·1	62·9	1·59	1·42	106·8
3	·906	99·2	90·1	57·6	1·72	1·55	108·9
10	·903	98·8	91·2	55·4	1·79	1·63	110·7
50	·904	99·1	92·7	52·9	1·87	1·74	112·2
100	·892	97·7	94·0	49·4	1·98	1·86	115·2
150	·858	94·0	95·1	45·7	2·06	1·96	121·2
200	·836	91·6	95·7	43·9	2·09	2·00	125·2
250	·803	88·0	96·1	40·0	2·20	2·11	131·0
300	·766	83·9	96·7	35·4	2·37	2·29	138·2
350	·724	79·3	97·3	30·1	2·64	2·57	147·0
400	·692	75·8	97·7	28·5	2·66	2·60	154·5
450	·637	69·8	98·2	19·4	3·61	3·54	168·8
500	·653	71·5	98·0	20·4	3·51	3·44	164·2

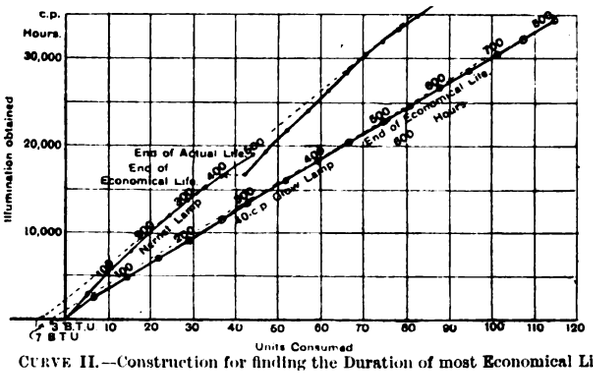
The respective lives of the three lamps were 509, 490, and 425 hours, the average being 473 hours. The cause of destruction in each case was the breakage of platinum contact at the positive end of the rod. This may have been due to the deterioration of contact and consequent local heating.

Length of Efficient Life ("Smashing Point").—It will be seen that towards the end of the life the efficiency is seriously decreased, the lamp being ultimately no more efficient than an ordinary incandescent lamp. Curve II., obtained from Table I., shows the relation for the lamp (at the pressure under consideration) which exists between the cost of energy expended and candle-power hours obtained, the latter being plotted vertically. From the common zero, set backwards horizontally the cost of the refill for the lamp, adding any increase in rate of depreciation of the iron resistance due to using a new burner, and subtracting any allowance which may be obtainable for the platinum heating coil in the discarded one. A tangent from the point so obtained to the curve gives the point at which the candle-power hours will bear the greatest ratio to the total expenditure, and it is at this point that it will best pay to get a new burner. From this curve the following figures have been taken:

Length of run (hours)	100	200	300	400	500
Units consumed	9·88	19·31	28·12	36·09	43·28
Candle-power hours obtained ...	5,280	9,890	13,880	16,970	19,170

Assuming the cost per unit to be 6d., and that of the burner, fitting, and depreciation of lamp and resistance at 3s., it is found by this method that it will pay to get a new burner at 350 hours; total cost being up to that point 19s.; candle-power hours = 15,500, or ·0147d. per candle-power hour. Under the very best conditions, with power at 6d. per unit, an incandescent lamp will cost over ·02d. per candle-power hour. The relatively short life of the Nernst lamp (about 450 hours) is probably not disadvantageous, since it prevents the use of the lamp under uneconomical conditions after the proper "smashing" point has been reached. The natural life of the burner is very near that at which it will best pay to replace it, as calculated above. This is very far from being the case with most incandescent lamps.

2. *Over-run Test.*—This shows that over-running is not only detrimental to the life of the lamp, but also that there is not the gain in efficiency which occurs with an ordinary incandescent lamp. Table II. (not reproduced herewith) also indicates that the percentage of energy absorbed in the iron resistance of a 110-volt Nernst lamp run on a constant pressure of 116·5 volts is greater than it is with the lamps



CURVE II.—Construction for finding the Duration of most Economical Life.

tested at normal volts, but the watts expended on the rod per candle-power are a very little less. The behaviour of the rod in this test was somewhat uncertain, and it appeared that the lamp was on the point of going a short time before it actually broke down. The life was very short (only 220 hours), and failure was again due to the breakage of joint at positive end. It is pointed out that the iron regulating resistance limits to a comparatively restricted range the amount by which the Nernst lamp can possibly be overrun, since this resistance will be destroyed before a large excess pressure is attained.

3. *Under-run Test.*—Long life and a very big drop in candle-power are the chief characteristics of this test. At no time did the candle-power remain at all constant as previously was the case, the decrease continuing throughout the whole life of the lamp and the efficiency falling off in the same way; and towards the end the luminous rod lacked that brilliancy and whiteness which usually characterises the Nernst lamp. The difference between the watts expended on the rod and the total watts supplied to lamp is in this case very small, owing to the small drop on the iron resistance.

TABLE III.—Life Test on Constant Pressure (under-run, Volts 105·8).

Hours after start.	Total watts supplied to lamp.	Candle-power.	Watts per candle. Total.	On rod only.
0	99·5	84·2	1·19	1·11
1	96·9	68·2	1·42	1·35
3	95·9	63·0	1·52	1·433
10	93·5	60·9	1·53	1·45
50	88·9	43·0	2·06	1·99
100	86·8	38·1	2·28	2·21
200	83·6	33·9	2·46	2·42
400	73·4	24	3·06	2·99
600	66·2	19·0	3·48	3·42
900	57·6	11·2	5·14	5·06
1,200	53·0	8·7	6·10	6·00

4. *Test with Constant Current.*—The most interesting test of the series is probably that in which constant current is maintained. Under ordinary conditions the current falls off to a large extent, and the burner is then no longer run at its best efficiency, the decrease in candle-power being also objectionable and detrimental to the reputation of the lamp. But with constant current the candle-power, after its first drop, which is characteristic of every case, remains constant

* The initial reduction is characteristic of the Welsbach burner also; in fact, is a property of all oxides used as illuminants.

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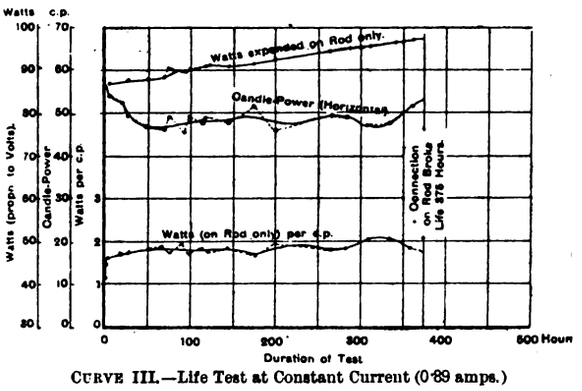
until that point is reached where, under normal conditions, the candle-power would have fallen off very rapidly, and here, instead of a drop, the candle-power *increases* for a short time until the lamp burns itself out (Curve III.).

TABLE IV.—Life Test on Constant Current (·89 Ampere).

Hours after start.	Watts (on rod only.	Candle-power.	Watts per candle (rod only).	Resistance of rod (ohms).
0	87·3	76·1	1·15	110·1
1	87·8	57·0	1·54	110·7
3	87·8	55·0	1·60	110·9
10	88·0	52·2	1·69	111·1
50	88·7	46·8	1·90	112·0
100	90·0	47·4	1·90	113·7
150	90·5	48·1	1·88	114·0
200	92·1	47·2	1·95	116·4
250	93·1	49·8	1·87	118·4
300	94·7	49·2	1·92	119·7
350	96·6	50·8	1·90	121·9

The life under these conditions was 372 hours. The total power taken is not given, since this depends upon the variable resistance

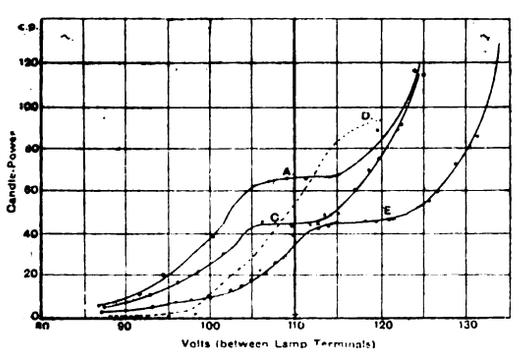


CURVE III.—Life Test at Constant Current (0·89 amps.)

used to keep the current constant. By running at constant current the life has been shortened by about 100 hours, but a high efficiency is retained to the end.

TESTS WITH VARYING PRESSURE.

Candle-Power-Voltage Tests. Steadying Resistance. — A most important feature in the lamp is the iron regulating resistance, which is a fine piece of iron wire kept in a partial vacuum. The vacuum was found by comparing the volume of water sucked in when broken under water to the total volume of glass bulb. The mean value found was 26in. Hg. The regulating effect of this resistance was found by increasing the volts and taking readings of candle-power and watts supplied. (See Curve IV.)



CURVE IV.—C.P. Voltage Tests. A, new lamp; C, after 11 hours' use; D, after 212 hours' use; E, after 116 hours' use.

TABLE V. — Regulation Tests on 100-Watt 110-Volt Lamps at Variable Volts.

Volts.	Candle-power. New.	After 10 hours new iron resistance.	After 10 hours old iron resistance.	After 116 hours.	After 212 hours.
90	9·5	7·7	8·5	2·8	0·5
100	35·5	27·5	32·5	9·6	12·5
105	60·0	42·6	48·0	17·8	25·7
108	63·7	46·0	49·7	26·5	38·5
110	64·5	46·7	50·7	37·0	56·0
112	65·0	48·0	52·7	43·0	74·0
115	66·0	54·0	59·3	46·0	83·5
120	83·0	80·0	94·5	48·0	—
130	—	—	—	81·0	—

Although when the lamp is new there is a remarkable regulating effect for 5 per cent. above and below normal pressure (there being almost no variation in candle-power during this period), yet as the age of the lamp increases this regulation becomes less and less. A different value for the iron resistance, it will be seen, gives a regulating effect at some other point. Usually the iron resistance will be destroyed before the lamp in candle-power voltage tests, especially if the lamp be new; and to burn the rod out a special resistance had to be made, the observations commencing where the others left off. The candle-power and watts on rod curve which can be plotted from these results show that the candle-power varies as the 2·6th power of the watts expended on the luminous rod. This value was taken from the results given by two old lamps, and satisfies these to within 1 per cent. for a range of from 60 to 100 watts.

TABLE VI.—Variation of Candle-Power and Resistance of Rod with the Power Absorbed in the Rod only (after 10 Hours' Run).

Watts on rod.	Candle-power.	Resistance, ohms.
40	5·5	16
60	17·5	145
80	34 0	118
100	53·5	96
120	80	80

Variation of Resistance with Watts Expended. 1. *For Luminous Rod.*—The watts, being the rate of dissipation of energy, are a measure of the temperature, and the resistance varies with the temperature; so that by plotting resistance against the watts expended on the rod, we have a curve connecting resistance with some power of the temperature, but no absolute values of temperature can be given.

2. *Iron Steadying Resistance.*—A similar curve can be plotted for the iron resistance, and the similarity between this curve and that obtained by direct observation at different temperatures is very striking. The life of the steadying resistance cannot be correctly stated, but is very considerable. One used for over 1,000 hours in connection with normal pressure tests has deteriorated very little.

Behaviour of Luminous Rod.—The rod always became crystalline after being in use for a short time, and near the negative end was blackened, changing through grey to a faint yellow at the positive end. In all cases where life tests have been made there was a white deposit in glass globe during first part of life, and more especially in the case of the over-run lamp. It was noticed that at certain times a faint singing or hissing sound is emitted by the luminous rod. This occurs particularly with new or over-run lamps, and was accompanied with a fluctuation (usually a diminution) of current amounting to about 2 per cent., and an even greater alteration of the power supplied to the rod. It would be very interesting to know how this sound is caused, and whether it is associated with the crystallisation referred to. These fluctuations of current occur under all conditions of testing, but when they were not great the sound could not be detected. The current sometimes varied 2 or 3 per cent. when the external pressure on the lamp terminals was absolutely steady. In all the life tests the end of the test was determined by the breaking away of the positive connection at the platinum wire. This is at the lower end of the rod according to the instructions sent with each lamp. Of 17 burners tested, none but three ended at all prematurely; and these three, curiously enough, were being *under*-run, and, in fact, were undergoing the earlier stages of a regulation test with gradually increasing pressure. Removal of the globe appears to cool the luminous rod, increasing its resistance and decreasing the current supplied by about 1 per cent. When once started it is found that a very small current will suffice to heat the rod enough to make it conduct. In this way a burner was observed to give only ·175 c.p., the current taken being ·193 ampere, and pressure on lamp 87·4 volts. A new luminous rod when normally burning has a specific resistance of about ·7 ohm per centimetre cube (about 100 times that of a carbon filament). The average of three rods which had each run for 450 hours was 1·06 ohms per centimetre cube.

Heating Coil and Automatic Switch.—The heating coil, which consists of a clay spiral (arranged around the luminous rod), closely overwound with fine platinum wire, was tested by continuously running it on 110 volts for over 48 hours. No alteration of the heating current occurred during this period, which corresponds to lighting the lamp a very large number of times, since the lamp only takes about half a minute to light up. It was also found that the period required to heat the rod to the point of conducting was not sensibly increased after the starting of the lamp 120 times (the rod being allowed to cool between each start); while the diminution in candle-power of the burner due to this frequent heating and cooling was no greater than would have been the case if the lamp had been continuously run for a corresponding time. The heating coil will plainly last longer than the rod, and it should be possible to use up heating coils by replacing the rod alone. At no time has the automatic switch failed to act, nor has its contact given any trouble.

In conclusion, there seems to be a wide field for the Nernst lamp where fairly large candle-powers are required and where power is not cheap. The Nernst lamp will give on the average throughout a life of 400 hours at least ·48 c.p. per watt expended, as against not more than 1·28 c.p. per watt in the case of good incandescent lamps. The cost of renewals would appear to be not more than three times as much for the Nernst as for the incandescent lamp, allowing for the shorter life of the former. In a 100-watt Nernst lamp (see Curve II.) the total energy used is over 35 units during economical life; and at 4d. a unit this costs 11s. 8d., or, say, not more than 15s. when all expenditure due to renewal of the burner is taken into account. Thus the Nernst lamp will furnish 1,000 candle-power hours at a cost of 11d., while 1s. 3d. is the approximate cost of the same amount of illumination from good incandescent lamps. In this comparative estimate the cost of renewals in each case has been included, the price per unit assumed to be 4d., while the incandescent lamp has been taken at an average of 3·6 watts per candle-power throughout a life of 700 hours.

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If the incandescent lamp be run for a longer period, or the price of the unit increased, the case will be all the more favourable to the Nernst lamp. Under-running might pay where power is cheaper, owing to the increased life; and this in spite of the low efficiency towards the end, say after about 800 hours (see Table III.). Over-running of the lamps, on the other hand, is, as stated above, not economical. The rapid falling off in the efficiency of the lamp under normal conditions after 300 hours seems to show that after this time it would be better to replace the iron resistance shown by one of a smaller value, and so maintain the candle-power at a steady value throughout the life.

[In our issue of March 14, 1902, pp. 375 and 376, we gave a short description of the "1902 model" Nernst lamp, while information on the distribution of light in Nernst lamps, and the ratio of horizontal to mean spherical candle-power, will be found in our issues of Nov. 22 and 39, 1901, pp. 726-728 and 765-767 respectively.—Ed., *E. E.*]

THE MAINS DEPARTMENT OF A DIRECT-CURRENT ELECTRIC SUPPLY STATION.*

BY J. F. MOORE.

Introduction.

The above title treats with a subject of considerable magnitude, and this paper therefore must deal with the department in a somewhat general manner.

Systems of Distribution.

Upon the system practically depends the eventual reliability and success of electrical supply, as upon the proper choice depends the reliability of working, good pressure, and freedom from the usual electrical troubles incidental to the undertaking. The general method of supply of continuous current is either by the three or plain wire distribution, the former—viz., the three-wire system—being at present in the majority. The advantage of the three-wire system, 440 volts between outers, is chiefly the cost of mains; but the chief disadvantage which occurs in practice is due to the trouble caused by short-circuits of the neutral and outer, causing increased pressure between the neutral and remaining outer, the cost of these little troubles being very considerable. (Who pays?) To the newly organised three-wire stations perhaps this is not of so frequent occurrence, but in those systems that have been in operation for several years, very probably in the future these occurrences will be greatly increased.

When discussing the type of mains to be used, there are several practical points which it is well to consider: (1) the possibility and effect of short-circuits; (2) the possibility and effects of earths; (3) easy repair, examination in case of the two former; (4) the probable extension and enlargement of sectional area; (5) first cost; (6) maintenance.

From the central-station engineer's point of view, I take it that it is infinitely more preferable to be troubled with earths or faults than short-circuits, especially in the earlier years of an electric supply undertaking, as the energy required from the 'bus bars for short-circuits is not always forthcoming, consequently the system is indisposed with a slight attack of darkness.

Of the principal types of cables every electrical engineer is pretty well conversant; but as it is desirable to give the peculiar advantages appertaining to them I herewith give a table (Table I.) showing these comparisons. From Table I. the chief characteristics are plainly visible, and as the personal ideas of engineers differ, so, consequently, does the system put in operation by those engineers.

Table I.

Type.	Liability to short.	Liability to earth.	Repairs.	Alteration of section.	Cost.	Life.
Single cable, lead covered and armoured. Laid direct.	No	Yes	Bad	Bad	Cheap	Short
Concentric cable, lead-covered and armoured. Laid direct.	Yes	Yes	Bad	Bad	Cheap	Short
Concentric cable, lead-covered and armoured. Laid solid.	Yes	Yes	Bad	Bad	Moderate	Long
Single cables, laid solid.	Yes, at boxes	Yes, at boxes	Bad	Bad	Very Heavy	Long
Single cables, laid solid in separate ducts.	No	No	Bad	Bad	Heavy	Long
Single cables in cast-iron pipes or stone-ware casing.	No	Yes	Good	Good	Heavy	Short

The question of the seriousness of short-circuits in distributors in large stations is diminished a good deal by the fact that the energy available is usually sufficient to burn them out. The one vulnerable part open, therefore, to cause extinction of supply is the feeders, and I think some attention should be paid to this fact. It is also extremely important to minimise the probable quantity of short-circuits between the middle and outers of a three-wire system, for even in distributors these momentary short-circuits are quite sufficient in themselves to do a great deal of damage in the way of burning out of lamps, blowing fuses, etc. I should like to suggest for discussion the advisability of taking the positive, middle, and negative feeders to the same distributing point, as one of the chief points in direct-current supply is the equality of pressure. I take it that it is far preferable to separate them by a distance of some hundred yards. This, as you will see, will give a far better distribution of pressure. This I have shown in the diagram (Fig. 1).

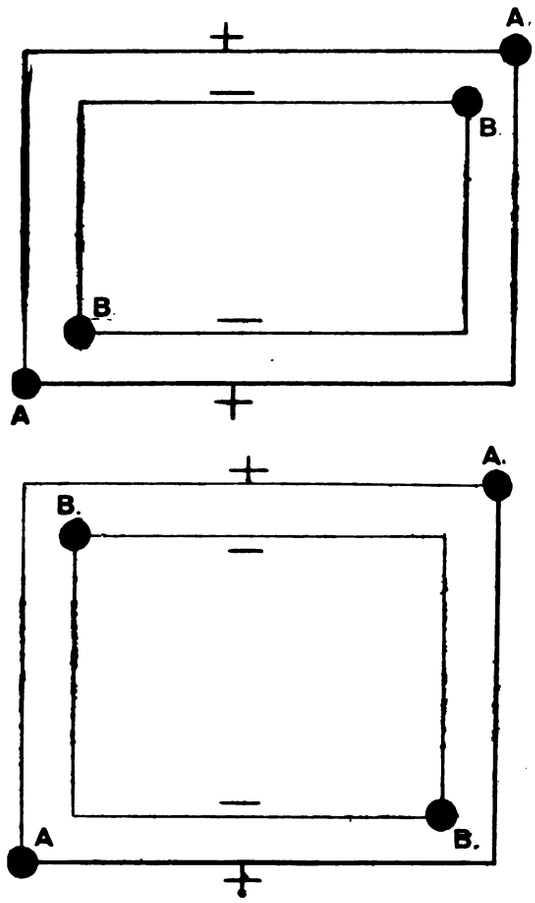

Fig. 1.—A, positive feeding point; B, negative feeding point.

Having now roughly sketched the different characteristics of the several classes of cable, it should be a necessity that the system of distribution should admit of quick fault localisation, etc. In direct-current work this is somewhat difficult. But the proper arrangement of section pillars and disconnecting boxes arranged in co-operation with the switchboard feeders, will allow of a section being run on independent 'bus bars in the event of abnormal earths, large fires, or indications of trouble. In concluding this section, might I point out the necessity for convenience of keeping the number of sizes of cable to a minimum, this being the one great advantage of uniformity of system. For indiarubber or bitumen cables in conduits the chief sizes are $^{19}/_{20}$, $^{19}/_{18}$, ·1, ·15, and ·25 for distributors, and ·5, ·75, and 1 square inch for feeders.

Localisation of Faults.

The above title is quite sufficient to bring to the minds of mains superintendents little happy times spent on the localisation of faults under many interesting conditions of weather, etc., when the theoretical Murray loop or any other loop is quietly consigned to the lowest depths. However, there is no doubt that theoretical working

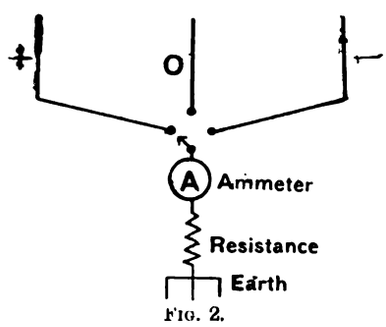

Fig. 2.

out of localisation of faults is particularly interesting, but the practical application usually induces an inflammatory effect on the language, actions, etc., which long hours without substantial meals, as well as midnights spent in earnest research, do not tend to modify. There is usually a record kept of ammeter or voltmeter readings which will in themselves give you the approximate insulation resistance of the mains. The two chief methods are as under;

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, April 7.

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1. *Frisch's Method* (Fig. 2).—If C and C_1 are the readings obtained from the positive and middle, or middle and negative, R the resistance of the ammeter (this includes external resistance), and V the voltage between the positive and middle and negative, then

$$\text{Insulation resistance in ohms} = \frac{V}{C - C_1} - R.$$

Care should be taken that the middle wire is allotted the positive or negative value according to the current coming in or going out.

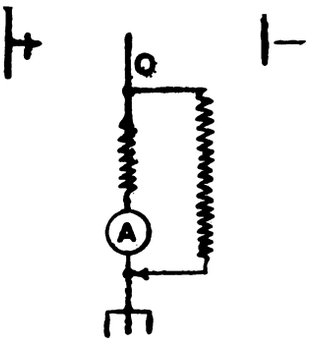

FIG. 3.

2. *Frohlich's Method* (Fig. 3).—Let $R = R_1$; C = amperes to E through R; C_1 = amperes to E through R with R_1 in parallel. Then

$$\text{Insulation resistance in ohms} = \frac{C - C_1}{2\ C_1 - C} R.$$

The two methods above are usually quite sufficient, but for the detailed methods, etc., appertaining to this reference to such a book as Mr. F. C. Raphael's and Mr. A. Russell's papers, etc., will give all the calculations necessary. No doubt the perfect system of fault finding is one in which the position of the fault is found to within a few yards, without in any way cutting off the supply of current, or in any way affecting the supply. As we have, however, not yet developed an "earth finder" on the principles of a "water finder," who merrily goes strolling over the ground localising the position, depth, and quantity of running water, we have not developed a mains superintendent who with a magnetic needle, or the like, contentedly strolls over the route of mains, locating position, depth, and amperage of a contented negative (usually) leak; happy would a borough electrical engineer feel himself if he had that man to do his localisation of faults. We are, however, assisted at times in different manners - the deflection of feeder ampere-meters, telephone messages, consumers complaining of bad pressure, and observations on feeders when testing.

With direct-current stations where the distributors are interconnected at boxes, or preferably section pillars, allowing the different sections to be run on different 'bus bars, this materially helps one in localising. In the testing for shorts, the usual method is first sectionalising the system, then again dividing, and then, if necessary, the overlap, or Blavier's method. The localisation of earths is carried out in a similar way to the above, but with Varley's or Murray's loop test. Great care must be used to ensure good and clean contact of testing wires. There is also another method that is extremely useful if proper care is given to it. I mean the induction method. Earths can be found in the majority of cases in this manner without disconnecting the supply from consumers. The faulty section is run separately, and the usual induction method carried out. This method no doubt is familiar to

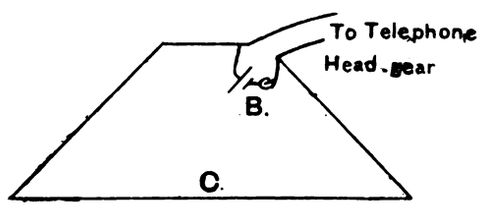

FIG. 4.—B, battery to test telephones; C, coil, 4ft. base, 400 turns, No. 28 S.W.G.

you all. The apparatus that I use personally for this work is as in Fig. 4.

METER DEPARTMENT.

As the whole of the income is derived from the periodical reading of the meters, too much care cannot be taken in this department to see that everything is in order, and that correct records of meter readings meter tests, etc., are taken. For the purpose of testing the most satisfactory results are to be obtained, I think, with secondary batteries, as a much steadier current can be maintained than that directly from the network, as large motors, etc., vary the supply pressure on the network considerably. For this purpose four or six secondary cells with motor-generator, standard ampere balances, to standardise a Weston or similar ampere-meter, and graduated resistances are necessary.

With respect to the choice of meters, no doubt every engineer's views vary on the subject, but I think that the general rule can be taken that the meter liable to be affected by sudden variations should be of the wattmeter type, while for the general consumer with incandescent lamps, ampere-hour meters are preferable. Here I should just like to say a word on the system of charging. More care should be given to this, as when once a system is in vogue it should be adhered to. The maximum demand indicator and discount system should not be in use in the same system of supply. I am of opinion that the more preferable system for simplicity, absence of complaints, etc., is that of the discount. While on the subject of meters I should like to call attention to meter rents. Some corporate bodies charge on the number of lamps connected, some on the size of the meter, and some nothing at all; that this is not at all satisfactory there is no doubt, as it goes without saying that the number of lamps are never two weeks alike, and sometimes meters are installed larger than requisite for lifts, for example; but where they are given away free gratis with 1lb. tea, this is not satisfactory from a financial point of view. Consequently, I think that if the nominal charge of 1s. or such small sum was exacted, it would materially decrease the labour of clerks, and be more satisfying to consumers.

ESTIMATING AND POST OFFICE NOTICES SECTION.

With all contemplated extensions of mains, it is necessary that estimates, plans of extension, etc., should be placed before the borough electrical engineer by the mains assistant prior to the discussion of same by the committee for necessary sanction to proceed with the work, and for which purpose an estimating book will be required, arranged according to the general system adopted. After the sanction of the committee and council has been received, all necessary monthly notices and plans have to be sent out. This is not so simple a matter as one would at first think. I therefore give an extract from the *Electrical Review* dealing with the subject:

"*Mains Plans.*—By the Electric Lighting Act of 1882, undertakers possessing statutory powers are required before laying down any electric line within 10 yards of any part of a telegraph line to give at least seven days' notice to the Post Office, with full particulars of the works contemplated. A further restriction was embodied in the 1888 Act, wherein power was given to the Board of Trade to require that any electric line or work should be used only in accordance with such conditions, and subject to such regulations for the protection of the lines and works of the Post Office as the Board might think fit to prescribe. In the London provisional orders there is a section

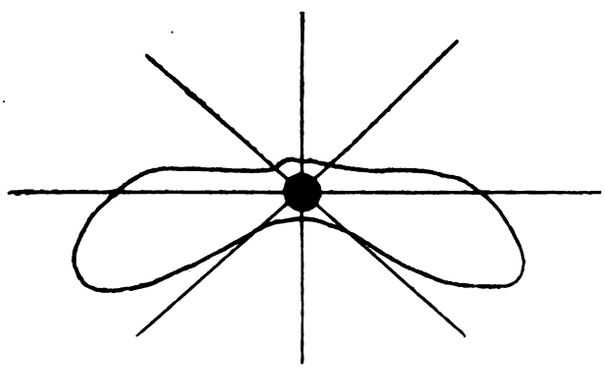

FIG. 5.

requiring undertakers to give one month's notice to the Post Office before commencing street works, and a plan of the proposed works must accompany the notice. The Post Office may approve of such works either absolutely or conditionally. This word 'plan' is by Section I. of the schedule to the Electric Lighting (Clauses) Act of 1899, defined to mean a drawing to a horizontal scale of at least 1in. to 88ft., and, where possible, a section drawn to the same horizontal section as the plan, and to a vertical scale of at least 1in. to 11ft. Owing to the extensive works now being carried out by the Postal Telegraph Department in connection with the telephone system, it becomes a matter of importance that the Department should be acquainted with the location of street works belonging to electric supply undertakings, and in improving electric works recently the Post Office has made certain stipulations which burden undertakers with new responsibilities. Whereas the plans previously required were of suggested works, and to a scale of 5ft. to the mile, the Post Office now require to be furnished within one month of the completion of the various portions of such works with plans drawn to a scale of 10ft. to the mile. On such drawings high and low tension mains must be respectively shown by continuous and dotted lines, and the depth of the mains below the surface by figures inside a circle, and the variations in horizontal position relatively to the kerb and building line by plain figures without a circle, the position being indicated by giving the party walls or street number where changes occur. The requirements have been considered by some of the undertakers to whom they apply as unnecessarily onerous, and steps have been taken to lay before the Post Office authorities the difficulties which will be created in attempting to carry them out. Simple as it may seem to provide such details, it is only known to those who have charge of such works how many obstacles there are when an effort is made to prepare plans giving full data as to the location of mains in the public thoroughfares, and it is the general experience that gas and water companies rely more upon the personal knowledge of the distributing staff than upon accurate and detailed plans when it comes to the question of where their pipes are laid."

As it is necessary to make several plans for the different officials, also duplicates for record, I have found that the best and most methodical way to do this is by the gelatine process, the paper being especially printed for this purpose, as shown herewith; and the little details, such as trimming tracing paper, and fitting the necessary notation, scale, etc., is already done, this saves a considerable amount

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of time, the cardinal direction being attached by a rubber stamp kept for the purpose.

Public Lighting.

Public lighting is an exceedingly important branch of the mains department, and more thought should be given to a duplicate supply of same in the event of breakdown, more especially in the central portion of the town, where tramway and vehicular traffic is considerable. At the present moment there is a good deal of attention given to the introduction of enclosed arc lamps for street-lighting. Fig. 5 shows the approximate curve of light for an enclosed type arc; Fig. 6 for open type. Moreover, there are several economic features in the enclosed type which are important considerations—viz., economy of carbons and economy of trimming and labour. We have not, however, had the experience with this class of lamp extended over periods of time compared with the open type, and at present I think practical experience with the enclosed arc lamps of the present day is not such as would lead one to have a favourable opinion of their stability of

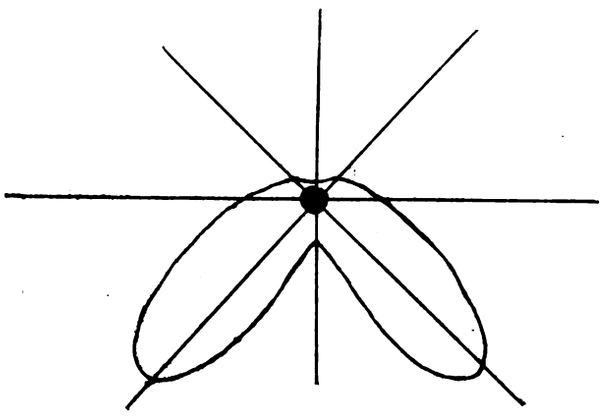

Fig. 6.

construction and reliability in working. At present the series system is chiefly adopted, the lamps taking some 11 to 12 amperes placed across the outers of a three-wire system, or run by a special arc lighter, with substitutional resistances and automatic cut-out placed in the base of the pillar as per Fig. 7. It is also preferable to make the first substitutional resistance act as a series resistance and start same by a two-way switch. This obviates the sudden rush of current at the start, and allows smaller fuses to be safely used, otherwise a fuse is necessary to be made large enough to carry in the case of a series of four 11-ampere arcs across a 220-volt supply, some 44 amperes taking the series resistance as five ohms, which by the introduction of a substitutional resistance in series reduces same to 24 amperes. Five

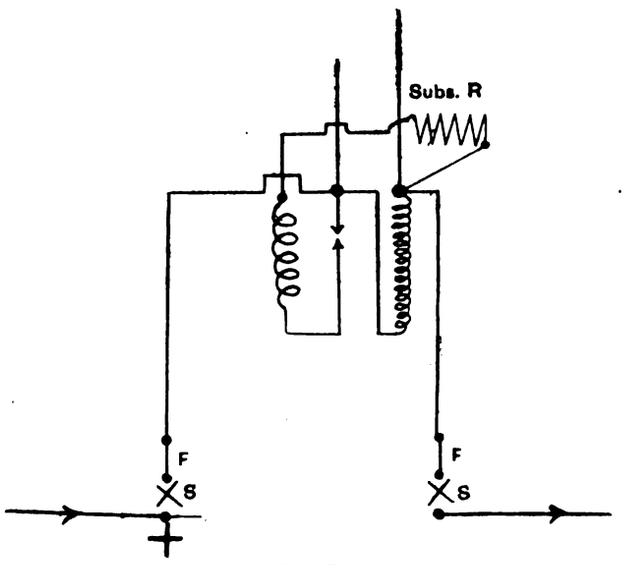

Fig. 7.

11-ampere arcs can be safely run off a 220-volt supply by the temporary introduction of a series resistance.

As with most instruments accidents will occur, I append herewith a list of the most frequent: (1) cable burnt through, due to water chiefly at the bend into arc lamp pillar; (2) shunt coils burnt out, due to earth or lamp sticking; (3) broken circuits in lamp itself; (4) short-circuits in lamp itself; (5) break, due to heat in the series resistance; (6) want of attention in cleaning.

There will no doubt be a considerable advance in the lighting of branch streets by incandescent lamps placed in special fittings with Holophane or similar globes in the present gas lamp columns, and as it is sometimes necessary for question of cost, I give a list herewith showing cubic feet of gas burnt by gas burners of different types: Bray ordinary, five cubic feet; incandescent, 3½ cubic feet. Great care, however, should be exercised, as in some of the gas lanterns it is difficult to adopt incandescent electric lighting in such a manner as to obtain the best results. In comparing the cost of lighting by gas and incandescent electric light, Table II. may be useful:

Table II.

Month.	Average time for lighting up during month.	Average time for extinguishing during month.	Approximate No. of lighting hours per month.	Ordinary street gas lamp burning five cubic feet per hour.	Welsbach, 30 c.p.	16-c.p. incandescent electric lamp.	11-ampere open-type arc lamp.
January...	3.55 p.m.	8.0 a.m.	500	2,500	1,750	31·25	312·5
February.	5.0 ,,	7.15 ,,	400	2,000	1,400	25·0	250
March ...	5.55 ,,	6.10 ,,	380	1,900	1,330	23·75	237·5
April	7.0 ,,	5.0 ,,	300	1,500	1,050	18·75	187·5
May	7.50 ,,	4.0 ,,	250	1,250	875	15·6	156·25
June	8.45 ,,	3.25 ,,	200	1,000	700	12·5	125
July	8.35 ,,	3.40 ,,	220	1,100	770	13·75	137·5
August ...	7.15 ,,	4.55 ,,	300	1,500	1,050	18·75	187·5
September	6.10 ,,	5.50 ,,	350	1,750	1,225	21·87	218·75
October...	5.5 ,,	6.35 ,,	420	2,100	1,470	26·25	262·5
November	4.5 ,,	7.25 ,,	460	2,300	1,610	28·75	287·5
December	3.25 ,,	8.10 ,,	520	2,600	1,820	32·5	325
Totals ...	—	—	4,300	21,500	15,050	268·72	2,687·5

Table III.

Price of B.T.U.	Three watts.	Four watts.
d.	s. d.	s. d.
1	1 0	1 2
2	1 9	2 0
3	2 5	2 9
4	3 2	3 7
5	3 11	4 5
6	4 8	5 3

These are taken on the assumption that a five cubic feet gas burner gives 12 c.p. In conjunction with street-lighting there is another point which occurs to me—viz., that the present universally extending system of tramways, and the tendency of most city and borough surveyors to reduce the obstruction on footpaths, etc., will culminate in the fixing of the street arc lamps on the trolley poles, either by brackets or cradles, the trolley poles being especially constructed to allow of resistances, etc., being fixed inside or upon the pillar, or the adoption of series lighting with all resistance or controlling mechanism at the supply station.

I should just like to draw your attention to a peculiar result due to the effect of frost on some arc lamp finials which came under the author's care. Fig. 8 gives a section drawing of same. It is evident that rain had found its way into the space B, and the result of the freezing of this contained water can be seen on the same figure, the

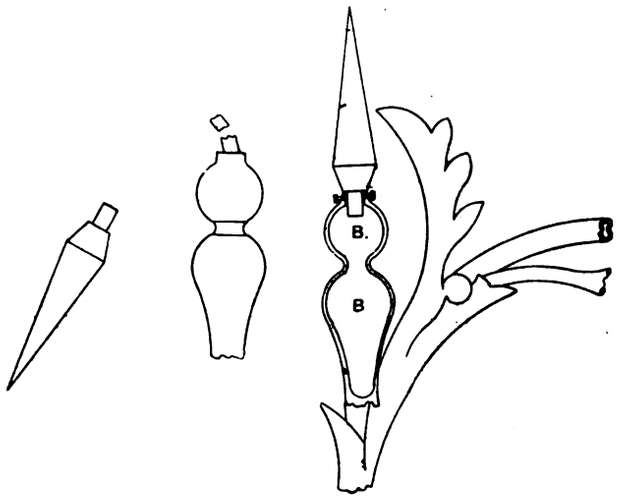

Fig. 8.

author's first attention being drawn to this by a report from the chief constable of an arrest of an arc lamp finial by Constable X, the finial being for the time located at the police station awaiting sentence.

Laying of Mains.

In days gone by your professor used to take a piece of chalk and draw a line along a blackboard, with the quiet remark that this was a distributing main; one's ideas, consequently, of the laying of mains were very pleasant, and particularly simple. To those that have to lay them, dodge water-pipes, gas-pipes, cellars, telephones, drains, catch-pits, gas lamps, trolley poles, etc., that idea of straight lines becomes a thing of the past, as at times considerable skill and ingenuity is requisite for the satisfactory laying of mains.

General Remarks.

Rivals in all undertakings are undoubtedly beneficial to the community or consumers' supply, and in the case of electric supply the

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common question often cropping up is, "How does it compare with gas?" Perhaps a few remarks dealing with this much debatable question will not be out of place. Table IV. is calculated on the basis of a five cubic feet gas burner at different candle-power, and a 16-c.p. incandescent electric lamp at three and four watts per candle.

TABLE IV.

Incandescent Electric Lamps.		Gas Supply. 5 Cubic Feet Gas Burner giving		
3 watts ... 4 watts	.....	10 c.p. ...	12 c.p. ...	14 c.p.
C.P. hours per unit.		C.P. hours per 1,000 cubic feet.		
333 ... 250	.....	2,000 ...	2,400 ...	2,800

The table gives the comparative prices that touch the pocket; prices which do not are all in favour of electric supply. Consequently, taking a 4-watt 16-c.p. incandescent lamp at 4d. per unit with a 12-c.p. 5 cubic feet gas burner at 2s. per 1,000, comes out as follows:

Price of gas per 1,000 cubic feet equivalent to electricity at 4d. per Board of Trade unit

$$= \frac{4d. \times 2,400}{250} = 3s.\ 2d.$$

Another remark, although scarcely coming under the heading of this paper—viz., Why not have your boilers worked 201b. to 251b. to the square inch above the engine pressure specified at the stop valve? Somehow local considerations materially alter the results of a test at the makers' works, and the running in the generating station; irrespective of this, however, this arrangement would allow one to have a little power in reserve, and on occasions when, owing to thunderstorms, fogs, and the like, and the pressure begins to fall, and despite the endeavours of the station staff (only known to those who have been there), volts begin to drop, chief begins to worry, and consumers to expostulate (swear). Such conditions would give, one might term it, an elastic critical limit instead of a fixed one. Another point that may eventually settle the question of system of distribution will be the pressure allowed by the Board of Trade for lighting supply to customers; at present the maximum is 250 volts; perhaps in the future this may be increased to, say, 400 volts, allowing incandescent lamps to be run two in series, or the introduction of the 400-volt lamp.

BOOKS.

I think it advisable that the books relating to the mains department should be kept under one heading, and as space will not permit me go into the detailed analyses of them, the below-mentioned are those in common use: estimate book; mains superintendent's daily report book; balancing book; stores book (inwards); stores book (outwards); stores ledger; public lamp register; meter test books; stock books; meter reading books; house inspector's daily report; meter repair books; Postmaster-General's notices and plans; borough surveyor's notices; foremen's works order books; duplicate plans (gelatine process); consumers' register.

COST OF MAINS.

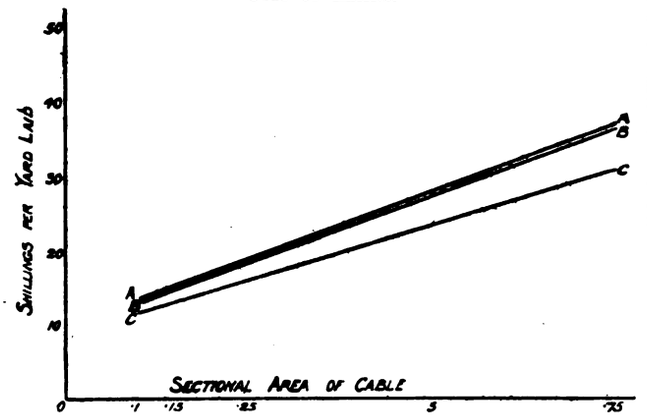

FIG. 9.—A, two cables of sections as shown, laid with three-way Doulton casing; B, two cables of sections as shown, laid solid, or in C.I. pipes, or in two-way Doulton casing; C, armoured concentric cable of sections as shown, laid direct in the ground.

I give herewith a diagram (Fig. 9) that will be sufficient for approximate purposes, cost of cables laid as shown on diagram.

TRADE NOTICES AND NOVELTIES.

United States Metallic Packing.

From the United States Metallic Packing Company, Limited, Soho Works, Thornton-road, Bradford, we have received a copy of a pamphlet recently issued by them, containing copies of letters from firms in all parts of the United Kingdom who are users of their packing. The testimonials thus collected are very numerous, covering some 130 pages, and the evidence which they bear as to the efficiency of the packing in question is sufficiently convincing. Another pamphlet gives a list of the firms to whom the packing has already been supplied, also a long list of ships. We note that the British navy and mercantile marine are large users. The railway companies supplied are separately enumerated, as also the electric lighting and power stations. In all over 130,000 of the packings have been supplied and fitted to all sorts and conditions of engines, we are told. It is claimed that the efficiency of an engine is increased by the application of the packing, often by 10 to 12 per cent.

Motors and Accessories.

We have received from Cryselco, Limited, Kempston Works, Bedford, a copy of their new illustrated price-list of motors and electrical accessories. Continuous-current shunt and series wound motors of the firm's manufacture, ranging in output from ½ b.h.p. to 12 b.h.p., are quoted. Up to 3 h.p., each of these motors, we are told, has a body made in a single casting. The pole-rings are of laminated steel, the bearings being of gunmetal fitted with ring lubricators. The armature core is built up of soft slotted iron plates, insulated from one another with a patent compound involving six operations, but at the same time rendering the losses through hysteresis practically nil, it is claimed. The electrical accessories listed include high-voltage ceiling roses, tumbler switches, wall plugs, lampholders, ball fittings, brackets, counterweight fittings, cut-outs, shades, and "Cryselco" incandescent lamps, etc.

Illuminated Busts.

The Electrical Company, Limited, 122-124, Charing Cross-road, London, W.C., inform us that they have on view at their showrooms, 162, Shaftesbury-avenue, busts of their Majesties the King and Queen and of their Royal Highnesses the Prince and Princess of Wales, illustrations of which are contained in a well-executed pamphlet just issued by the firm. These busts are made in Parian marble, illuminated by lamps placed inside. They are from original models of the well-known sculptor, E. W. Lowton, and are all manufactured in England we are told. The prices quoted include handsome metal stands and holders ready wired. These busts should provide a most effective form of illumination for purposes in connection with the forthcoming Coronation festivities.

"Ark" Lamps for Decorative Effects.

We are informed by Messrs. Johnson and Phillips, Victoria Works, Old Charlton, Kent, that they are prepared to loan out supplies of their "Ark" lamps for purposes in connection with the Coronation. The suitability of these lamps for use in connection with the forthcoming festivities, on account of their high candle-power (2,000 nominal) and also great economic value—namely, about 15 to 1 compared with incandescent lamps—is pointed out. Messrs. Johnson and Phillips are turning out the lamps at the rate of about 100 per week, and keep a large stock for immediate delivery which can be drawn upon. The lamps can be fitted with either pink, green, or ruby globes instead of the ordinary alabaster or clear globes, and by a combination of these different colours an effect closely resembling daylight may be obtained, we are told.

International Company's Bulletins.

The International Electrical Engineering Company, of Clun House, Surrey-street, Strand, W.C., sent us recently a copy of their bulletin No. 4 (26 pages), giving particulars of their continuous-current dynamos, motors, switchboards, starting switches, etc. All the coils of the machine are wound on formers so as to be strictly interchangeable, and they are taped by special machinery. The firm manufactures all its own micanite and other insulation. Great care is taken to have the magnetic value of each pole the same. The last nine pages of the bulletin give dimensions of standard sizes of machines ranging from ½ h.p. to 475 h.p. We have also received from this firm a copy of their No. 5 bulletin. This bulletin contains 14 pages and a dozen illustrations, and it describes the electrical power installation which the Liège works of the firm carried out at the famous Ougree blast furnaces and steelworks. These steelworks rank amongst the finest in Europe, 5,500 hands being employed. The electrical power installation is of unique interest, in that the dynamos are direct coupled to single-cylinder blast-furnace gas-engines of 600 h.p. each. They are said to run perfectly in parallel. Besides the motor equipments for the hoists, conveyors, live rolls, etc., the installation includes 10 overhead travelling cranes, some with four motors, and also electric locomotives for moving the 20-ton steel ladles.

APPOINTMENTS VACANT.

Erector for electric car equipments. Full particulars in our advertisement columns.

Traveller for continuous and alternating current motors. Full particulars in our advertisement columns.

Premium Pupil, Sleaford Urban District Council electricity works. Premium, £50. Full particulars in our advertisement columns.

Switchboard Attendant, in central power station, Gloucester Railway Carriage and Wagon Company, Limited. Full particulars in our advertisement columns.

Power Station Superintendent. Glasgow Corporation Tramways, first-class mechanical engineer to take charge of Pinkston power station, £250 per annum, April 21. Full particulars in our advertisement columns.

Burton.—The Town Council have agreed to ask the sanction of the Board of Trade to a loan of £11,000 for three traction generating sets.

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TO CORRESPONDENTS.

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DEPRECIATION STATISTICS.

There are said to be three kinds of lies, which were classified by an eminent expert as Lies, D—— Lies, and Statistics. In spite of this, the demand for statistics is so great that popular articles on the same are to be found in the monthly magazines, amongst detective stories, and other light literature for relieving the tedium of railway journeys. These popular articles with picturesque illustrations do not as a rule contain the large tables of figures which are so dear to the expert in statistics. That these tables have a limited usefulness we should be the last to deny, but the fact remains that in practically every case they are only of service to the expert, and may even mislead him. The uninitiated are deceived by them, and the deception is often accompanied with a monetary loss. As an example of this, we remember that when the South London Electric Supply Company was first started, and at the time when the boom in electric lighting companies' shares was under weigh, there appeared a critical article in one of the best financial papers in which such tables were used. In these tables there was given the capital outlay per kilowatt installed of all the electric lighting companies in London, and in an adjoining column there appeared the dividends which these companies were able to pay. The list clearly showed that the companies having the lowest capital expenditure per kilowatt installed were paying highest dividends, and for obvious reasons. The South London Electric Supply Company, whose station was then in course of erection, was shown to have a very low capital cost per kilowatt installed, and it was hence deduced that the company must necessarily earn enormous dividends. We believe that the shares of this company in consequence of this article went up to considerably over par, but the people who then acquired shares have since learned that a load for their large plant has to be obtained before a dividend can be earned. There was obviously, however, no error in the statistical article above referred to, only it did not give the whole truth. The same applies to a tabulated statement which has appeared this last week in nearly all the financial papers as to the depreciation which the various electric lighting companies in London are now writing off annually from their capital account. This table is drawn up on the idea that 2½ per cent. per annum on all capital likely to depreciate is reasonable, and this figure is confirmed by our contemporary *Electrical Investments* as being a fair working one. The table then goes on to show that out of ten companies only four are writing off annually 2½ per cent. or more, and that two companies are making absolutely no provision for the depreciation of their plant, although they are distributing dividends. The conclusions from the article are, obviously, that four of the electric lighting companies are working on sound financial lines, another four are endeavouring to do so as far as their more limited profits seem to allow, and that the other two are not making the provision they should do for the future. These conclusions are not incorrect in themselves, but they fall into the error, which is to be found in practically all statistics, of assuming that 2½ per cent. depreciation is equally applicable to the plants owned by all these companies. Every electrical engineer knows that this is not the case, and, unfortunately, those companies which are providing no depreciation fund, or at the best a small one, are the very ones for which a 2½ per cent. depreciation is quite inadequate. They have plant now in certain of their stations which the engineers would at once throw on to the scrap heap if only money could be raised to replace it, and the retention of which means increased annual expenditure over what would be the cost if modern plant were installed. Even in certain

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cases we believe that plant which still stands on the books of the companies at its original value has actually been thrown away. These facts are not noted in the table of statistics, and if the table is accepted, the defaulting companies have only to write off 2½ per cent. per annum in order for the public to assume that they have entered upon a sound financial career. We had to complain of the same system of averaging when commenting upon the resolution as to depreciation which was passed by the recent special meeting of the Municipal Electrical Association. This resolution, which was carried almost unanimously by a large meeting of municipal electrical engineers and of chairmen of electric lighting committees, definitely stated that the annual repayment on loans made ample provision for depreciation, and rendered any further depreciation fund unnecessary. This is generally true, although it has repeatedly been denied by the contemporary referred to above, but it may not be true individually, and its consequence will be that a few municipal electric light stations equipped with obsolete and inefficient plant will suddenly find themselves in a bad way in future years through adopting the general advice of the Municipal Electrical Association. In conclusion, let us compare the varying judgments of that financial expert, *Electrical Investments*, on the great question of depreciation, as the value of its views may well be compared to that of a table of statistics. As regards the depreciation of electric lighting companies, it states that "about 3 per cent. may be considered an ample allowance . . . . 2½ per cent. is a fair working figure." These two figures correspond to a life of from thirty-three to forty years for the plant, or to a period, on the average, longer than that for which the municipal loans are granted. Yet readers of our contemporary have been frequently warned against the unsound financial policy of our municipalities in not allowing for depreciation in their electric lighting accounts. The conclusion, obviously, is that municipalities are forced by their system of finance to provide annually in their repayments of loans an amount for depreciation which is considered ample for electric lighting companies.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ESTIMATING.

SIR,—After undergoing a lengthy period of technical training in "electrical engineering," I am now setting up in business in a small way, and should feel obliged if any of your readers could advise me on the following points:

(*a*) Is there any book published on electrical engineering estimates, and, if so, who are the publishers?

(*b*) What proportion does the upkeep of a small electric light installation bear to first cost (1) private installation, (2) deriving current from a central station?

(*c*) What is the average cost per unit on a small electric light installation (about 50 lights), the motive power being, say, a gas-engine?

(*d*) What is the average *cost* for time only per point—(1) daywork; (2) piecework—for the different methods of wiring?

(*e*) What proportion do the various methods of wiring bear to one another: (1) as regards first cost; (2) as regards repairs?

(*f*) What percentage profit is usually charged on the man's time in repair accounts in this trade?—Yours, etc.,

A BEGINNER.

[We are pleased to insert the above, but are afraid that on many of the points raised "A Beginner" will have to acquire knowledge at his own cost. After all this is best, as average figures of cost may be very misleading in special cases.—ED. *E. E.*]

FORTHCOMING EVENTS.

FRIDAY, APRIL 11.

Royal Institution.—At 9 p.m., Prof. Dewar on "Problems of the Atmosphere."

Electro-Harmonic Society.—At 8 p.m., St. James's Restaurant, final smoking concert of season.

Physical Society.—At 5 p.m., ordinary meeting. Papers: "An Apparatus for Vapour-Pressure Measurements," by Mr. Grant; "The Use of Cathode Rays for Alternating-Current Measurements," by Mr. Morris; "An Experiment on the Current Growth in an Inductive Circuit," by Mr. Morris; "An Electric Heater," by Dr. R. A. Lehfeldt; and "Note on the Compound Pendulum," by Mr. S. A. F. White.

TUESDAY, APRIL 15.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., ordinary meeting. Paper: "The Treatment and Use of Air-Core Cables," by Mr. G. E. Fletcher.

Royal Institution.—At 3 p.m., Prof. Dewar on "The Oxygen Group of Elements" (Lecture II.).

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Papers to be further discussed: "The Greenwich Footway Tunnel," by Mr. W. C. Copperthwaite; and "Subaqueous Tunnelling through the Thames Gravel: Baker-street and Waterloo Railway," by Mr. Arthur H. Haigh. Paper to be read: "On Locomotive Fire-Box Stays," by Mr. F. W. Webb.

WEDNESDAY, APRIL 16.

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "Photography as applied to Architectural Measurement and Surveying," by Mr. J. Bridges Lee.

Royal Meteorological Society.—At 7.30 p.m., Captain D. Wilson-Barker on "Clouds."

THURSDAY, APRIL 17.

Institution of Electrical Engineers (Dublin Section).—At 8 p.m., ordinary meeting. Paper: "Railway Blocks, Telegraphs and Accessories—Recent Practice," by Mr. A. T. Kinsey.

Institution of Mechanical Engineers.—Anniversary dinner at the Hotel Cecil.

FRIDAY, APRIL 18.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. Paper: "The Standardisation of Pipe Flanges and Flange Fittings," by Mr. Robert E. Atkinson.

Royal Institution.—At 9 p.m., the Right Hon. Sir John H. A. Macdonald, K.C.B., on "The Autocar."

North-East Coast Institution of Engineers.—General meeting at Sunderland.

SATURDAY, APRIL 19.

National Association of Electrical Contractors (Northern Section).—At 3 p.m., meeting at Exchange Station Hotel, Liverpool.

THE DISTRIBUTION OF MAGNETIC FLUX IN LARGE ELECTROMAGNETS.*

BY W. M. THORNTON, M.SC. (MEMBER).

§ 1. INTRODUCTION.

For the purposes of magnetic measurement electromagnets may be divided into two classes, those of which the time-constant is large compared with the period of an ordinary ballistic galvanometer, and those of which it is relatively so small that it may be neglected when testing by the ballistic galvanometer method. I shall define as large magnets those of the first class to which ballistic methods are inapplicable. The most difficult problem in the design of large electromagnetic machinery is the predetermination of the appropriate magnetising force to be applied. For the ideal case of a magnetic circuit of known reluctance and with no magnetic leakage, the magnetomotive force required is the product of the flux and reluctance. In all electromagnets, however, more lines pass through the primary circuit inducing the magnetism than through the secondary, considering the armatures of machines as rotating secondaries as compared with the fixed coils of static transformers. For any given type of circuit the ratio of primary to secondary flux—the "leakage coefficient"—is practically the same for all large sizes, and if determined for one machine after construction is known for the type. The performance of large machines or transformers under load is, in general, the only test which has hitherto been applied to the correctness of the design. An exact agreement—that is, within ½ per cent.—between the calculated and observed voltages is rare, and may almost be considered accidental for a first test on a new type. Any divergence from the required value is compensated by the removal or addition of turns on the windings, or, if the disagreement is not too great, and there is ample driving power, by suitable adjustment of the shunt rheostat in the case of shunt or compound wound machines. It has not been possible to locate the part of the magnetic circuit which is responsible for discrepancies in performance. The use of the bismuth spiral—based on Lenard's research on the change of resistance of bismuth when placed in a magnetic field—is coming into more general works practice. By it the flux in the air-gap and its distribution is determined with considerable accuracy; but beyond being a check on the

* Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, March 24.

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correctness of the armature winding, and affording some insight into the magnitude of armature reaction, it does not help to solve the problem. It is hoped that the method to be described will prove of use to makers of large machines, and in research upon large electromagnets, by giving precise knowledge of the flux at any desired point of the circuit and of its variation with magnetising current or with time. By its means the range of experimental research on magnetic flux is extended from the point where the ballistic galvanometer ceases to be of use to the largest electromagnets, and the larger the solid core the greater the accuracy attainable, by reason of the eddy current induced in it at "make" or "short circuit" being then more powerful and prolonged.

Working with the ballistic method the time of discharge is made as short as possible, some form of spring-break switch being used for this purpose. With large electromagnets, however, a sudden interruption of the current would probably cause the insulation of the windings to be pierced. It is thus necessary to prolong the rate of change of the magnetism as much as possible. One must also have had some experience with galvanometers before ballistic readings can be relied on to

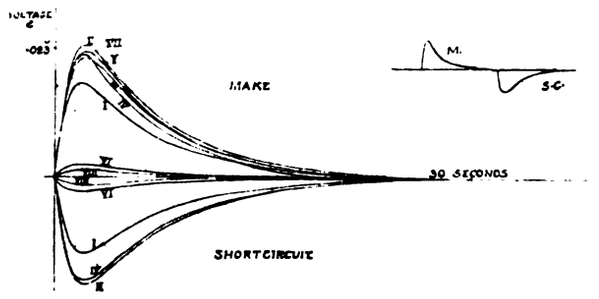

PLATE I

½ per cent., and it is not to be expected that ordinary test-room assistants should be skilled to this extent. It has been one object of the work to make the method independent of direct personal observation, beyond the adjustment of resistances, so that the records which were taken photographically should all be within the width of film used; to do, in short, for magnetic observations what the indicator diagram does for engine testing.

After the calibration of the elastic control, which is necessary in both cases, the measurement of flux is similar to that of work by the p.v. diagram, in that it only involves the measurement of an area. The essential part of the method consists in observing a prolonged induced voltage in a secondary exploring coil when the current in a primary is made or short-circuited. The main difference between this and the ballistic method is that it is essential in the latter that the time of discharge should be as short as possible; in the former, as long as possible.

In what follows a general description is first given in § 2 of the method with details of the tests on a 50-kw. "Castle" dynamo with 16in. diameter magnet cores. The maximum leakage coefficient, λ, is found and shown to vary with the load, decreasing as the load increases. Tables are given of the relative and absolute flux through several sections of the magnetic circuit. The effect of hunting in the

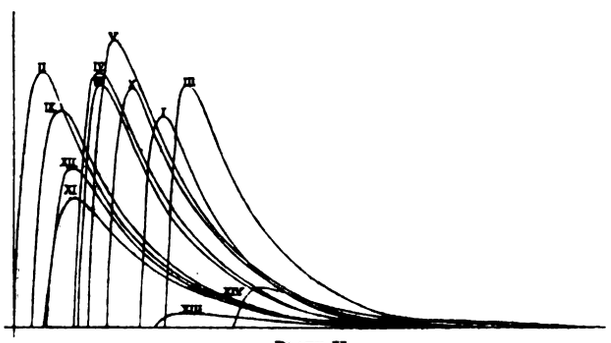

PLATE II

engine and of irregular turning moment is observed by variations of the magnetisation of the machine. § 3 contains an analysis of the curves, and a comparison with theory. The initial rate of change of permeability at "make" and "short-circuit" is found, and its effect on the shape of the curves discussed. The initial throw is shown to be independent of the material of the core. In the appendix to § 3 the reliability of the galvanometer as a recorder is examined, and curves obtained from which correcting factors may be calculated for a too heavily damped galvanometer. The amount of magnetic shunting to make the motion dead-beat is also discussed, and a new method of suspending moving coils to obtain the same effect. The appropriate size of copper former is given for a particular set of suspensions. A powerful recording ammeter, specially designed for this class of work, is described in § 4. An appendix contains a description of experiments with a chronograph, and with a Duddell oscillograph. In § 5 tests on a Brown-Boveri 500-kw. generator, a Silvertown 125-kw., and a Parker 125-kw. generator are given, and the leakages at several parts of their circuits at no load examined. In § 6 a new method of determining the permeability of large iron cores is given, with experiments on three machines. An extension describes tests on transformers by the same method. An investigation of the change of permeability with time shows slipping of the molecules at saturation, as indicated by Ewing's theory of magnetism, but not hitherto observed. § 7 contains an application of Heaviside's formulæ for the decay of induction in cores to the Holmes machine, and a satisfactory agreement is found. The modification introduced by elliptical and rectangular cores is indicated. In § 8 the surface leakage formulæ generally used are experimentally examined for the case of the Holmes machine. Plates of curves reproduced from photographs accompany the paper.

§ 2. Description of Method.

Consider, first, the arrangement of the primary circuit, which in general must be such that the fields are separately excited, in order that they may be dealt with independently of the armature or secondary circuit. Since it was frequently necessary in the course of the experiments to excite and destroy the magnetism many times in succession, the connections were so arranged that the coil current, instead of being broken, was short-circuited. Even when the circuit is broken across a non-inductive resistance, there is always a considerable arc if the exciting voltage is 100 or upwards, and short-circuiting has the advantage of not damaging the switch contacts. If the permeability of the cores were constant, the rate of change of flux at any instant would be the same at short-circuit as at make, the curve of coil current being merely inverted. Using a three-way switch with a non-inductive resistance across the break whose value is that of the

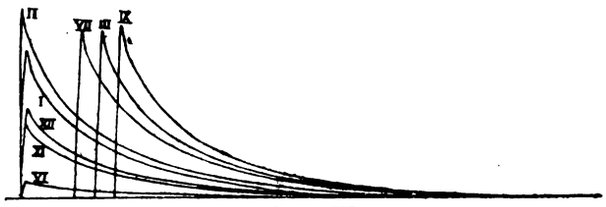

PLATE III.

coil resistance or less, there is no spark if the throw over is made by a spring release.

Fig. 1 shows the actual arrangement. The centre arm, a, is first placed in contact with b, when the coil current passes, practically none going by the non-inductive resistance. When the steady state has been reached the arm is thrown over to c, and if the break is slow there is an arc from b following it. With a spring release the action is so rapid that the current passes by the non-inductive resistance (and the smaller this is the better, the lower limit being that which gives the safe maximum current for the battery or leads), no spark appearing at b. This is, in the writer's opinion, the only safe way of destroying the magnetism in very large electromagnets. On making the contact, a c, the coil current will decay according to an approximately logarithmic law as the energy of the field is dissipated as heat in the core and coil, the current being maintained by a voltage due and proportional to the rate of change of the flux as it is dissipated. In the establishment of a uniform magnetisation in a large solid core, eddy currents are produced coaxial with the core, which retard the action for many seconds—in some cases minutes. Heaviside has fully discussed the process for circular cores of constant permeability, and his

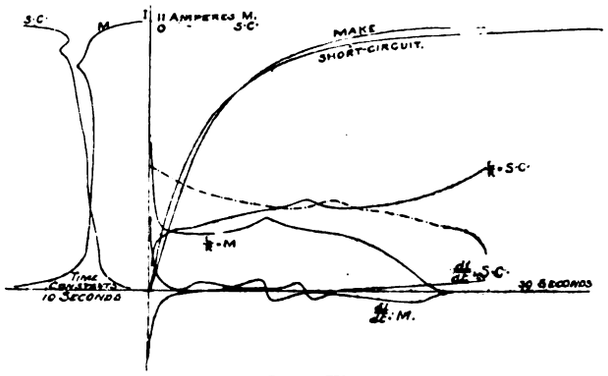

PLATE IV.

analysis thus includes the action at short-circuit ("Electrical Papers," vol. I., p. 353). It is necessary, however, to have recourse to experiment to find the influence of variable permeability on the rate of change of flux at any instant.

To observe variations of magnetisation the most convenient way is to note the voltage induced in an exploring coil wound to surround the core. It is not, of course, possible to observe the voltage induced in the magnet coils themselves, but a dead-beat ammeter in the circuit will give readings proportional to the induced voltage if the resistance remains constant.

Let e be the voltage generated in each turn of the windings as the lines shrink into the core. Then

$$e = 10^{-8}\, d\,N/dt,$$

N being the total flux. Thus

$$N = 10^{-8} \int e\, dt,$$

or,

$$N = 10^{8}\, \bar{e}\, T \quad \ldots\ldots\ldots \quad (1)$$

$\bar{e}$ being the average voltage during the total time, T seconds, of decay. The measurement of a flux is thus that of a voltage and of a time. When an ammeter is used,

$$N = 10^{8}\, r\, \bar{i}\, T/s,$$

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TABLE I.

Curve.	Position.	Plate I. Area, sq. in.	Plate I. λ	Plate II. Area, sq. in.	Plate II. λ	Plate III. Area, sq. in.	Plate III. λ	Plate IV. (A). Area, sq. in.	Plate IV. (A). λ	Plate XI. Area, sq. in.	Plate XI. λ	Plate XII. Area, sq. in.	Plate XII. λ	Plate IV. (B). Area, sq. in.	Plate IV. (B). λ
I.	Armature	9·2	1	19·2	1	7·4	1	5·7	1	—	Full load	7·85	1	5·31	1
II.	L.H. bobbin	13·58	1·47	29·07	1·51	10·2	1·38	4·0	1·4	—	Half load	10·05	1·28	7·45	1·4
III.	Yoke	12·17	1·32	23·76	1·24	8·3	1·12	—	—	L.H. B.(A)		7·2	1	6·78	1·27
IV.	Top L.H.B.	13·5	1·47	27·8	1·44	—	—	—	—			9·75	1·35	—	—
V.	Bottom L.H.B.	12·8	1·39	32·68	1·38	—	—	—	—	—	—	—	—	—	—
VI.	Surface L.H.P.	1·16	·126	—	—	·81	·109	—	—	12·8	(·109)	—	—	—	—
VII.	C.R.H. Bobbin	12·5	1·35	25·35	1·34	8·68	1·172	—	—	—	—	—	—	—	—
VIII.	Quarter-surface L.H.B.	·65	·07	—	—	—	—	—	—	5·34	·045	—	—	—	—
IX.	Bottom R.H.B.	—	—	24·9	1·3	8·6	1·16	—	—	—	—	—	—	—	—
X.	Top R.H. core	—	—	24·3	1·26	—	—	—	—	—	—	—	—	—	—
XI.	R.H. pole on centre line	—	—	15·58	·662	3·7	·495	—	—	—	—	—	—	—	—
XII.	L.H. pole on centre line	—	—	17·65	·75	4·62	·62	—	—	—	—	—	—	—	—
XIII.	Bottom R.H.P.	—	—	1·72	·089	—	—	—	—	—	—	—	—	—	—
XIV.	Bottom L.H.P.	—	—	4·33	·101	—	—	—	—	6·05	·051	—	—	—	—
XV.	Half-surface yoke	—	—	—	—	—	—	—	—	3·675	·031	—	—	—	—
XVI.	Pole-face L.H.	—	—	—	—	—	—	5·2	·91	—	—	—	—	—	—
XVII.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

s being the turns on the winding. In every turn of an exploring coil surrounding the core the relation (1) also holds, and by observing e from start to finish, N, the total flux, can be obtained at any cross-section, and the distribution of magnetism round the circuit in this way examined. It is evident that the accuracy of the result will depend upon that of measuring the voltage, e, and the greater part of the time spent in developing the method has been given to the design and construction of apparatus for this purpose. Great difficulty was experienced in finding a recording instrument sufficiently accurate and dead-beat. Photographic records were first obtained using a Ewing's curve-tracer, but the mirror was too liable to stick, and no results of more than rough comparative value were obtained. A Hartmann-Braun Kohlrausch ammeter was then tried, but was not sufficiently free from friction or dead-beat. It might, however, be made a very serviceable instrument for this class of work. After the usual failures a galvanometer was obtained which proved satisfactory, and with this, after the preliminary trials had been made with a specially-designed ammeter, most of the experiments were conducted.

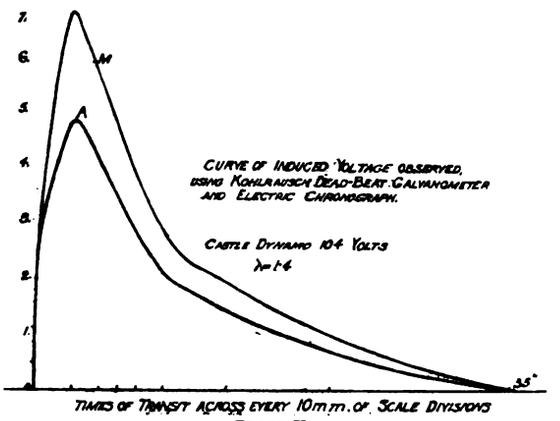

PLATE V.

The instrument, together with the recording arrangement, is by Pitkin, and is of the Holden-D'Arsonval pattern. Its resistance is 144·3 ohms, and the coil consists of 100 turns wound upon a copper former. The suspension strips are of phosphor bronze, soldered to the coil wire and clamped by screws top and bottom, the top end having a screw adjustment for increasing the tension in the strips, and the lower attached to a movable head by means of which the zero may be changed. The mirror receives a narrow beam of light projected by a right-angled prism from an arc lamp placed at the side of the case. The reflected beam is thrown half through a long slot provided with a shutter, or to a recording drum carried in a separate box, which can be removed and the photographic paper renewed without disturbing the rest of the apparatus. The other half is projected upwards by a long narrow mirror on to a scale in the top of the case, so that the motion of the spot can be observed at the same time that it is being photographed. It is necessary to use arc light to get a record of the very rapid changes during the initial rush of current. The paper used was 20in. by 16in. Barnet extra rapid bromide, the sheets being cut to 10in. by 16in. The records were about 8in. wide in most cases. The drum was arranged so that it could be wound, stopped, and started without light entering the case.

In carrying out the experiments the 50-kw. "Castle" continuous-current dynamo used for lighting the college was separately excited from a set of 52 storage cells. An exploring coil was wound round the core and connected to the galvanometer, or to the ammeter, which is then practically a milli-voltmeter taking a large current. Any induced current flowing round the core helps to prolong the decay of the magnetisation, thus the extra 50 ampere-turns added to the coil when the ammeter is used is an advantage. On account of the smallness of the diagrams and because some uncertainty was introduced when the instrument was not compounded, the ammeter was only used until the galvanometer had been made perfectly dead-beat and both instruments gave the same values for the magnetisation; and though all the curves in the plates were obtained by using the galvanometer, the ammeter is described because in the future it will probably prove the more useful all-round instrument for this work. When the galvanometer was used, one turn of 18 S.W.G. copper wire was sufficient, this being connected through a standard resistance box of 1,100 ohms maximum.

On making the circuit, allowing the steady state to be reached, then short-circuiting, the curves given in Plate I. were obtained. These have been drawn from the photographs, so that their zeros correspond. A section of the machine is given in Plate —, and the numbers show the positions of the exploring coils corresponding to the curves in Plates I., II., III., IV., XI., XII. It was at once noticed that the curves were more rounded than by theory one would expect, and the analysis of § 3 led to the conversion of the galvanometer suspensions from unifilar to a partial bifilar. The relative influence of the damping was thus greatly reduced, and the records of Plates III., IV., and XII. are believed to be as perfect as can be obtained from a moving-coil instrument. The closeness of the relation between the actual and recorded values may be seen from Plate VII., Curves d and e, where

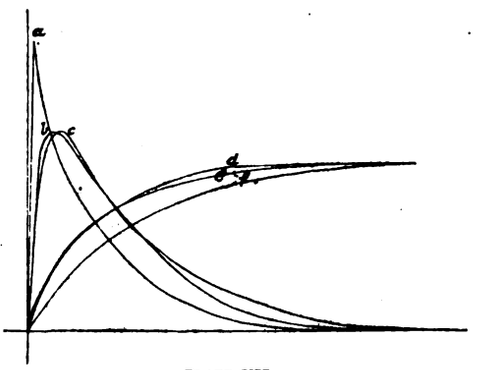

PLATE VII.

d is the theoretical exponential curve of rise with constant permeability, and e the record of the actual current as observed with the galvanometer shunted. Since at low magnetisations the current should be greater and at high values less than that with the permeability constant, it will be seen that the galvanometer record must fit very closely the true changes of current.

Repeating the more important curves with the converted galvanometer, those of Plates III. and IV. were obtained. Several months separate these records, and no attempt was made to adjust the galvanometer tensions to the same degree in both cases.

The primary object of the work being to find the leakage coefficient of the machine—that is, between the windings and armature—Table I. was prepared, which gives the comparative values of λ not only for the windings, but other important sections of the circuit. To check the relative values of the curves taken before the change to bifilar suspension was made, readings were obtained by winding the exploring coil round the armature and varying the galvanometer resistance for each throw. The total resistances in the exploring coil circuit being respectively 444·3, 544·3, 644·3 ohms, the areas should be in the ratio 1 : 1·25 : 1·45. They are 1 : 1·2 : 1·42, which may be taken as proportional for general comparison.

The cause of the high coefficients of leakage found with the unifilar system is that the damping being then excessive relative to the strength of the elastic control, the coil was delayed in returning to rest and the areas accordingly increased, the curves of greatest amplitude being most affected. This can be seen in Plate VII., where the three curves, a, b, c, are respectively the theoretical impressed voltage, the calculated record allowing for damping and an actual record of the same amplitude. The theory of the first two is discussed in the appendix to § 3, and the excess of the area of c over that of a is evident. All the records with the bifilar galvanometer were given small amplitudes, both to avoid the influence of damping and to keep the deflection within the range over which, in bifilar instruments, it is

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proportional to the current. That it is practically so in this instrument, the suspensions of which are three in number, may be seen from the following record of deflections obtained by applying a steady voltage of ·11 to the galvanometer circuit and varying the resistance. The spot of light was so broad that the third place is uncertain.

TABLE II.

Resistance coil in box.	Total resistance.	Deflection.	Deflection per ·001 volt on galvanometer.
300	444·3	17·48	4·9
400	544·3	14·33	4·9
500	644·3	12·18	4·93
600	744·3	10·53	4·95
700	844·3	9·33	4·97
800	944·3	8·33	4·97
900	1044·3	7·58	4·98
1,000	1144·3	6·85	4·95
1,100	1244·3	6·28	4·93

From Table I. it is seen that the no-load leakage coefficient is 1·4 for this bipolar smooth-core slow-speed generator, and compared with the values given in Fisher-Hinnen and Wiener it is rather high. It is not, however, the leakage coefficient at no load which is important, but that under the normal working conditions. To find this, it is necessary to wind an exploring coil round the armature which does not foul it when the machine is running. (In the case of revolving magnet types a special pair of slip rings must be temporarily attached to the shaft to carry the exploring coil connections to the galvanometer.) It is now impossible to obtain the curves at make, but by short-circuiting the field the magnetism dies slowly out of the circuit, and the records can be taken as before. The machine is in a state of considerable mechanical vibration, and strong residual magnetism is rapidly shaken out. There is no sudden change at short-circuit either in the field or armature current, less shock, in fact, than by breaking the armature circuit with any load on when there are compounding turns. With self-exciting machines the same process may be adopted, provided a fuse is placed in the connection to the armature. For high-voltage machines a magnetic blow-out should be employed, but for 100 or 240 volts soft fuse wire goes at the short-circuit before the brushes show any sign of sparking. In finding the leakage coefficient under load for small machines, the connections should be so arranged that the field and armature circuits are broken simultaneously. With large machines as above, the armature current is left to die out with the field. In a compound machine at full load the magnetic action is due to the shunt and series windings and the cross and demagnetising effect of the armature current. The resultant magnetomotive force directly

PLATE IX.

applied to the circuit can be found knowing the lead of the brushes, and the cross magnetisation by exploring the commutator by the twin pilot brush method.

Experiment on the Castle dynamo shows a decrease in the value of λ with increase of load. From Plate XII. it is seen that the ratios of the flux at the centre of the left-hand bobbin to that through the armature are thus:

TABLE III.

	λ.
No load	1·4
Half-load	1·35
Full load	1·28

The probable explanation is that, as seen from Curves XI. and XII. and from VII. and X., Plate II., the flux in the right-hand limb is much more irregularly distributed at no load than in the left. The reason for this is that there are 1,637 shunt turns on the left and 757 on the right. At full load the compounding turns add an equivalent 585 turns to the right-hand winding. The leakage is clearly greater from the right than from the left at no load, and the proportion of the total flux passing through the centre line section of the poles is less on the right-hand side than the left. The action of the compounding turns is to straighten the lines, as a long orifice directs water flow better than a short, and the distorting effect of the armature current is also in the direction of strengthening the lower half of the right-hand pole. Thus there is less leakage above the top of the armature between the bobbins or pole tips; and since that from the sides of the poles passes in great part through the prolonged armature conductors where they are attached to the spirals, which are active in generating voltage, there will be less waste field.

The actual performance of the machine is as follows: The voltage at no load and 494 revolutions per minute is 103·1, and since there are 90 conductors on the armature, the flux is then $13·95 \times 10^6$ lines through the core and end connections. At full load the brush voltage is 100, and the drop in the armature is 6·5 volts, the speed being 462. Thus the flux has risen to $15·3 \times 10^6$ lines, in a ratio of 1·097. The windings cold have a resistance of 9·7 ohms, and 10·5 hot. The ratio of the total ampere-turns at full load to those at no load is, adding 5,000 ampere-turns for the series coils, less 1,750 for armature reaction, 26,050/25,700 = 1·014. The increase of flux corresponding to this is found from the curve of magnetisation to be ·008. Thus the leakage coefficient is reduced in the ratio $\frac{1·008}{1·097} \times 1·4$—*i.e.*, 1·285—which agrees with the ratio of the areas. It will be noted that the decrease of λ is proportional to the increase of load—that is, to the current in the compounding turns. It is not suggested that there is in all machines a fall of the leakage coefficient with load, but in the compound bipolar type with series turns immediately above the pole to which the top of the armature is running, there will probably always be an action of this kind.

So far the results have been only comparative, they may be made absolute by calibrating the galvanometer and the speed of the recording drum. The latter need not be known accurately for every curve, if the time of rise is taken once for all for any particular machine. The mean of many experiments on the Holmes dynamo gives 33 seconds as the time for the full magnetisation to be reached when the circuit is excited from storage cells at 104 volts. The galvanometer was calibrated by placing in series with the windings of the machine a Crompton standard ·01 ohm resistance and connecting the galvanometer across it. The current was observed by a portable type Weston ammeter calibrated by the potentiometer. The voltage per centimetre deflection is thus known. The size of the curves can be readily controlled by a resistance box in the galvanometer circuit. The readings should be calibrated for every set of curves, the mechanical shock of carriage changing slightly the tensions of the suspensions. It is, however advisable in tests on completed machines to check the areas by finding the armature flux with the machine running on open circuit.

TABLE IV.—Flux Corresponding to the Curves of Table I. in Millions of Lines.

Curve.	I.	II.	III.	IV.A	XI.	XII.	IV.B
1	14	14	14	14	14	15·3	14
2	20·6	21·11	19·6	19·6	—	19·6	19·6
3	18·5	17·7	15·7	—	—	14·65	—
4	20·6	20·2	—	—	—	19·8	—
5	19·48	19·3	—	—	—	—	—
6	1·762	—	1·527	—	—	—	—
7	19	18·75	16·42	—	—	—	—
8	·98	—	—	—	1·527	—	—
9	—	18·2	16·25	—	—	—	—
10	—	17·63	—	—	·631	—	—
11	—	9·26	6·94	—	—	—	—
12	—	10·5	8·69	—	—	—	—
13	—	1·245	—	—	—	—	—
14	—	1·415	—	—	·701	—	—
15	—	—	—	—	·425	—	—
16	—	—	—	12·71	—	—	—

Table IV. gives the results of Table I. in terms of flux, the armature flux being taken as 14×10^{-6} lines. Plates I. and II. were taken with

PLATE XII.

the unifilar galvanometer, the resistance in series for all the curves of Plate I. being 120 ohms. In Plate II. Curves II. and III. had 300 ohms in circuit; I. and IV. to XI., 400 ohms; and XII., 100 ohms, the exciting voltage being 104. In Plate III. there was a constant resistance of 500 ohms in circuit for set (*a*) and 200 ohms for set (*b*). In Plate IV., 690 ohms.

At the close of a set of experiments the exploring coil was left connected to the recorder when the machine was at work lighting the building. It was noticed that the spot of light was in a constant state of oscillation, and that this was not mechanical vibration was shown by the effect ceasing when the galvanometer was disconnected. One concludes, therefore, that the magnetism of the machine is in a constant state of change within small limits (see *a*, Plate XVII.). On photographing the motion it was found that, in addition to the simple oscillation, there was a slower swing shown by drawing a mean line through the ripples at *b* and *c*, the time scale of the latter curve being one-sixth of *a*. The ripples are caused by the variation of speed of the Robey engine flywheel and armature during one stroke, the former working with a single cylinder at present, the speed being 74 revolutions per minute. The considerable fluctuations of Curve *a* were caused by one of the valve trips being lifted so that the engine missed a portion of the stroke. The slow swing shows the hunting of the governor, and in Curve *c* the combined period of the engine and of the flywheel and armature can be observed.

§ 3. THEORY AND ANALYSIS OF CURVES.

The induced voltage in one turn of the exploring coil is $10^{-8}\, dN/dt$, N being the total flux through the core, and

$$N = \frac{4\pi}{10} \cdot \frac{iS}{R},$$

where S is the number of turns on the shunt winding, i the current in them, and R the reluctance of the magnetic circuit—*i.e.*, $\Sigma\left(\frac{l}{A\mu}\right)$.

Thus
$$e = 4\pi S \frac{d}{dt} \cdot \left(\frac{i}{R}\right) \cdot 10^{-8} \text{ volts} \quad . \quad . \quad . \quad . \quad (2)$$

This equation can be best expressed in terms of the inductance L henries, for

$$N = \frac{L\,i}{10\,S}, \text{ and } \frac{dN}{dt} = \frac{1}{10\,S} \cdot \frac{d}{dt}(L\,i).$$

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Therefore $$e = \frac{1}{10\,S}\left(L\frac{di}{dt} + i\frac{dL}{dt}\right) \text{ volts} \quad . \quad . \quad . \quad . \quad (3)$$

The equation of rise of current in the magnetising circuit under constant voltage, E, is

$$L\frac{di}{dt} + r\,i = E,$$

and here L is not constant, but varies with the time in a manner which can be determined by experiment.

Writing $(E - r\,i) = L\frac{di}{dt}$, and substituting in (3),

$$e = \frac{1}{10\,S}\left(E - r\,i + i\frac{dL}{dt}\right),$$

or, $$e = \frac{E}{10\,S} + \frac{i}{10\,S}\left(\frac{dL}{dt} - r\right) \quad . \quad . \quad . \quad . \quad . \quad (4)$$

All the quantities are known but $\frac{dL}{dt}$, and this may readily be found from the actual recorded curve of rise of the current at make or of its fall at short-circuit. Let P (Fig. 3) denote any point on the curve of rise, PM the value of the current at time OM, and OQ the maximum current. If QR be drawn parallel to the tangent at P, and RP parallel to OX, the length RS will represent the time constant of the circuit corresponding to the current and time (Sumpner, *Phil. Mag.*, June, 1888). Since the resistance of the circuit is constant, RS is a measure of the inductance, L. Transferring the curve to the time axis—*i.e.*, marking lengths, as MK equal to RS—the rate of change of inductance with time is found by graphical differentiation. Values of $\frac{di}{dt}$ so found are drawn below OX, and may be used in the calculation of e by equation (4). At the instant of make i is zero. Thus $e_0 = \frac{E}{10\,S}$, and the initial throw of the galvanometer is independent of the iron part of the circuit, depending only on the exciting voltage, since S is constant. The rise of induced voltage, however, is not necessarily instantaneous, for

$$\frac{de}{dt} = \frac{1}{10\,S}\cdot\frac{d}{dt}\left\{i\left(\frac{dL}{dt} - r\right)\right\};$$

or, $$10\,S\frac{de}{dt} = i\cdot\frac{d}{dt}\left(\frac{dL}{dt} - r\right) + \left(\frac{dL}{dt} - r\right)\frac{di}{dt} \quad . \quad . \quad (5)$$

Thus the rate of change when i is zero is

$$= \frac{1}{10\,S}\cdot\left(\frac{dL}{dt} - r\right)\cdot\frac{di}{dt} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

and since $\frac{di}{dt}$ has a finite value the curve will be inclined to the vertical axis (see Plates I. and II.). The magnet current does not rise according to an exponential law, the changes in permeability of the core at low and high magnetisations distorting the curve. The first change is, however, so rapid that the exponential curve is approximated to in less than the tenth of a second, and beyond this, until approaching saturation, the circuit behaves as if the permeability were practically constant. Neglecting the first slight change and taking

$$i = i_0\left(1 - \epsilon^{-\frac{rt}{L}}\right)$$

$$\frac{di}{dt} = -\frac{E}{L}\,e^{-\frac{rt}{L}};\ \text{and at zero}\ \frac{di}{dt} = \frac{E}{L}.$$

Thus from (6) $$\frac{de}{dt} = -\left(\frac{dL}{dt} - r\right)\frac{E}{S\,L}\cdot 10^{-1} \quad . \quad . \quad . \quad . \quad . \quad (7)$$

and since the exponential rise implies constant permeability

$$\frac{de}{dt} = +\frac{r\,E}{S\,L}10^{-1} \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Instead of proceeding further and finding the tangent corresponding to the value of $\frac{di}{dt}$ as obtained from the curve of make, it is better to take the value of $\frac{de}{dt}$ from one of the curves, and thus find the true $\frac{dL}{dt}$ at zero.

From (6) $$\frac{dL}{dt} = 10\,S\cdot\frac{\frac{de}{dt}}{\frac{di}{dt}} + r \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

From Curve M, Plate V., $\frac{de}{dt}$, reduced to the scale of 1cm. per volt and second, gives ·0086 as the tangent, and $r = 9{\cdot}7$ ohms, $\frac{di}{dt} = {\cdot}48$. Thus $\frac{dL_0}{dt} = 998$ henries per second, and since for this particular machine $L = {\cdot}4\ \mu$, the initial change of permeability, $\frac{d\mu}{dt} = 2{,}495$.

It was thought that the inertia of the moving coil might distort the records, as indicated by the analysis of the galvanometer damping given in the appendix to § 3. When the instrument was made bifilar, the curve of rise changed from that of Plate V. to Plate IV. A dead-beat instrument shows a curve steeper than the logarithmic; one too heavily damped, flatter. (*a*) Fig. 4 shows the shape at the origin obtained from the galvanometer record; (*b*) that given by substituting a Duddell oscillograph for the galvanometer. It will be noted that the curve is not retarded parallel to the time axis, but rises nearly vertical, reaches in (*a*) a point where a slight flattening takes place, and then becomes the normal logarithmic until near saturation. The slight hump on the Curve (*a*) may be due to the coil overshooting the steady rise, but the inertia of the oscillograph strips is so exceedingly small compared with the tension that the shape of the Curve (*b*) can only be attributed to changes in the flux within the core. The experiment was made with the oil space filled and the instrument cold, when the damping is greater than in the normal working condition. A horizontal flattening of the curve corresponds to an increase in permeability, and an increase in steepness to a smaller permeability than would give the logarithmic rise. Thus the steep rise is due to the low permeability observed with very weak magnetising forces. The initial tangent is now ·998, the scale of the curve being 1·86cm. per ampere and 1·1cm. per second.

Thus $\frac{di}{dt} = {\cdot}59$. And from (6) $\frac{dL}{dt} = 10\,S\frac{\frac{de}{dt}}{\frac{di}{dt}} + r$; and $\frac{de}{dt} = {\cdot}0086$.

Thus $\frac{dL}{dt} = 357{\cdot}7$; also $L = {\cdot}4\ \mu$. Therefore $\frac{d\mu}{dt} = 894$; and as compared with the former value (2,495) the reduction is due to the momentary lag before the molecules begin to come into line. The effect of increased steepness at zero on the inductance as found by the graphical method is to bring the curve back as in Fig. 5. So that the inductance of the whole machine follows, as one would expect, the curve of permeability of soft iron. If the establishment of the magnetism in the core were more uniformly distributed, instead of being retarded at the centre by the eddy currents, this effect would no doubt be more marked.

From equation (5), when $de/dt = 0$

$$i\frac{d}{dt}\left(\frac{dL}{dt} - r\right) + \left(\frac{dL}{dt} - r\right)\frac{di}{dt} = 0;$$

or, $$\frac{di}{dt}\left(\frac{dL}{dt} - r\right) + i\frac{d^2L}{dt^2} = 0 \quad . \quad . \quad . \quad . \quad . \quad (10)$$

This cannot be solved, except by trial, to find the time or current when the condition is fulfilled. Taking points in the curves of i, $\frac{dL}{dt}$, $\frac{d^2L}{dt^2}$, as given in Plate 5, from ·3″ to ·8″, and substituting in equation (10), the nearest approach to satisfying the equation was when $\frac{di}{dt}$, $\frac{dL}{dt}$, $\frac{d^2L}{dt^2}$, and i were respectively 2·74, 6·36, 7·7, and 1·2; the left-hand side then reducing to ·08, the time then being ·45″. The actual average time of reaching the maximum induced voltage is ·5″, the correspondence being within the limits of experimental error. As an additional check on the general reasoning, put $\frac{dL}{dt}$, $\frac{d^2L}{db^2} = 0$ as they are in Plate 5 for a current of 5·6 amperes.

Then $$10\,S\frac{de}{dt} = -r\frac{di}{dt}.$$

The number of shunt turns on the Holmes machine is 2,393, and $\frac{di}{dt} = 1{\cdot}4$ at the current 5·6 amperes. Thus

$$de/dt = {\cdot}000572.$$

The scale for this curve being 122·5cm. per volt, the tangent should be ·7. It is actually ·76, the difference between the calculated and observed tangent being 2deg.

The effect of the rate of change of inductance in shearing over the initial rise may be seen by writing (10)

$$\frac{di}{i} = -\frac{\frac{d^2L}{dt^2}}{\left(\frac{dL}{dt} - r\right)}\cdot dt,$$

or, $$\log i = -\int\frac{d^2L/dt^2}{\left(\frac{dL}{dt} - r\right)}\cdot dt.$$

That is, $$i = \epsilon^{-\int\frac{d^2L/dt^2}{\left(\frac{dL}{dt} - r\right)}\cdot dt};\ \text{when}\ de/dt = 0. \quad (11)$$

Since at this point $\frac{dL}{dt}$ is less than r, the power is positive, and the greater the inductive acceleration at this point the greater the time of reaching the maximum is prolonged. This delay may be seen in Plate VII., where the actual curve reaches its maximum later than the theoretical. If, however, the permeability remained constant, we should have $e = \frac{E - ir}{10\,S}$ from (4),

and now $$i = i_0\left(1 - \epsilon^{-\frac{rt}{L}}\right)$$

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Hence $$e = \frac{E}{10\,S}\epsilon^{-\frac{rt}{L}}$$

and when $t = 0$, $e = E/S \,.\, 10$.

The maximum throw for the Holmes machine is when $E = 104$ volts, and then $e = \frac{104}{23{,}930} = .0047$ volt.

(To be continued.)

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

471. Describe the construction of and method of using a photometer for giving mean horizontal candle-power of incandescent lamps?—PHOTOS.

472. Three 200-kw. Siemens alternators, each coupled direct to Willans engines, are running in parallel. Nos. 1 and 2 are fully loaded. A No. 4 set, of 100 kw. capacity, is the only spare machine. The exciters are running in parallel, and supply current to the field windings of alternator from 'bus bars. Please give a practical description of what to do should one of the armature coils start to burn out—say No. 1 alternator. A Ferranti switchboard is used.—R. H.

ANSWERS.

Question No. 465.—Is there any objection to feeding an overhead wire system of trams by means of a three-wire system, with, say, 1,000 volts between the outers and the inner earthed?

Best Answer to No. 465 (*awarded* 10*s.*).—The greatest and most insurmountable objection to the supplying of trolley wires with current at 1,000 volts in a three-wire system is that it is not in accordance with the Board of Trade rules, which read as follows: "The electrical pressure or difference of potential between any suspended conductors used in connection with the working of the tramways by electrical power and earth, or between any two such suspended conductors, shall in no case exceed 500 volts continuous pressure." Apart from the rigid views of that all powerful safety-seeking body, there are other objections to such a scheme. The three-wire system of distribution for traction has been anything but satisfactory. In a system where the load fluctuates so rapidly as it does in traction work, severe momentary strains are thrown upon the generating plant, and with a three-wire system these strains are, if anything, increased at times rather than lessened, and then comes the difficulty of balancing. Such fluctuations would necessitate the use of very large balancers; in fact, no matter how well balanced the system is, it has been found from practice that the machines necessary to deal with the out-of-balance current must be almost as large as the main generators.

In a large system of tramways, where the two sides are fairly well balanced, it would seem to be most favourable to the three-wire arrangement, but even then there are grave difficulties. A few such systems are in use in America, but as a whole they prove that the three-wire method, so far as traction is concerned, is a failure. The only advantage gained would be that the trolley could be fed direct from the power station, but with long feeders it is doubtful if this advantage could be used, owing to the restrictions of the Board of Trade as regards the drop of volts. On the whole, it seems to me that the advantages to be gained are more apparent than real; as will be seen from a close study, one is gained at the expense of another. I do not think such a scheme would be advisable, and as the system is conspicuous by its absence both in Britain and the Continent, it is apparent that the difficulties to contend with are considerable.—THREE PHASE.

Answer to No. 465 (*awarded* 5*s.*).—The principal objection to the employment of 1,000 volts on a tramway system is on the score of public safety. Mr. Trotter has recently read a most interesting paper on "Electric Shocks" before the Institution of Electrical Engineers, in which he shows that, *except under abnormal circumstances*, a shock from a 500-volt trolley wire, although unpleasant, is not by any means dangerous. Under the same conditions, however, a 1,000-volt shock would be about twice as dangerous as a 500-volt one; and as 500 volts seems to be, with average conditions, about the maximum "safe" voltage, the question is whether it would be advisable to go to 1,000 volts, unless the risk of getting a shock can be made much less than it is now. It is usually the pedestrians who get the shocks, not the occupants of the car. For this reason a much higher voltage than 500 would seem to be permissible on light railways or tramways using a private road. If we adopt a three-wire system, making the track the earthed middle wire, as proposed, we shall have + 500 volts on one trolley wire and − 500 volts on the other. Now, the trolley wire itself rarely falls. By far the most frequent cause of accidents is falling telegraph wires, which fall in a coiled-up mass on the unsuspecting passer-by, making contact with the trolley wire as they fall. The danger of a shock increases rapidly with the time of contact, and when one gets coiled round with wire it takes some little time to get free. This is the cause of a good many dangerous shocks. With the three-wire system, so long as the telegraph wire only touched one of the trolley wires the shock would be no worse than with the ordinary system; but it is quite possible under certain circumstances to get the full difference of potential between the trolley wires (1,000 volts), when the results would very probably be serious. There is also the danger that the trolley pole might jump the wire and manage to short-circuit itself across the two overhead conductors.

But if we do adopt this system, I do not quite see what we are to gain by it. We are still employing 500 volts across our motor terminals, and hence the total current carried by the overhead wires, and therefore their cross-section, must be the same. The principal advantage of the three-wire system over a two-wire system (of half the voltage between the outers) is that we can save anything up to 40 per cent. or so of the total copper in the leads by reducing the size of the middle wire. But as the track is in this case the middle wire, we cannot reduce its size, so we may as well stick to the old system. It is true we might do with fewer bonds, but then we should probably have to provide boosters, etc., to equalise the current, so that there does not appear much saving in it. It is true, however, that owing to the much smaller current flowing back along the track the drop would be much less, and hence leakage current and electrolysis would be very much reduced. If, however, we could employ 1,000 volts direct across the motor terminals by simply increasing the volts on both trolley wires to + 1,000, we should gain several improvements worth having, and it is questionable if this arrangement is really much more dangerous than the three-wire system proposed. In the first place, the size, and therefore cost, of the overhead wire, would be halved. The output of the motors might have to be very slightly reduced, as the heating would be greater owing to the greater percentage of insulation required at 1,000 volts, but the size of commutator would be less owing to the smaller current taken. The efficiency of the motors would remain the same, but the danger of flashing across from one brush arm to the next would be greater. However, if the motors are well designed and constructed from the commutation point of view, there will be no trouble on this score, especially if the brushes are of hard non-powdering carbon and the commutators are kept in good condition. A great number of stationary motors round about 20 b.h.p. and 30 b.h.p. are now running off 1,000 volts without the least trouble.

Another point is that the current in the track is half that returning on the 500-volt system, so that electrolysis

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is very much reduced; or, to put it another way, we can halve the number of our return feeders and still get as good results. At the generating station all the copper in cables and switchgear will be halved in weight and very nearly so in cost. The same remarks apply to the generators as to the motors, except that here, of course, the brushes are so far apart that there is absolutely no danger of their flashing across. The best current per circuit in a large tramway generator varies from about 150 to 200 amperes for all voltages according as we are running at a high or low speed. Hence the number of poles required =

$$\frac{\text{Kilowatt output of generator}}{\text{Voltage} \times (150 - 200)}.$$

So that for a 1,000-volt generator we should only require about half the number of poles for 500 volts, which will tend to cheapen the machines and will also improve the commutation since the space between poles will be wider, and, as Prof. Carus-Wilson states, the density of the field produced by the armature tending to hinder commutation depends directly on the distance between pole-tips for a given armature ampere-turns per pole.

The ordinary guard wires by themselves seem of little use in preventing serious accidents; they should be fitted with some form of safety device for automatically cutting off the current directly an accident occurs. A very good form is one which is used in Santiago, Chili; it acts instantaneously before the telegraph wire touches the ground. In this arrangement (Fig. 1), if a telegraph wire,

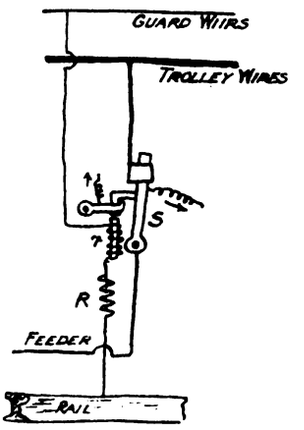


FIG. 1.

etc., breaks and falls to the ground, it is bound if it falls across the trolley wire to touch the guard wire also. This at once charges up the guard wires, and a current begins to flow through the solenoid, r, and the resistance, R, to the rails, as the alternative path (down the post and through the ground to the rails) is of very much higher resistance. This instantly breaks the section switch, S, and cuts off the current. Two amperes has been found sufficient to work the cut-out, and the resistances, R and r, are proportioned, so that

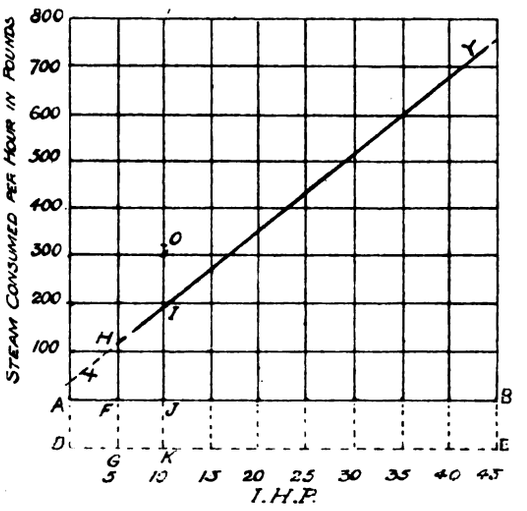
$$\frac{\text{Line voltage}}{R + r} = \text{not more than 2.}$$

Hence the maximum current the guard wire can have to carry is two amperes, so that it may be made as small as desirable without any danger of its being fused.

With some arrangement of this kind 1,000 volts may become possible, but it scarcely seems probable that the Board of Trade will take kindly to it for some time to come.—T. SQUARE.

Question No. 466.—Many high-speed steam-engines which govern well when running on the condenser show a tendency to hunt when exhausting into the atmosphere. What is the cause of this tendency, and to what extent can it be corrected?

Best Answer to No. 466 (*awarded* 10*s.*).—Perhaps the simplest method of showing the difference between the action of the governor when the engine is running on the condenser and that required when the same engine is exhausting into the atmosphere, is by investigating the relative amounts of steam required by means of the "Willans straight line diagram," which is a curve in which the ordinates are the number of pounds of steam consumed per hour, with the output in indicated horse-power for abscissæ. Where the adjustment of power is effected by varying the initial pressure of the steam—the point of cut-off remaining constant, as is the general practice with "high-speed" engines in this country—this curve is approximately a straight line. Herewith is a diagram of the above type drawn for a small high-speed engine running on the condenser at a normal speed of 400 revolutions per minute. Now, if it is assumed that the opening to steam given through the throttle valve is proportionate to the amount of steam consumed, which is sufficiently near the truth for the present purpose, the distance from the base line, A B, to the Willans line, x y, will give, not only the amount of steam consumed at any load, but also, to another scale, the corresponding opening through the throttle valve. Now, if the engine be put to run on the atmosphere, the quantity of steam consumed at all loads will be increased, and as this increment is constant it may be shown on the diagram by drawing a line, D E, at a distance below A B equal at the same scale to the extra amount of steam required owing to the higher back pressure involved. When the engine is running on the atmosphere this line becomes the base, or zero line, of the diagram. It becomes at once evident that if the speed of the engine is to remain constant the opening of the throttle valve at any point, say F, will have to be greater than



in the previous case in the ratio of G H to F H, and if the engine were required to run at this load only it would simply be necessary to increase the governor controlling force by increasing the tension on the spring adjustable by hand. But this would by no means improve the governing through any proportionately large variation of load, for the addition of the constant opening to steam, D A, necessary when the engine is running on the atmosphere, alters the existing proportion between the steam opening and the indicated horse-power for which the governor has been set, within the limit variation of speed.

For instance, if when the engine was running on the condenser the load had been increased from 5 i.h.p. to 10 i.h.p., the governor would (the speed of the engine falling, to say, 399 revolutions per minute) have increased the steam opening from F H to J I—that is to say, the steam opening would have been approximately doubled. Therefore, if the engine be put to run on the atmosphere and the controlling force on the governor be increased by means of the adjustable spring, so that the engine would run at 400 revolutions per minute at 5 i.h.p., under a load of 10 i.h.p. a fall in speed to 399 revolutions per minute as previously would force the governor into a position of over-control, increasing the steam opening from G H to K O—that is, doubling the opening as previously—therefore the steam opening K I required to develop 10 i.h.p. on the atmosphere would be reached considerably before the engine speed had fallen by one revolution per minute. Thus, it is quite possible that the engine, though governing closely on the condenser, might show a tendency to hunt when running on the atmosphere at light loads, owing to the governor being over-sensitive.

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The only way in which this could be remedied is (1) by increasing the tension on the adjustable governor control spring, and at the same time (2) altering the ratio which increase of the governor controlling force bears to the increase of the centrifugal force of the governor weights as they open out. This latter can be accomplished only in such governors as are designed so as to allow the virtual length of the spring to be increased by releasing one or more coils that have previously been kept out of action. In such cases the best working tension and number of coils in action of governor hand spring should be carefully noted when the engine is exhausting into the atmosphere, and marked on the mechanism for future use. As a rule it is more easy to obtain close governing on the atmosphere than on the condenser, especially with oil relay governors.—C. L. B.

NEW COMPANIES REGISTERED.

London Motor Garage Company, Limited.—Capital, £20,000. Objects: to carry on business as storers and repairers of motors of every description, etc.

Industrial Electric Company, Limited. — Capital, £2,000. Objects: to acquire and carry on the business of Siegbert Raphael and Joseph Gray, trading as the Industrial Electric Company, at Egremont, Cheshire.

Invention Proprietary Syndicate, Limited.—Capital, £1,000. Objects: to acquire from A. J. Thomas and E. J. Richardson certain patents relating to improvements in harmonic telegraphy and to develop and turn to account the same.

Gillet Motor Company, Limited.—Capital, £10,000. Objects: to acquire patent from the Motor Omnibus Syndicate, Limited, relating to improvements in water-tube or sectional steam-boilers, and in atmospheric burners for hydrocarbons, and to develop and turn to account the same; also as electricians, mechanical engineers, etc.

COMPANIES' MEETINGS AND REPORTS

BRUSH ELECTRICAL ENGINEERING.

The annual general meeting of the shareholders in this Company was held at Winchester House, E.C., at noon yesterday (Thursday), Lord Vaux of Harrowden in the chair. The full report of the directors, together with the accounts, appeared in our last issue.

The **Chairman,** in submitting the report for adoption, said it was with great regret that on the first occasion on which the directors met the shareholders they found themselves in a position which did not warrant the declaration of a dividend. After referring to the retirement of Mr. J. B. Braithwaite, jun., from the Board, and the death of Mr. J. Slater Lewis, he mentioned that Mr. W. L. Maglen, who was elected to the directorate last December, had been appointed to carry out the duties of "executive director," and changes had already been made which would certainly effect economies. With regard to the accounts, although the gross profit (£61,054. 8s. 2d.) was £700 behind last year, they had, in fact, earned during the period under review £2,800 more than last year. The larger amount carried forward this year accounted for that difference. The position of the Company was that their capital was £117,000 higher than the previous year, and the interest on that money was not yet in their pockets, although it was visibly accruing. He then referred to several smaller items in the accounts, and stated that the directors had in view the creation of a general reserve fund, which at present they had not. With regard to the auditors' certificate, which stated that the item of patents and goodwill had remained at £181,397. 8s. 9d. for the past five years, the directors were quite alive to the importance of that matter, but they were not yet prepared to make any recommendation. It was, however, receiving the directors' very careful attention. On the whole the prospects of the Company were good. The demand for all electrical equipment would go on increasing, with the result that they would find their works at Loughborough fully ready to meet that demand.

Mr. J. S. Raworth, in seconding the motion, said he endorsed every word the chairman had said with regard to the prospects of the Company and their future success.

A lengthy discussion ensued, in the course of which the present position of the Company was severely criticised by certain of the shareholders.

Mr. Sisley (a shareholder) questioned the policy of the Board in spending £80,000 on buildings and plant when they were unable to pay any interest on the outlay. Where, he asked, was the profit the shareholders were told they were going to get for it?

Mr. Conroy referred to the item of "patents and goodwill." He asked what was the directors' estimate as to the value of that £181,397.

Another **Shareholder** said he viewed the present position of the Company with dismay, and asked what were the relations between the Brush Company and the British Electric Traction Company.

Mr. Garcke said he was thoroughly satisfied with the report which the directors had placed before them. As to the relations between this Company and the British Electric Traction Company, he explained that in consequence of the latter company not being a manufacturing concern the proposal was made some nine or ten months ago for an exchange of shares at the then market price, and in consequence of that the British Electric Traction Company underwrote £50,000 of the capital of the Brush Company at par. He thought he should have some difficulty in justifying that action with the shareholders in the British Electric Traction Company, but he was sure that in course of time it would prove a good investment. To his knowledge the Brush Company had never financed or underwritten any of the undertakings of the British Electric Traction Company. With regard to the item of goodwill, his feeling was that so long as the capital was remunerative there was no harm in leaving it at the same figure. It was only when an undertaking ceased to make a fair return on its capital that the value of the goodwill was called in question.

The discussion was continued by other shareholders, some of whom referred to the sale of the Company's shares on the Stock Exchange. One speaker remarked that the reason for the present position of the Company was because the Board of directors did not consist of business men.

The **Chairman**, in reply, said Mr. Garcke had answered many of the questions which had been put. As to the selling of shares on the Stock Exchange, the directors were utterly unaware that anything of the sort was being done at the time, and they had no means of finding out how information with regard to the payment of the preference dividend had become known to some persons before it was officially announced.

A **Shareholder:** There was a rumour on the Stock Exchange that the dividend was absolutely to be paid a week before it was announced.

Another **Shareholder** said it was gross carelessness on the part of the directors.

The **Chairman** closed the question with the remark that the Board had absolutely no information on the subject. With regard to the item of goodwill, he repeated that the matter was receiving the earnest attention of the directors. In any case it was impossible to find out what the goodwill of any company was, nor could patents be placed at any accurate value. He then formally put the motion to the meeting, and on a show of hands it was carried with some five or six dissentients.

After some formal business had been transacted the meeting terminated.

BABCOCK AND WILCOX, LIMITED.

The report of the directors for the year ended Dec. 31, 1901, states that the net profit during the year, after deducting depreciation on plant, etc., amounts to £157,267. 3s. 4d.; to this has to be added the balance brought forward from last account, £15,678. 17s. 10d.; making a balance of £172,946. 1s. 2d.; from which has to be deducted the interim dividends to June 30, 1901, at the rate of 3 per cent. on the preference shares, and 6 per cent. on the ordinary shares, amounting to £34,800, leaving a balance of £138,146. 1s. 2d., from which the directors recommend that the following dividends be paid for the half-year ending Dec. 31, 1901: dividend at the rate of 3 per cent. on the preference shares (from which income tax is to be deducted), £3,000; dividends at the rate of 9 per cent. on the ordinary shares (free of income tax), £47,700; placing to the reserve fund £45,000; placing to the dividend equalisation fund, £25,000; and leaving a balance to be carried forward of £17,446. 1s. 2d. The new marine works are now completed and actively working. Amongst other smaller marine orders, the boilers for H.M.S. "Hermes," "Challenger," and "Odin" may be mentioned as having been constructed therein. The directors are pleased to be enabled to recommend this year substantial additions to the reserve fund, which, in view of the business extending all over the world, they consider a safe and wise policy, tending as it does to strengthen the resources of the business. The directors retiring at this general meeting are Mr. John Dewrance and Mr. Charles A. Knight, who, being eligible, offer themselves for re-election.

SOUTH LONDON ELECTRIC SUPPLY.

Directors: George Ellis, J.P. (chairman); Captain E. Ironside Bax; F. J. Leslie; W. W. Phipps; Algernon Turnor, C.B. Consulting engineers: Kincaid, Waller, and Manville. Engineer-in-chief: H. W. Sprunt, A.M.I.E.E., A.M.I.M.E. Secretary: Herbert H. Boyer.

The report of the directors for the year ending Dec. 31, 1901, states that the revenue account shows a credit balance of £1,691. 8s. 11d., as against a loss of £889. 14s. 3d. in the previous year. On Dec. 31, 1900, current was being supplied to the equivalent of 43,322 lamps of 8 c.p. On Dec. 31, 1901, this number had increased to 56,510. At the present time there are on circuit the equivalent of 59,663 lamps of 8 c.p., and applications are to hand for a further 1,385 lamps. It will be observed that there is a slight falling off in the units sold to consumers when compared with last year. This is due to the fact that in 1900, during the reconstruction of works by a neighbouring supply company, there were sold to them no less than 330,753 units, which realised £3,719. 18s. 4d. The length of roadway in which mains have been laid is now 49 miles of high-tension and 42 miles low-tension ways, in which 33½ miles of high-tension and 42 miles of low-tension cable have been laid. The high price of coal in the first half of the year has again considerably affected the net revenue, and the great increase in rates and taxes, and costs incurred in obtaining an equitable assessment, have materially decreased the profit balance. The original assessment was £5,667 ratable value, which has now been reduced to £3,000. During 1901 economisers and condensing plant were erected, and although these were not completed until the end of the year, the directors are pleased to report that already a considerable decrease is evident in the consumption of coal. Had this plant been in operation at the time contracted for, a further decrease in the cost of coal would have been shown. It will doubtless be a source of much satisfaction to note the

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substantial decrease in the costs of generating and distributing the current. These, which last year were 3·65d. per Board of Trade unit sold, are this year 2·95d. The plant and mains have been maintained in a very high state of efficiency, and so soon as the load is commensurate with the size of the station, the directors feel sure that the economy of the working costs will be more clearly apparent. The action brought by the Lambeth Borough Council against this Corporation in respect of the stoppage of the dust destructor came before Mr. Justice Wright on March 12. After hearing the plaintiff's case the judge suggested the desirability of an amicable settlement being arrived at, and offered to adjourn the case for this purpose. As the directors have throughout been desirous of such a result they welcomed the suggestion, and an adjournment for four weeks was accordingly arranged. The directors are now waiting to hear what proposals the Lambeth Council have to make in pursuance of the judge's expressed opinion. The Board have pleasure in reporting that a favourable agreement has been entered into with the London County Council. By this agreement the Corporation will supply steam to drive machinery of 5,000 h.p. about to be erected at the sole expense of the Council on the property of this Corporation for operating the municipal tramways. This will utilise the existing boiler plant for some time to come, thus tending to reduce generating costs, and at the same time providing a beneficial revenue during the currency of the agreement. In accordance with the articles of association two of the directors—W. W. Phipps, Esq., and Algernon Turnor, Esq., C.B.—retire, but, being eligible, offer themselves for re-election. The auditors, Messrs. Price, Waterhouse, and Co., also retire, and they, being eligible, offer themselves for re-election.

ABSTRACT OF REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation.						
Coal, including cartage	£6,432	5	7			
Oil, waste, water, and stores	745	7	3			
Proportion of salaries	633	4	8			
Wages at generating station	1,324	3	7			
Repairs and maintenance	1,246	3	0			
Other miscellaneous expenses	155	6	1			
				10,536	10	2
Distribution.						
Proportion of salaries	120	0	0			
Wages in distribution of current	131	12	4			
Repairs and maintenance of mains	92	11	4			
Repairs to meters, etc.	63	8	3			
Repairs to transformers, etc.	81	17	10			
Other miscellaneous expenses	7	0	1			
				496	9	10
Maintenance and repairs of public arc lamps				270	14	8
Rents, rates, and taxes				810	7	10
Management Expenses.						
Directors' remuneration	1,200	0	0			
Salaries—secretary, clerks, etc.	824	4	2			
Canvassing and advertising expenses	184	6	3			
Stationery and printing	122	17	8			
General establishment charges	344	6	4			
Auditors of Company	63	0	0			
Auditor—Board of Trade	60	0	0			
				2,798	14	5
Law and Parliamentary Charges.						
Law expenses	306	8	1			
Costs incurred in obtaining equitable assessment	262	10	0			
				568	18	1
Special Charges.						
Costs incurred in cancelling a contract	152	10	0			
Insurance	246	0	6			
				398	10	6
Balance carried to net revenue account				1,691	8	11
				£17,571	14	5

Cr.	£	s.	d.
Sale of current, per meter, after deducting bad debts	16,919	7	9
Meter rentals	568	12	3
Transfer fees	7	12	6
Sundry fees	2	10	6
Discount on purchases	5	3	2
Sales of clinker, etc.	36	16	7
Electric lamps	31	11	8
	£17,571	14	5

ABSTRACT OF BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	324,980	0	0
Due from sundry contractors and others	12,281	18	1
Sundry creditors on open accounts	1,225	7	1
Contractors for deposit on account of repaving the streets	100	0	0
Deposit by consumers	5	0	0
Depreciation account	2,033	5	7
	£340,625	10	9

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	280,290	12	8
Cost of acquisition of provisional order, etc.	46,649	0	0
Stores on hand at Dec. 31, 1901	1,908	9	8
Sundry debtors for current supplied, etc.	6,064	14	4
Deposit with Vestry for repaving the streets	100	0	0
Cash at bankers and in hand	5,612	14	1
	£340,625	10	9

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Board of Trade units generated			1,288,657
Sold to consumers			854,217
Quantity used on works			156,680
Expended in distribution.	In batteries and motor alternators	57,783	267,331
	In feeders	34,694	
	Transformers	174,854	
Total quantity accounted for			1,278,228
Quantity unaccounted for			10,429
Number of lamps on circuit, equivalent in 8 c.p.			56,510

The annual general meeting of the above Company was held on Tuesday, 8th inst., at the offices of the Company, Bengeworth-road, Loughborough Junction, S.E.

After the notice convening the meeting and the auditors' report had been read, **Mr. G. Ellis, J.P.**, the chairman, moved the adoption of this report. In the course of his speech he referred to the increase of 30 per cent. in the lamps connected during the past year. The accounts this last year showed a credit balance of £1,691, as against an adverse balance of £889 in 1900. The appeal of the directors against the assessment of the works had resulted in a reduction of 45 per cent. in the same. The law expenses had been incurred over the smoke summonses. These had become so serious that the Board took a test case to the divisional court in respect of a fine imposed by the magistrate for black smoke alleged to have come from the chimney at a particular time when the Board was meeting, and were watching the chimney at the hour named in the summons. They knew there was no black smoke, but the magistrate would not believe them, and fined them on the evidence of men paid by the Borough Council to watch the works and get a conviction, and the Lord Chief Justice said the magistrate's finding was conclusive. He was glad to say that the fight made seemed to have caused the Borough Council to be chary about issuing further summonses. With regard to the arrangement whereby the London County Council were putting down plant at their works to be supplied with steam from their boilers, no capital expenditure would be incurred by the Company over this work, which would bring them in a good profit, and provide a load for their boilers while their lighting load was increasing. The dispute between the Lambeth Council and the Company over the dust destructor had been taken before Mr. Justice Wright. The Council had stopped them using their destructor and then commenced proceedings against the Company for not taking their ashbin refuse. The judge's decision had been deferred until the two parties had had an opportunity of meeting and discussing a settlement satisfactory to both. This meeting was likely to be held very shortly. To show the effect of the condenser on the saving costs of the station Mr. Ellis then gave the following figures for the first three months of this year as compared with those for 1901 :

	1901.		1902.
Units generated	387,926		423,238
Salaries	£146		£135
Wages	341		318
Coal	2,434		1,464
Stores	386		159
Water	63		32
Repairs	240		168
	£3,610		£2,276

This showed a saving of £1,334.

Captain E. Ironside Bax seconded the adoption of the report and accounts.

In reply to questions **Mr. E. Manville** explained that it paid to supply the London Electric Supply Company in bulk at a price per unit which was under the average cost per unit sold, as there were distribution expenses incurred. The chairman said that the London County Council were spending £15,000 on their land and had agreed to take steam for a minimum of 18 months. The actual period would most probably be longer than this. He also explained that they were now offering wiring contractors a bonus for every lamp wired, and that they found this, so far, to give more satisfactory results than paying canvassers.

The report and accounts were then adopted.

Mr. W. W. Phipps, one of the retiring directors, then said that he did not seek re-election, as stated in the report, as he wished to retire in favour of Mr. Jacob Atherton. That gentleman had retired from the Board during the past year.

Mr. Briggs proposed the election of Mr. Atherton as director, and **Colonel Philpotts** seconded the motion.

A long and heated discussion then followed, in which personalities were freely used. The shareholders opposing the election of Mr. Atherton objected to the lack of notice as to the retirement of Mr. Phipps and the candidature of Mr. Atherton. The motion was negatived, but a poll was demanded on behalf of Mr. Atherton, which the **Chairman** decided should be held at same place at 3 p.m. on Tuesday next.

Mr. Algernon Turnor was re-elected a director, and after re-electing the auditors the meeting terminated.

ANGLO-ARGENTINE TRAMWAYS.

The report of the directors for 1901 states that the result of the year's working is as follows: receipts, £253,865; working expenses, £186,571; leaving a profit of £67,294, less interest on debenture stock, £14,368, and interim dividend (2s. per share), £26,000, leaving an available balance of £26,925. The directors recommend that this balance be disposed of as follows: that the sum of £6,250 be placed to the credit of reserve fund, that £566 be appropriated towards the

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debenture stock sinking fund, and that after transferring, in accordance with the terms of the agreement with the Argentina Electric Traction Company, Limited, the sum of £5,891 from the accumulation fund, a dividend of 2s. per share be paid, absorbing £26,001. With the interim dividend of 2s. per share paid in October last, this will make 4s. per share for the year 1901. The receipts show a decrease of £10,749, due to the general state of depression which has existed in Buenos Ayres, to the interruptions to traffic caused by the work of conversion, and to the slightly increased premium on gold. The expenses, on the other hand, show a decline of £2,067, which is to be attributed principally to the reduction in the maintenance of the rolling-stock, as, although the exchange caused a decrease to the extent of about £1,276, this has been neutralised by the increased cost of forage. The conversion of the Company's system to electric traction is rapidly progressing, and the directors are satisfied that the work is being carried out in a substantial manner.

BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS.

The report of the directors for 1901 states that the total receipts amounted to £147,212, and total expenditure to £87,712, leaving a balance of £59,500. This balance, with the amount brought forward from last year (£1,474), has been carried to net revenue account. After providing for debenture stock and other interest, and placing £3,000 to the credit of renewals fund, and setting aside £2,500 as a provision for pending compensation cases, there remains a balance of £31,851 at the credit of net revenue account. An interim dividend of 3s. per share on the "A" preference shares was paid in October last, and the directors now recommend the payment of a further 3s. per share, making the full dividend of 6 per cent. on these shares for 1901. An interim dividend of 3s. per share on the "B" preference shares was also paid in October last, and the directors now recommend the payment of the balance of 3s. per share, making the full dividend of 6 per cent. on these shares for 1901, together with a further dividend of 7 per cent., or 7s. per share, on account of arrears of dividends on these shares. Deducting these dividends now recommended, amounting altogether to 10s. per share, or 10 per cent., the arrears on the "B" preference shares will amount to 7s. 6d. per share, or 7½ per cent. The foregoing dividends on both classes of preference shares will absorb £19,750, leaving a balance of £1,976 to be carried forward to next account.

CALCUTTA TRAMWAYS.

The report of the directors for 1901 states that the exchange is taken at the rate of 1s. 4d. per rupee, instead of at 1s. 8d. per rupee. This change, of course, materially affects the figures on both sides of the account when stated in sterling money, and renders any comparison with previous years fallacious. The accounts show gross receipts £72,171, expenditure under all heads £54,572, and a revenue balance of £17,599. To this sum must be added the interest earned by the employment of moneys in hand during the currency of the year £1,721, and the net balance from the accounts of 1900, after payment of the dividend (£5,519), which bring up the amount to £24,840, from which £13,904 has been paid in respect of debenture interest. The available surplus is therefore £10,935, from which the directors recommend that a dividend be paid at the rate of 3 per cent. per annum, free of income tax, which will absorb £10,332, and that the balance of £603 be carried forward. The great works rendered necessary by the introduction of electricity have been actively carried on both by the Company and the contractors throughout the year, and within the last few days they have been able to commence running upon one section of the system. The remainder of the lines are now almost complete, and the directors hope that within a few months the whole system will be running by electricity.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Edinburgh.—The Corporation invite tenders for annual supplies from May 15 for the electric supply department.

Brisbane (Queensland).—The Postmaster-General invites tenders for a number of telephones. Tenders by April 14.

Alicante (Spain).—The Harbour Board require tenders for the supply of two movable cranes. Tenders by May 14.

Madrid.—The Telegraph Department invite tenders for 30,000 zinc cylinders, estimated at £2,260. A deposit of 5 per cent. is required. Tenders by April 14.

Peterborough.—The Electricity Committee invite tenders for supplying 43 arc lamp pillars. Tenders by April 12. Details in our advertisement columns.

Lytham.—The Urban District Council invite tenders for a 300-kw. plant complete for electric lighting. Tenders by April 26. Particulars may be obtained from the Clerk.

Madrid.—The Telegraph Department invite tenders for 40,000 porcelain insulators, estimated at £1,360. A deposit of 5 per cent. is required. Tenders by April 15.

Edinburgh.—The Corporation invite tenders for the supply of electricity meters for 12 months from May 15 next. Tenders by April 28. Particulars in our advertisement columns.

Hartlepool.—The Corporation invite tenders for one 200-kw. to 250-kw. high-speed steam-engine, continuous-current dynamo, extension to switchboard panel, etc. Tenders by April 30.

Southampton.—The Corporation invite tenders for the construction of tramways in St. Deny's-road. Specification, etc., may be obtained at the Borough Engineer's Office, Southampton. Tenders by April 16.

Glasgow.—The Corporation invite tenders for the supply of 50 tons of tiebars. Specification, etc., can be obtained from Mr. John Young, general manager, 88, Renfield-street, Glasgow. Tenders by 10 a.m. on April 14.

Devonport.—The Corporation invite tenders for materials and work for about three miles of double tramway track. Specification, etc., may be obtained from Mr. C. Chadwell, 20, Victoria-street, Westminster. Tenders by April 16.

Dundee.—The Town Council invite tenders for the delivery of six electrical car bodies. Specifications, etc., may be obtained from Mr. Peter Fisher, tramway manager, Town House Buildings, Dundee. Tenders by 14th inst.

Rathmines.—The District Council invites tenders for supply and erection of engine-house plant, extension of switchboard and electricity supply mains. Tenders by April 24. Full particulars in our advertisement columns.

Hull.—The Electric Lighting Committee invite tenders for pipework, pumps, motors, etc., and work required to be executed at Sculcoates-lane generating station. Tenders by April 24. Details in our advertisement columns.

Swindon.—The Corporation invite tenders for the supply, delivery, and laying in the borough of Swindon (Wilts) of feeder and distributing cables, conduits, and accessories. Tenders by April 23. Details in our advertisement columns.

Mansfield.—The Corporation invite tenders for the construction and erection of pipework, valves, and tanks, steam, exhaust, water, and other pipes, valves, tanks, foot-plates, and accessories. Tenders by May 1. Details in our advertisement columns.

Stockport.—The Gas and Electricity Committee invite tenders for supply and erection of a 200-kw. engine and dynamo for traction purposes. Specification, etc., can be obtained on application to the Engineer on or before 19th inst. Tenders by 23rd inst.

Warrington.—The Electricity Committee invite tenders for supply of one 20-h.p. motor. Specifications and particulars can be obtained from Mr. William H. Grimsdale, borough electrical engineer, Electric Light Station, Howley, Warrington. Tenders by 12th inst.

Oldham.—The Electricity Committee invite tenders for the supply, delivery, and erection, complete, of lighting and traction switchboards, with connections and instruments comprised in Specification No. 5. Tenders by May 6. Full details in our advertisement columns.

Dundee.—The Town Council invite tenders for six complete sets of four-motor equipment, with bogies, for single-deck cars. Specifications may be obtained from Mr. Walter H. Tittensor, city electrical engineer, Dudhope-crescent-road, Dundee. Tenders by April 14.

London, S.W.—Tenders are invited for wiring and fittings for the electric lighting of the Scotland-yard fire station, for the London County Council. Specification, etc., can be obtained at the Chief's Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by April 17.

Glasgow.—The Corporation invite tenders for the supply of concentric and single main cables, insulated with paper or fibre, impregnated with oil, bitumen, or other substance impervious to moisture, or with vulcanised bitumen. Tenders by April 21. Details in our advertisement columns.

Sydney.—The Municipal Council invite tenders for supply and erection of plant and machinery required for the complete equipment of their proposed electricity supply stations and sub-stations. Particulars may be obtained from Messrs. Preece and Cardew, Westminster. Tenders by May 7 at noon.

Brighton.—The Town Council invite tenders for supply and erection at the Corporation electricity works, North-road, Brighton, by July 1, 1902, of a high-rate discharge battery and an automatic reversing booster and switchgear. Specifications, etc., may be obtained at the Town Hall, Brighton. Tenders by April 14.

Edinburgh.—The Corporation invite tenders for the supply of the following materials for the electricity supply department for the year from May 15, 1902: cast-iron pipes, pavement and road box frames and covers, etc. Specifications, etc., can be obtained at the Resident Engineer's Office, 5, Dewar-place, Edinburgh. Tenders by April 12.

Dundee.—The Gas Commissioners invite tenders for triple-expansion engine and dynamo, 750 kw. capacity at 200-230 revolutions, to be supplied and erected at the electrical power station, Dudhope-crescent-road, Dundee. Specifications may be obtained from Mr. Walter H. Tittensor, city electrical engineer, Dudhope-crescent-road, Dundee. Tenders by April 24.

George Town (Penang).—The Municipal Commissioners invite tenders for the supply and delivery, f.o.b., of boilers, etc., ejector condenser, pumps, tanks, etc., pipes, steam dynamos and balancer boosters, switchboards, batteries, cables, junction boxes, &c., and arc and glow lamps, posts, and accessories. Tenders by April 28. Details in our advertisement columns.

Aberdeen.—The Electric Lighting Committee invite tenders for the supply and erection of a 20-ton electrically-driven overhead crane, with the necessary supporting columns and girders, for their Dee Village electricity works. Specification, etc., may be obtained from Mr. J. Alex. Bell, city electrical engineer. Tenders by May 7. Details in our advertisement columns.

London, W.—The Central Electric Supply Company, Limited, invite tenders for the supply, delivery, and erection of high and low tension switchboards at the company's generating station at Grove-road, St. John's Wood, N.W. Specification, etc., can be obtained

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from the General Manager of the Company, 19, Carnaby-street, Golden-square, W. Tenders by April 23.

Trowbridge.—The Trowbridge Urban District Council having obtained a provisional order for the supply of electricity in their district, are prepared to receive applications for a lease of their powers under the said order. A plan of the district can be seen at the offices of the Council. Applications to be sent to Mr. T. S. Hill, clerk, Council Offices, Town Hall, Trowbridge, by April 30.

Rotherham.—The Corporation invite tenders for the supply, delivery, and erection of rolling stock; overhead construction, with trolley wires, posts, switch pillars, etc.; and permanent-way construction, excavation, concrete foundations, steel rails, and special work, paving, etc. Specifications, etc., can be obtained from Mr. H. Hampton Copnall, town clerk. Tenders by April 23.

Burton-upon-Trent.—The Corporation invite tenders for the construction of about 5¾ miles of route length of tramways, constructed as single line with passing places. Specifications, etc., may be inspected and obtained at the office of the consulting engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, or at the Borough Engineer's Office, Town Hall, Burton-on-Trent. Tenders by April 22.

Bermondsey.—The Council invite tenders for the supply of the undermentioned articles up to March 31, 1903: arc lamp carbons, electricity meters, demand indicators, and main fuses, engine oils, incandescent lamps, indiarubber cables and jointing material, ironmongery and engine-room stores, lead-covered cables, and meter boards. Tenders by April 14. Details in our advertisement columns.

Bath.—The Corporation invite tenders for supply and erection of steam dynamos, motor-alternator, motor-driven balancer, switchgear for continuous current, transformers, water-softening plant, H.T plug switch fuse gear, L.T. plug switch fuse gear, arc lamps, cables, meters, glow lamps. Specification, etc., may be obtained from Mr. Francis Teague, city electrical engineer. Tenders by April 21. Full particulars in our advertisement columns.

Falkirk.—The Corporation invite tenders for the supply and erection of the following: three 100-kw. steam dynamos (vertical enclosed high-speed engines); two dry-back marine-type boilers, with fittings; economiser, with dampers. Specifications, etc., can be inspected and all information obtained at the offices of Messrs. Burstall and Monkhouse, consulting engineers to the Corporation, 14, Old Queen-street, Westminster, S.W. Tenders by April 12.

London, S.W.—The London County Council invite tenders for the supply, delivery, and laying on the routes of the London County Council tramways (southern system) of (a) 48 miles of extra high-tension three-core lead-covered, paper-insulated cables; and (b) 87 miles of low-tension single, lead-covered, paper-insulated cables, and 14 miles of dry-core telephone cables. Particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by April 22.

London, S.W.—The London County Council invite tenders for the supply, delivery, and laying on the routes of the London County Council tramways (southern system) of (a) 48 miles of extra high-tension three-core lead-covered, paper-insulated cables; and (b) 87 miles of low-tension single, lead-covered, paper-insulated cables, and 14 miles of dry-core telephone cables. Specifications, etc., may be obtained from the County Hall, Spring-gardens, S.W. Tenders by April 22.

Nelson (Lancs.).—The Tramways Committee invite tenders for the supply and fixing of rails, overhead equipment, etc., for the light railways to Colne and Barrowford boundaries, comprising rails, fish-plates, crossings, etc., overhead equipment, bonds, feeding pillars, etc., 1,000 yards ·25 cable, and laying, and tramcars. Specifications, etc., may be obtained from Mr. B. Ball, borough engineer, Nelson, and Mr. W. A. Fraser, electrical engineer, Electricity Works, Nelson. Tenders by 28th inst.

Sudbury.—The Corporation invite tenders for the supply and erection of water-tube boiler, with fittings, feed-water heater, feed pumps, etc.; pipework, etc., in engine and boiler house; two steam dynamos (vertical enclosed high-speed engines) and motor boosters; storage batteries, main switchboard and connections; underground mains, conduits, and roadwork for private and public lighting; and station lighting. Copies of specification, etc., may be obtained at the offices of Mr. W. B. Ransom, town clerk, Town Hall, Sudbury, Suffolk, on and after April 14. Tenders by May 1. Full particulars in our advertisement columns.

Madrid.—The Secretary of State has received a dispatch from his Majesty's Ambassador at Madrid stating that tenders are invited by the Spanish naval authorities for the supply and installation of the photo-electrical material necessary for three gunboats. Tenders must be received before 11 a.m. on the 14th inst., and plans, etc., may be seen at the office of the Director of Material for the Navy (Direccion del Material, Ministerio de Marina) on all working days from 10 a.m. to 3 p.m. until April 14. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m.

Bexleyheath (Kent).—The Electric Lighting and Traction Committee invite tenders for the supply and delivery of tramway rails and accessories; also the supply, delivery, and erection of engines, alternators, dynamos, etc., under the following specifications: Specification No. 1 (Section A) tramway rails; (B) fishplates; (C) anchor plates; (D) tie-bars, bolts, etc. Specification No. 2 (Section A) engines; (B) alternators and exciters; (C) direct-current dynamos. Specifications, etc., may be obtained from the engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W. Tenders must reach Mr. T. G. Baynes, clerk, Public Hall, Bexleyheath, on or before the following dates: specification No. 1, April 21: specification No. 2, April 28.

RESULTS OF TENDERS.

Aston Manor.—The District Council have accepted the tender of the British Insulated Wire Company for the supply of cables at £22,281.

Shipley (Yorks).—The School Board have accepted the tender of H. A. Jackson and Co., 7, Standish-street, Burnley, for the work of installation of electric light at the Central School.

York.—The City Council have accepted the tenders of Dick, Kerr, and Co., Manchester, for extensions to the machinery at the electric light works, as follows: Section A, £4,725; Section B, £12,179.

Birkenhead.—The Corporation have accepted the tender of the Electrical Power Storage Company, 4, Great Winchester-street, London, E.C., for the storage battery for their South End generating station.

Bournemouth.—The Town Council have accepted the tender of J. G. White and Co. for the laying of the track in connection with the tramcar shed at £1,849, and also that of Jenkins and Sons for construction of cooling tanks at £550.

Coventry.—The City Council have accepted the tender of J. and H. McLaren for an additional 1,000-h.p. engine at £4,275, and that of the British Schuckert Electric Company for supply of an additional 600-kw. two-phase alternator at £1,580.

Stoke-on-Trent.—The Guardians have accepted the following tenders for the engineering plant at the workhouse: Lancashire Dynamo and Motor Company, engine and dynamo, £876; Morley Engineering Company, Leeds, motor for pump and armature, £92. 15s.

Southampton.—The Tramways Committee have accepted the tender of W. Scott, Limited, Leeds, for the supply of 200 tons of rails, with the necessary fishplates, at £7. 10s. per ton for rails and £9. 15s. per ton for the fishplates. The contract for overhead equipment has been distributed between several firms.

West Ham.—The Corporation have accepted the following tenders: Geipel and Lange, meters; Premier Electric Lamp Company, incandescent lamps; British Insulated Wire Company, cable, etc.; Electric and Ordnance Accessories Company, cut-out boxes; S. Z. de Ferranti Limited, transformers; Wiggins and Rhill, engine-room stores.

London, S.W.—The Fulham Board of Guardians have accepted the following tenders for engineering and electric lighting works: Greenwood and Batley, engines, £1,301; H. T. Danks, Limited, boilers, £1,465; British Power, Traction, and Lighting Company, battery, £562. 18s.; R. Dawson and Co., wiring, £2,250; Universal Engineering Company, Nottingham, chimney shaft, £685. 10s.

Ilford.—The Urban District Council have accepted the following tenders for the 12 months ending March 31, 1903: British Thomson-Houston Company, ordinary type meters; Geipel and Lange, prepayment type meters; Reason Manufacturing Company, demand indicators; British Thomson-Houston Company, 8-c.p., 16-c.p., 25-c.p., and 32-c.p. incandescent lamps; Vacuum Oil Company, oil; Willcox and Co., engine-room stores; Henley's Telegraph Works Company, cables, boxes, etc.

Leyton (Essex).—The Electric Lighting Committee have received the following tenders for the supply and erection of steam, exhaust, and water pipes for engine and boiler rooms:

Suffield and Brown, Dolphin Works, Poplar (accepted)	£972	0	0
Aiton and Co.	1,130	0	0
Babcock and Wilcox	1,146	10	0
Sir H. Maxim, Limited	1,240	0	0
Jones Ironfoundry Company	1,326	0	0
Priddle and Heppell	1,480	0	0
A. Miller, jun.	1,584	0	0

BUSINESS NOTES.

TRACTION.

Manchester.—The Tramways Committee have adopted a new scale of fares.

Sheffield.—The work of doubling the tramlines in Church-street has been commenced.

Somerset.—The County Council have given their assent to the Bath and District light railway scheme.

Clacton.—The principal question being debated in the town at present is the light railway scheme.

Brighton.—The electric cars now run on Sundays, an innovation which is welcomed in many quarters in the town.

Shields.—The North and South Shields Electric Railway Bill has been read a second time in the House of Commons.

Rochdale.—It is hoped to be able to run the electric cars along the Bury-road route of the tramways on Coronation Day.

Padua.—The municipality are about to lay down plant and to convert the tramways for electric traction, at a cost of £152,000.

Cleckheaton.—The streets are in the hands of the British Insulated Wire Company, who are busily laying cables for tramways and electric lighting.

Nottingham.—The introduction of ½d. fares on the tramcars was considered at the meeting of the Town Council on Monday, but the proposal was rejected almost unanimously.

Cardiff.—In view of the fact that within a few weeks the electric cars will be running on some of the routes in the town, the training of men to act as motormen has been commenced.

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Mansfield.—The promoters of the Mansfield and district light railways announce that the construction of the lines authorised by the order of 1901 will be commenced at an early date.

Wrexham.—The Rural District Council have agreed to remain neutral to the scheme of tramways which the district electric tramways company are promoting in Parliament this session.

Farsley.—The District Council have written to the Bradford Corporation asking for an interview with the object of inducing Bradford to revert to the old rate of 2d. from Stanningley to Bradford.

Dover.—The opposition of the Rural District Council to the light railways scheme, which provides for a system of light railways to run in connection with the Corporation tramways, has been withdrawn.

Colne.—An interview between members of the Town Council and representatives of the Colne and Trawden light railway scheme is being arranged with a view to an amicable agreement being arrived at.

Batley.—Draft heads of terms for the proposed agreement between the Corporation and the British Electric Traction Company for leases of the tramways have been prepared and forwarded to the company for approval.

Nelson.—The draft agreement for the construction and working of the Nelson and Barrowford light railway by the Corporation and the Barrowford Urban District Council jointly has been approved by the Town Council.

West Bromwich.—Mr. D. Ellison, assistant surveyor, has been appointed assistant engineer to discharge the duties of clerk of works in connection with the reconstruction of the tramways at a salary of £200 per annum.

Proposed Electric Line to Dover.—In connection with the scheme for building an electric railway between London and Dover, two alternative routes are being surveyed. One route is *via* Maidstone and the other *via* Chatham.

Worthing.—The Parliamentary Committee have been instructed to consider and report to the Council at an early date what steps shall be taken to obtain powers for the construction of electric tramways within the borough.

Dundee.—There is a complaint in the town that the Perth-road section of the electric tramways in regard to fares is charged in much higher proportion than the other routes. The matter is to be taken up at the next committee meeting.

Light Railways in Kent.—The Dartford district light railway and the light railway from Tenterden to Headcorn have been approved, and Maidstone now proposes to run a light railway from High-street to Barming Bull, the estimated cost being £15,000.

Southampton.—The extension of the tramways to St. Denys will be commenced very shortly, contracts for the supply of materials and for the overhead equipment having been placed. Tenders will soon be invited for the construction of the permanent way.

Portsmouth.—Progress is being made with the construction of the electric tramway from Cosham to Horndean, *viâ* Waterlooville. Under the provisional order the cars must be running by July 1 next. The new line will have cost when complete between £60,000 and £70,000.

Crewe.—The proposal to construct light railways has again been defeated by a town's meeting. The Mayor declared the result of the last poll on Saturday night as follows: for the railways, 1,076; against, 1,418. This is the fourth time that the scheme has failed to receive the popular support.

Glasgow.—The decision of the City Council with regard to the reduction of the tram fares is dealt with in our "Notes" this week. The First District Committee of the Renfrew County Council have agreed to grant permission to the Corporation to proceed with the tramway extension to Crookston.

Broadstairs.—Attention was drawn at the last meeting of the District Council to the nuisance arising from the smoke emitted by the chimney at the tramway depôt, St. Peter's. It was stated that this was a small matter, because the company could introduce machinery which would consume the smoke.

Russia.—We understand that an American syndicate has obtained a concession for constructing the St. Petersburg Metropolitan Electric Railway. It is to connect the Russian and Finnish railway system, and also to take the place of the existing horse tramways. The estimated cost of the scheme is said to be £8,000,000.

Darlington.—A meeting of the Town Council was held last week, when the recommendations of the Tramways Committee, based on the report of Messrs. Kennedy and Jenkin, were adopted. The estimated cost of the scheme, including the purchase of the present tramway, is £97,500. Particulars have already appeared in these columns.

Motor-Speed Record.—A message from Paris states that Mr. C. S. Rolls has successfully attacked the record for the kilometre (1,098 yards) with a flying start. The trial was made at the Parc d'Achères, near Paris, and the former best time was shortened by 6⅘ seconds, the speed attained being 64 miles an hour. The motorcar was a Mors 28-h.p.

Worcester.—Efforts are being made to induce the tramways company to complete the conversion of the tramways to electric traction in the centre of the city prior to the musical festival and hop fair, but it is said the company prefer to wait until a later date, although they are under agreement to take the current from the Corporation works in December.

Salford.—The new electric tramway to Weaste and Trafford Bridge was opened to the public at the end of last week, and it is expected that the Sussex-street, Lower Broughton-road, and Cliff lines will shortly be ready. When these are in use the electric car service of the Salford Corporation, so far as the boundaries of the borough are concerned, will be complete.

Deal.—In connection with the projected light railway between Deal and Sandwich, there is now a proposal to include Walmer also. The Kent Electric Power Syndicate have offered to submit a comprehensive scheme, and, if desired, they are prepared to undertake the working of the line. The question is being considered by the three councils interested.

Bury.—The routes to be followed in the construction of the new tramways have now been decided upon. The estimated cost of the system is stated to be £186,000. The annual expenditure is estimated at £23,847, and the annual receipts at £21,770. The aggregate length of the proposed lines is just over 10 miles. A provisional order will next be applied for.

Barrow.—The negotiations between the Council, the railway company, and the British Electric Traction Company still drag on, and it seems there is not much prospect of an early agreement. The draft agreement has now been in the hands of the two companies for some time, and the Council threaten to break off the negotiations if a settlement is not come to within a month.

South Lancs. Tramways.—Considerable discontent is felt in the St. Helens district at the fact that the tramway from Knotty Ash to St. Helens, which has been completed for a month, is not yet open to the public. A correspondent to the local Press, in drawing attention to the matter, says that at the next meeting of the shareholders some searching questions will be addressed to the chair.

Bournemouth.—It is recommended that Mr. Barber be engaged as works engineer and traffic manager of the tramways at a salary of £250 per annum, subject to his producing to the committee satisfactory testimonials from the Corporation of Blackburn. Tenders for the supply of traction and arc lighting switchboards, and for coal and ash conveyors, have been referred to the engineers to report on.

West London Accident.—As an electric car was proceeding between Chiswick and Gunnersbury the driver observed a phaeton being driven towards him, the near wheel being perilously near the tram track. The tram driver rang the gong and put on the brake, but the bell was unheeded, and a collision took place. The phaeton was smashed to pieces; its occupant was thrown out and killed instantly.

Another Brighton Scheme.—We have it on the authority of a news agency that Mr. Behr has been commissioned by an influential syndicate to prepare plans for an electric railway from London to Brighton. If the above information be correct, there should be an interesting fight before the Parliamentary Committees next session, as the promoters of the original scheme, which was thrown out a few weeks back, have announced their intention of reviving their proposals next year.

Burnley.—It is proposed to extend the tramway cables along Padiham-road and Colne-road, at an estimated expenditure of £330 and £320 respectively. There is also some talk of instituting a 2½-minute service on these routes. The electricity department was complimented at the last meeting of the Town Council on its supply of current for the trams during the past few weeks. It was stated that over 100,000 passengers had been carried during the four Easter days without a single hitch.

Newport (Mon.).—At the meeting of the Council on Tuesday the direct labour question in connection with the reconstruction of the tramways for electrical traction was discussed, the Electricity and Tramways Committee being equally divided as to the question of contract *versus* direct labour, and therefore leaving the matter to the Council to decide. After some discussion an amendment that the work be carried out by direct labour was lost, and it was decided to invite tenders in the usual way.

Aberdeen.—The newly electrically-equipped tramway to Mannofield was inspected on Tuesday by Colonel Van Donop on behalf of the Board of Trade. It has been agreed that, in view of the annual adjustment of the fares in connection with the Corporation tramways, it be remitted to the Tramways Committee to consider and report as to the propriety and practicability, after the whole tramway system has been electrified, of fixing the fares at the rate of ½d. per half-mile upon all the routes.

Newcastle.—The official inspection of the new tramway routes, *viâ* Westmorland-road, Gosforth, and Byker, took place on Wednesday. Colonel Van Donop attended on behalf of the Board of Trade. The controversy between the Tramways Committee and the officials of St. John's Church in Westgate-road still goes on. It is alleged that the tramlines which have been laid down outside the church impede the business of weddings, funerals, etc. An effort is accordingly being made to compel the committee to abandon the line at this spot.

Northfleet.—Referring to the order made at the last District Council meeting that the tramway company be not allowed to lay their cables underneath the footpath, a letter has been received from the company's chief electrical engineer, stating that the laying of the cables in the roadway would involve a great deal of extra work and expense, and requesting that he should be given an opportunity of discussing the subject with the district surveyor and the Council. The engineer will be invited to attend the next meeting of the Council.

Harrow Weald.—A meeting of ratepayers has unanimously resolved: "That this meeting understanding that it is the intention of the County Council of Middlesex to apply for the third time to the Light Railway Commissioners for powers to construct an electric railway through this parish, strongly protests against being again obliged to incur the expense of opposing the scheme, which has been unanimously condemned on two former occasions, and for which there is not the slightest necessity in a rural and sparsely inhabited district such as Harrow Weald."

Failure on the "Tube."—Owing to a failure of the electric current on the Central London Railway on Monday morning, a train in the up tunnel between Lancaster-gate and the Marble Arch was

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brought to a standstill, with the result that the traffic westward of Lancaster-gate was for a time completely dislocated. After about half an hour's delay the difficulty was overcome, and the trains recommenced running. The blocked train remained about 15 minutes in the tunnel, and the passengers were in darkness, but there was no exhibition of panic or alarm.

Halifax.—The local bench have inflicted fines on the Corporation for obstructing the highway at Queensbury on four successive days. One of the electric cars was left standing at the terminus of the Corporation tramway system in Queensbury High-street from noon on Good Friday until 5.30 on the following Wednesday evening. Complaints were also made on behalf the prosecution that on the Monday the road was obstructed by other tramcars, as many as eight standing together. The magistrates decided as a fact that there was an obstruction, and imposed a fine of 5s. and 5s. costs in each case.

Eastbourne.—After a lengthy and animated discussion, the Town Council have thrown out the scheme for electric trams, on the double ground that it would not pay and that it would interfere with private carriage traffic. The proposal was to construct a single line from the Archery Hotel along Seaside to the Leaf Hall, and thence along Langney-road to opposite the post office, at an estimated cost of £20,525. An amendment was, however, adopted, and afterwards passed a a substantive resolution, deferring the question until a report on steam or motor omnibuses is considered by the Council.

Sunderland.—Last month's tramways receipts amounted to £4,871. 1s. 3d., the average receipts per car mile being 11·7d. A deputation has waited upon the Tramways Committee and laid before them the claims of the residents of the Tunstall-road district for the extension of the tramways in that direction, as provided for in the Bill. The matter has been relegated to the Permanent-Way Sub-Committee. It is decided to obtain three loading platforms for Roker to avoid the heavy crushes which occur at holiday times. A proposal is before the committee for the abolition of the present system of "transfer" tickets.

Bradford —Work has been begun on the conversion of the tramway in Wakefield-road from the town hall to the Royal Engineer Inn to electric traction. The rails on this section have some two or three years' life left to them, and only need the electrical bonding of the joints. This operation and the erection of the overhead equipment should be completed in about three weeks' time. Within the next few weeks it is intended to commence the construction of the projected line from Park-avenue and up Little Horton-lane to the end of Southfield-lane. The conversion of the Otley-road line may also be expected during the summer.

Aston.—As the result of the application of the District Council and the Birmingham and Aston Tramways Company to the Board of Trade, Sir Frederick Bramwell, Bart., has been appointed arbitrator between the parties, and inasmuch as the Council at present are only able to purchase that part of the tramway undertaking authorised by the order of 1880—that is to say, the lines commencing at the city boundary, running to the Vine Inn, thence along Church-lane, Witton-lane, Witton-road, Bevington-road, Trinity-road, and Park-road—they have opened negotiations for the purchase of the whole undertaking of the company, including the right to use the lines belonging to them within the city of Birmingham, and these negotiations are still pending.

The Paris Metropolitan.—The *Daily Telegraph* Paris correspondent says that no attempt is to be made—for the present, at least—to run a branch of the Metropolitan line under the main boulevard. It is proposed to construct a transverse line connecting the Champs Elysées and adjacent districts with the neighbourhood of the great eastern cemetery at Père Lachaise by the Rue du Quatre Septembre and the Rue Réaumur. This new and important line is to have stations near the Parc Monceau at the Gare Saint-Lazaire, the Place de l'Opéra, the Bourse, the square close to the Gaîté Theatre, the Rue de Temple, and the Place de la République. The construction of this new line will necessitate a vast upheaval almost in the centre of the city during the approaching summer.

Camberwell.—The proposal of the Crystal Palace Light Railways Company to construct electric tramways on the overhead trolley system was discussed at a special meeting of the Borough Council on Wednesday. The tramways would commence at Lordship-lane, Dulwich, close to the junction with Crystal Palace-road, and terminate at Church-road, near its intersection with Westow-hill—a total length of two miles two furlongs, the estimated expense being £57,460. The General Purposes Committee reported that the company had offered several concessions to the Council, one being that they would light the whole length of the roads through which the tramway would run with electric light. After nearly three hours' discussion, further consideration of the matter was adjourned in order that there might be a conference between representatives of the Borough Council and the London County Council.

Tipton.—A special meeting of the District Council has been held to consider an agreement between the Council and the tramway company in respect to the working of the tramways. The Solicitor to the Council explained that that body had promoted a Bill in Parliament for dealing with the tramways. An agreement had been entered into between the Council, the British Electric Traction Company, the Birmingham and Midland Company, and the South Staffordshire Company whereby within two years the tramways would be taken over and electrically equipped. The tramway company was to pay the Council a lump sum down and £150 per annum for 30 years from the date of the agreement. If the Bill before Parliament were dropped, the tramway company would pay the whole of the costs of promoting it. The chairman and other members expressed their satisfaction at the terms the Council had been able to obtain, and the meeting unanimously decided to seal the agreement, and also to drop the Bill now before Parliament.

London County Council Tramways.—Gangs of labourers are working this week on the London County Council tramways from Tooting to Westminster—this being the first outward sign that the Council are taking in hand the electrification of this section of their southern lines. The reconstruction of the tramway will not, it is believed, seriously dislocate the present horse service. About a mile of each line will be transformed in turn, and while this is "up" the cars will run over a single track, with sufficient loops to avoid delays. It is expected that the electric cars will be running from Tooting to Westminster in 12 months' time, and within about 18 months it is hoped that the whole system in South London, except the present cable line from Brixton to Streatham, will be worked by electricity. Until the Council's power-houses have been built electric current will be obtained from the South London Electric Company's mains.

Windsor.—The Metropolitan District Tramways Company have not been successful in their application for a light railway order to construct a line from Windsor to Maidenhead. The official enquiry into the matter was held by Colonel Boughey and Mr. Stewart at Windsor on Tuesday, when evidence in favour of the promoters' scheme was given by Sir Alexander Binnie, engineer, the Mayor of Maidenhead, and others. Without calling upon the opposition, Colonel Boughey said the Commissioners considered the case for the promoters had not been sufficiently proved, and they might add for general information that in their opinion, first, the extent to which the line would serve the public as presented by the witnesses called was not considerable nor such as would give a reasonable prospect of profit to the promoters of the undertaking; secondly, that some of the road authorities opposed, and the Commissioners considered the narrowest parts of the road might have been widened if the promoters had sought the necessary powers; thirdly, that considerable opposition from the landowners had been disclosed, which was entitled to some consideration. The application was, therefore, refused.

London Underground Railways.—The announcement was made in Thursday's *Times* that an agreement has been arrived at between Mr. Yerkes and Messrs. Speyer Bros., Speyer and Co., and the Old Colony Trust Company, of Boston, for the formation of a new company, which has been registered under the name of the Underground Electric Railways Company of London, Limited, with a capital of £5,000,000 sterling, for the purpose of electrifying the District Railway and building and working by electricity the following lines: the Brompton and Piccadilly Railway, the Great Northern and Strand Railway, the Charing Cross, Euston, and Hampstead Railway, and the Baker-street and Waterloo Railway. Particulars received state that the mode of construction proposed and the character of the work generally is to be similar to that adopted on the Central London Railway. The lines will be double throughout, each road being carried in separate tunnels, lined with cast iron. These tunnels will be constructed for the greater part of their length through London clay, will be driven in the ordinary way by means of the "Greathead" shield, and at such depths as to avoid interference with the sewers, gas, or water mains. At the stations there will be platforms of 300ft. in length and 11ft. in width. Lifts and stairways will also be provided. Facilities are to be given for the interchange of traffic where the lines cross each other and where they are adjacent to existing railways. Current for the proposed railways will be obtained from the central power station proposed to be constructed in Lot's-road, Chelsea. The electrification of the District Railway will considerably raise the speed of the trains, which, it is stated, ought to be 14 or 15 miles per hour, including stops. The working expenses should also be greatly reduced. Messrs. Speyer Bros., in conjunction with Messrs. Speyer and Co., of New York, and the Old Colony Trust Company, of Boston, are forming a syndicate to take the whole of the share capital of the Underground Electric Railway Company of London, Limited, which will carry out the construction of all these roads. The articles of association provide that the above-mentioned firms so long as they hold any shares in the company, will elect the majority of the board of directors for the period of 10 years. It may take five years to build the whole system of railways comprised in the scheme. The necessary powers to construct the lines in question have already been obtained by Parliament. The Underground Electric Railways Company will receive in payment for construction of the above lines stocks of those railways which Parliament has authorised, and the above arrangement practically means that Messrs. Speyer Bros. will stand ready to market the securities as work progresses, providing thereby the necessary funds to carry out Mr. Yerkes's comprehensive scheme, which has been thoroughly examined by competent experts on behalf of the above firm.

LIGHTING AND GENERAL.

Pacific Cable.—Reuter wired on Thursday that the Pacific cable had reached Fiji.

Portsmouth.—The first underground conduit of the new municipal telephones has been laid.

Carlisle.—The Council have agreed to apply for leave to borrow £24,000 for electric lighting extensions.

Lytham.—The Urban District Council have decided to advertise for tenders for an electric lighting plant.

Pinner.—It appears that the inhabitants of Pinner desire that the telephone service should be extended to them.

Share Market.—During the week there has been a steady business doing in electric shares, with slightly improved prices.

Nelson.—The Town Council have received sanction to the borrowing of £25,000 for electricity station and supply purposes.

Belfast.—Councillor George Andrews, J.P., has been re-elected chairman of the Gas and Electric Committee for the ensuing year.

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Ainsdale.—The Parochial Committee are sending a deputation to the manager of the Southport exchange with a view to obtaining a call office or exchange.

Malling.—The Rural District Council intend to petition the Postmaster-General to allow the Tunbridge Wells telephone license to be extended so as to include Malling.

Sunderland.—The electrical engineer has been authorised to visit Berlin and some English towns to report on the distribution of electrical energy for three-phase currents.

Melrose.—The Town Council have appointed a committee to confer with the asylum authorities and Messrs. Crompton and Co. with regard to the introduction of electric lighting.

Rochdale.—Advertisements are to be issued inviting contractors to supply particulars of methods under which they would be willing to carry out free or easy wiring in the borough.

Middlesbrough.—Mr. H. M. Taylor, of the British Westinghouse Company, London, has been elected electrical engineer to the Corporation at a commencing salary of £250 per annum.

Newtown (near Oswestry).—The Urban Council have agreed to support the telephone extension proposed by Mr. Denniss and to join in a guarantee to an extent not exceeding £150 per annum.

Maidstone.—The Urban District Council intend to apply for sanction to borrow £1,145 for erection of a coal-shed and travelling crane at the electricity station, and the laying of a permanent way.

West Hartlepool.—The gross profit on the electric lighting works for the past year was £1,238, about 3 per cent. on the capital involved, and it is estimated that the ensuing year will yield 7 per cent.

Sheffield.—The Electric Light Committee have requested Mr. Robert Hammond to visit Sheffield and examine the site of the proposed power station, and report on the scheme and plans prepared by Mr. Fedden.

Gosforth.—The Urban District Council have decided to allow the Newcastle Electric Supply Company to lay a power cable to the brickworks at Low Gosforth, owing to a portion of the cable being proposed to be overhead.

Warrington.—The receipts of the Town Council's electricity department for the past year amounted to £3,380. 5s. 9d., and the expenditure, excepting interest charges, to £2,100. 18s. 11d., leaving a gross profit of £1,279. 6s. 10d.

Mold.—The Highway, Lighting, and Watering Committee have been collecting information as to the cost of installing electric light for street-lighting purposes. We understand that they are corresponding with Mr. G. R. Peers in the matter.

Meters.—We are informed that the Wimbledon Urban District Council, as well as several other central stations, have renewed their contract with the Electrical Company, Limited, Charing Cross-road, W.C., for the supply of meters for the ensuing 12 months.

Newcastle.—The Finance Committee are negotiating with the Tramways Committee as to the terms upon which the latter committee will supply such electric lighting and other electric energy as may be required in connection with the various properties of this Corporation.

Northern Section of National Association of Electrical Contractors.—An open meeting of this association is to be held in Liverpool on the 19th inst. We note that during the present year contractors' associations have been formed in Liverpool and Manchester.

Manchester Institution of Electrical Engineers.—At Tuesday's meeting of the Manchester Section of the Institution of Electrical Engineers, in the new physical laboratory at Owens College, Mr. A. R. Bellamy delivered an address on "Large Gas-Engines for Driving Electric Generators."

Stockton.—The Town Council have received sanction to borrow the sum of £26,730 for electric light purposes, £21,000 being in respect of new works. A committee has been appointed to confer with the borough engineer with reference to the temporary repairs necessary to be done to the shambles.

Lectures.—Lectures on the domestic uses of electricity and demonstrations of electric apparatus are to be given at Brechin and at Montrose. In the former case the Town Council have agreed to pay the lecturers a fee of 10 guineas, in the latter residents are paying the cost, but the Council have granted the use of their hall.

Anglo-American Telegraph Co.—After placing £6,000 to the credit of the renewal fund, the directors declare an interim dividend for the quarter ended March 31 of 12s. 6d. per cent. on the ordinary stock and £1. 5s. per cent. on the preferred stock, less income tax, payable on May 1 to the stockholders registered on March 31.

Lanark.—The proposed combined scheme for destruction of refuse and electric lighting at Cambuslang has been approved, and application is to be made to the Standing Joint Committee for consent to the capital works involved, and to the County Council for borrowing the amount of the estimated cost of the scheme—namely, £10,000.

Rhodesia.—A 20-h.p. compound engine from the works of Messrs. Robey and Co., Limited, has been installed at the new brick and tile making works of Messrs. Taylor, Jarvis, and Short, Salisbury, Rhodesia. The new engine equipment of the Buluwayo electric lighting works was supplied by Messrs. Robey and Co., Limited.

West Bromwich.—Mr. G. H. Tulloch has held an enquiry into an application of the Corporation for sanction to borrow £10,000 for extensions, improvements, and new machinery at the borough electricity works. Mr A. Caddick (town clerk) and Mr. A. D. Greatorex (borough engineer and surveyor) gave evidence, the latter producing his plans.

Hamilton.—At a meeting of the Town Council on Wednesday the question of a generating station for the burgh electric lighting was settled. Almada Hill, which was acquired a couple of years ago as a reception house in connection with the threatened epidemic of smallpox, is to be offered to Messrs. Edmundson's, who are to work the proposed system.

Bristol.—The Town Council on Wednesday adopted a report of the Sanitary Committee, which recommended the addition of 366 arc lamps. It was estimated that the net cost would be £2,783 a year, and the total number of arc lamps in the streets would be 676. The Council agreed to the principle of extension, but postponed its application to streets.

Oriental Telephone and Electric Co.—The directors have resolved to recommend, subject to final audit of the accounts, the payment of a further dividend of 3½ per cent., free of income tax, making with the interim dividend paid on Oct. 31 last a total of 6 per cent. for the year ended Dec. 31, 1901. The transfer books will be closed from April 19 to 30, both days inclusive.

Southport.—The Electricity Committee estimate that they will be in a position when the accounts for the year ending March 31 are closed to hand over the sum of £2,000 in aid of the rates. Provision has been made for the extension of the present electric lighting suppiy to the end of Lord-street. In the Jubilee year the Electricity Committee supplied all public illumination free, and this policy will be again followed.

Country Telephones.—With regard to a paragraph which is going the round of the daily Press stating that telephones are in extensive use in Western America on the farms, part of the service being to distribute the news to the remoter farms, a correspondent from a place near Christchurch (Hants) writes to the *Globe*: "We are anxious to get a telephone to our works here, four miles from the railway station. For two years we have been trying to secure the consent of landlords for poles to be set in the road opposite their fields."

Tunbridge Wells.—The electrical engineer has been instructed to obtain a quotation for the building of a chimney shaft. At the last committee meeting the engineer produced a length of cable which had been damaged owing to a pick being driven into it, and pointed out the importance that every opening in the streets should be reported to the electric lighting department. It is proposed that each department of the Corporation should give notice to the electrical engineer whenever they intend to break the surface of the streets.

Poplar.—The Engineering Committee of the Board of Guardians reported at the last meeting upon a report from the architects with reference to the electric lighting and the hot and cold water service for the new buildings in connection with the medical officers and female officers. They recommended that the consulting engineer be instructed to examine and report as to the best arrangements with reference to the water service, and to supervise the work of wiring the new buildings for electric lighting. Mr. Giles, the electrical engineer to the Board, was, however, instructed to undertake the work.

Italy.—A syndicate has just been started at Milan with a nominal capital of £3,200,000 to acquire anywhere in Europe water right, and to lay down electrical plant in connection with the power so derived. The engineer, Usrio Alzria, is the principal promoter, and the Bank of Marseilles, which is financing the Continental Water and Electrical Power Syndicate, the Mont Cenis Power and Land Company are moving in the matter. They have already worked out schemes providing for three installations in Upper Italy, with plants of 140,000 h.p., 47,000 h.p., and 32,000 h.p. respectively, and a capital of £2,280,000.

"Institution Journal."—Part 155 of the *Journal* of the Institution of Electrical Engineers, editedby Mr. W. G. McMillan, secretary (E. and F. Spon, Strand), contains the following papers, with the discussions thereon: "Some Principles Underlying the Profitable Sale of Electricity," by Mr. Arthur Wright, associate member; reports of committees on the Institution visit to Germany in 1901; "Earth Currents Derived from Distributing Systems," by Mr. E. B. Wedmore, associate member; "Note on Alternate-Current Diagrams and the Testing of Motor Losses" (Birmingham Local Section), by Dr. W. E. Sumpner, member; "An Account of the Visit of the Institution of Electrical Engineers to Germany, June, 1901" (Dublin Local Section), by Mr. P. S. Sheardown, associate member; "The Breaking of Shafts in Direct-Coupled Units due to Oscillation set up at Critical Speeds" (Manchester Local Section), by Mr. Julius Frith, associate, and Mr. E. H. Lamb, B.Sc.; together with an abstract of a paper entitled "Electrical Car Equipments and their Maintenance" (Newcastle Local Section), by Mr. A. W. Wigram, associate.

Banbury.—The Town Council have referred to the Streets and Roads and Lighting Committee a letter from the Board of Trade, enclosing a description of the systems proposed to be adopted by the undertakers under the Banbury Electric Lighting Order, 1900, for the supply of energy, in the form in which the Board proposed to approve it, for any observations the Corporation of Banbury might wish to offer. The letter stated that the undertakers proposed to connect part of the electrical circuits with earth, and had applied to the Department for their approval under the provisions of Section 10, Sub-Section C, of the schedule to the Electric Lighting (Clauses) Act, 1899, as incorporated with the order. The Board were advised that the earth connection might be allowed under certain conditions, and they proposed to approve it in the terms and subject to the conditions set forth in the accompanying draft approval, which provided for a continuous-current direct supply at a pressure not exceeding 230 volts between the adjacent conductors of a three-wire system, and of about 550 volts for power purposes. The mains would be three-core or concentric armoured and laid in the ground, or would be laid in troughing filled in solid with composition. The low-pressure alternating current would be a three-phase supply at a pressure not exceeding 240 volts between phases and at a frequency of 50 complete periods per second, and of about 500 volts for power purposes, and those mains would be either three-core or separate single-core cables, laid armoured direct in the ground or in troughing filled in with composition.

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Epsom.—The electrical engineer's last report states that there are now 80 lamps connected to the public lighting. In consequence of his recommendation to adopt time switches so as to save the expense of an extra hand, it has been resolved to include the purchase of 30 time switches, at an estimated cost of £4 each, forming part of the £10,900 loan.

Night Calls.—Hitherto the smaller towns and villages of the country have been greatly inconvenienced by the shutting off of telegraphic communication with neighbouring towns at an early hour of the evening. The Postmaster-General is now, however, experimenting in the north-eastern postal district, which includes Yorkshire and Durham, with a new system whereby each rural telegraph office will be able to obtain communication with its head office at any time of the night.

Yarmouth.—The following charges for current for power purposes are to be made in future: 2½d. per unit up to 1,000 Board of Trade units, 2d. per unit up to 2,000, and 1½d. per unit from 2,000 up to 5,000 units. The Electric Lighting Committee offer to supply the current free of charge for illuminating the public buildings at the time of the Coronation, provided the General Purposes Committee furnish the necessary appliances. The new station of the Great Eastern Railway at North Lowestoft is to be lighted with electricity, and the Council will be asked to supply the current.

Derby.—The Town Council have instructed the Parliamentary Committee to reconsider the question of municipal telephones. Information from other towns is to be obtained, and an opportunity will be given to a deputation from the Chamber of Trade to wait upon the Council in the matter. It will be remembered that the Chamber of Commerce is greatly in favour of the introduction of municipal telephones, while the committee thought that the present moment was not opportune in the face of other liabilities already incurred by the Council. The electric lighting mains are to be extended to Bromley-street (Park Grove Estate).

Cheltenham.—The last report of the Lighting Committee states that there are at present 570 customers of the electric light, with the equivalent of 35,760 8-c.p. lamps connected to the mains, and applications are under consideration for the supply of the light to about 20 intending customers. It has been resolved to give the preliminary notices with a view to making application to the Board of Trade for an amendment of the Cheltenham Electric Lighting Order, 1890, by extending the area of supply described in the first schedule, to comprise the parishes of Prestbury, Bishop's Cleeve, Leckhampton, Swindon, Southam, Woodmancote, and Brockhampton.

Stock Exchange.—The Stock Exchange Committee have appointed April 16 a special settling day for City of London Electric Lighting Company's further issue of £100,000 4½ per cent. second debenture stock (redeemable), and Westminster Electric Supply Corporation's 28,141 5 per cent. cumulative preference shares of £5 each, £2. 10s. paid, Nos. 110,101 to 138,241. They have ordered the undermentioned securities to be quoted in the official list: Axminster and Lyme Regis Light Railway's £55,000 stock; City of London Electric Lighting Company's further issue of £100,000 4½ per cent. second debenture stock (redeemable); and Westminster Electric Supply Corporation's 28,141 5 per cent. cumulative preference shares of £5 each, £2. 10s. paid, Nos. 110,101 to 138,241.

Aberdeen Telephones.—The committee's canvass for subscribers to the proposed municipal telephones is proving highly satisfactory and encouraging. The rate offered—which may be reduced should the support received warrant it—is £6. 6s. per annum for an unlimited service, and £3. 10s. for restricted service, with 1d. in addition on each call originated by the subscriber. Nearly all the answers that have as yet come in are from those who already use the telephone, and are willing to support the municipal scheme, the only negative or uncertain replies being from several who have not the telephone at present. The committee only await replies from the remainder of those communicated with before finally recommending the Town Council that the municipal telephone service be at once proceeded with.

Post Office Appointment.—Mr. C. E. Stewart, controller of telegraph stores, who has retired, is succeeded in the appointment by Mr. Hooley, controller of postal stores, who henceforth will have charge of the combined departments. Sir George Murray, secretary to the Post Office, is introducing many administrative reforms within the department. His aim is to reduce the number of small sections, and as far as possible to minimise the number of scales of pay with which the postal estimates are encumbered. The amalgamation of the two stores departments has abolished a controllership worth £900 per annum, while raising the maximum of another post by £200. It is understood that the telegraph factories at Mount-pleasant and Holloway will be placed under the recently-appointed engineer-in-chief, Mr. Gavey.

Airdrie.—The following minute, being an extract of a letter sent to the Scottish House-to-House Electricity Company, Limited, has been approved by the Town Council: "The Fire and Lighting Committee of the Town Council are of opinion that the compulsory area can best be lighted as follows: 111 16-c.p. lamps, at 40s., £222; five 16-c.p. lamps, all night, at 60s., £15; 10 arc lamps, dusk to 11 p.m. (including maintenance, carbons, and trimmings), at £14, £140; 10 16-c.p. lamps, 11 p.m. to dawn, at £2, £20—total, £397. The arc lamps from dusk to 11 p.m. do not appear to be provided for in the agreement of Dec. 12, 1900, at £14 each. The committee think that £14 is too high, and ask that the rate should be £13. The exact position of the lamps would be settled by the burgh surveyor and the company's local engineer."

Bath.—The Town Council have again refused to consider any offer for the acquisition of the electric light undertaking by the Bath Gas Company, or to give any facilities to the directors of the company to view the electricity works, as they do not desire to dispose of the works to a company in such a way that they would lose all competition for public lighting in the city. The report of the Electric Light Enquiry Sub-Committee, presented on Tuesday last to the Council sitting as the Electric Light Committee, has been adopted, and the Enquiry and Management Sub-Committees will be amalgamated, so as to form one committee, with power to take all the steps necessary for an application to the Local Government Board for their sanction to a loan for a sum not exceeding £25,000 for the purposes of the electric light undertaking, and with power to obtain and deal with tenders.

Dungannon.—At the last meeting of the Council a report of the committee which lately visited Larne in connection with the electric lighting scheme was discussed. It was stated that the Council had obtained a provisional order for the supply of electric light only, and that any other project now would mean commencing anew. The electric lighting plant would cost about £4,000, whereas when the Council discussed the question of taking over the local gas company's works they were prepared to offer £10,000. The interest saved on the difference between those sums would pay for the working expenses of the electric lighting, and in addition they would have new plant instead of old, and a revolution would be accomplished in the matter of light. A special meeting of the Council will be held to discuss the subject at an early date. A hearty vote of thanks was accorded to the town clerk of Larne and to Mr. Smith, the electrical engineer, for their courtesy and assistance to the deputation.

Blast Furnaces.—The Normanby Ironworks Company, Limited, have just introduced at their Cargo Fleet Ironworks, near Middlesbrough, an extensive electrical plant for the operation of the pig-iron bed crane, the pig-breaker, and the blast-furnace hoist, as well as for the lighting of the shops and offices. It is believed that this is the first instance in the North of England of electricity being used for the working of a blast-furnace hoist. The change has been made with a view to facilitating the lifting of raw materials from the base level. The hoist motor is arranged to develop from 120 b.h.p. to 150 b.h.p. when running at a speed approximating 450 revolutions per minute. An automatic brake is fitted to the motor, so as to bring the hoist to a standstill in the event of the current being cut off, either intentionally or otherwise. The liquid switch is fixed at the bottom of the hoist, and is fitted with automatic steering gear to throw the switch out of action, when the cages reach a certain level, without being stopped by the attendant.

London Gazette.—The partnership existing between M. Lawton, W. J. Charles, and A. Watson (trading as Alfred Watson and Co.), electrical engineers and electrical accessories manufacturers, 180, Hockley-street, Birmingham, has been dissolved by mutual consent.—The first meeting in the estate of L. Bayliss (carrying on business as F. Terrill and Co., Cordwell and Co., and the Thames Electrical Manufacturing Company), electrical accessories manufacturer, Ridding-lane, Wednesbury, Stafford, will be held to-day, at 11.30 a.m., at Official Receiver's Offices, Wolverhampton, and the public examination on April 17, at 11.30 a.m., at Court House, Walsall.—Mr. A. Beavis, 11A, Union-court, Old Broad-street, E.C., has been appointed trustee in the estate of J. H. Redgrave, electrical engineer, lately carrying on business at 53, Regent House, Regent-street, London, but whose present address is unknown.—The estate of A. W. Hirst (trading as Hirst and Co.), electrical engineer, St. Michael's-road, West Croydon, Surrey, has been released from trusteeship.

Scunthorpe.—A combined electric lighting and pumping plant has just been completed for the Trent Ironworks (W. Shakespeare), Scunthorpe. It consists of a dynamo by the Electric Construction Company, of Wolverhampton, giving 143 amperes at 280 volts, one 13-b.h.p. motor, one 7-b.h.p. motor, three arc lamps, and 100 incandescent lamps. The motors, coupled direct to centrifugal pumps, are distant from the works a mile and a mile and a half respectively, and are capable of pumping 600 and 300 gallons per minute, lifting the water 30ft. from the mines into the drain. They can be started and stopped from the works, and, being self-oiling, will run continuously day and night when required. The power generated is from the surplus gas from the blast furnaces, thus effecting a great saving. The whole plant has been arranged by the manager, Mr. G. E. Drury, and the work carried out by Mr. Henry Hall, of Scunthorpe, who has done a great deal of electrical work both in North Lincolnshire and in South Africa. The slag breaker at these works is to be driven by electrical energy in the near future.

Barnsley.—The Town Council on Tuesday decided, owing to the satisfactory progress made by the electric light department, to reduce the price from 4½d. to 4d. per unit. During the past year the plant has been considerably extended, whilst the original plant and mains have been maintained in a good degree of efficiency. During the year £9,747. 17s. 9d. has been spent out of capital on machinery, leaving yet unexhausted borrowing powers to the extent of £4,536. 19s. 7d., £2,500 of which is reserved for works now in hand. The number of consumers has increased from 209 to 280, and 14 are now waiting to be connected. The number of arc lamps has been increased from 15 to 27, and 41 motors of 191 h.p. are now in use, and eight of 100 h.p. on order. The output has increased from an equivalent of 14,825 8-c.p. to 22,183 8-c.p. lamps. The total cost of the works has increased by £731. 9s., but owing to savings in other departments amounting to £148, this amount is reduced to £583. 9s. The revenue, however, has increased in more than a corresponding degree. The total receipts from the sale of current amounted to £4,460. 14s. 9d., and fittings £149. 6s. 1d., and the year's profit amounted to £2,543. 4s. 3d., or an increase of £292. 8s. 9d. over last year.

Cardiff Electric Light.—Mr. Arthur Ellis, in his last report, estimated that the financial year of the Lighting Committee just ended would result, after the payment of all costs, in a profit of £1,000. Interest and repayment of capital for the year would amount to £5,600, and the profit would be equivalent to 7 per cent. on the capital. He also stated that there was an increase of 32 per

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cent. in the revenue for February as compared with the corresponding month last year, and that applications were flowing in for light and power from tenants of the Cardiff Railway Company on the Moors, while the plant was now in a highly efficient state. The cost of working, including interest and repayment of capital, for the month of March worked out at 2¼d. per unit. The quantity of current generated during the past 12 months was 1,287,795 units, against 917,000 units in the previous year. Wages had remained the same, but 370,795 more units had been produced. The Board of Trade have approved of the alteration from the alternating to the continuous-current system. A scheme for the lighting along the tramway routes is being prepared by Mr. Ellis, and the town clerk is about to report upon an application from the Llanishen Parish Council for an extension of the Corporation electric mains to that district, where most of the houses are prepared to take electric light and where it is intended to adopt street-lighting.

Swansea.—The last report of Mr. Prusmann, the engineer, states that 200 consumers were unconnected with the mains, and there were 23,166 lamps. The maximum load during the month was 12,188 c.p. Generally the increase in the number of consumers and lamps had been satisfactory, while enquiries as to the supply of electrical energy had increased enormously, these not only relating to lighting customers, but, to a great extent, to large power consumers. Tenders have been received for the erection of two 600-kw. continuous-current steam dynamos, together with the condensing plant for each engine, and all steam-pipes, valves, connections, etc., from 27 firms, 21 being British. No decision was come to with respect to the dynamos pending the receipt of further information, but it has been decided to recommend the acceptance of the tender of Messrs. McLaren for the boilers, etc. A letter from the South Wales Electric Power Distribution Company, asking permission to run mains into the area of the Corporation, from which they were excluded by the Act of 1900, is before the electrical engineer for report. The Corporation Municipal Telephone Committee are making progress. Mr. Bennett is preparing plans for submission at the Local Government Board enquiry. There are already 369 subscribers (including the Corporation), while 190 agreements have been actually signed. Mr. Bennett has stated that with 400 the Corporation would be safe. It is estimated that these subscribers would produce a credit balance of £500. The municipal exchange is to be opened on Jan. 1 next, and three months' free use of the telephones will be given to all subscribers who sign before April 30. The surveyor is preparing plans for the new exchange to be built on Corporation land situate at the rear of Pier-street.

Power Plant for Sale.—The Dublin United Tramways Company are about to sell by private treaty the generating plant (described as in first-class condition) erected at their depôts, Clontarf and Ballsbridge, and which are superfluous, owing to the erection of the main generating station at Ringsend, from which they now work the whole of their tramway system. The Clontarf station was opened in November, 1897, and the Ballsbridge station in May, 1896, and both of which stations were closed in January, 1900, and the plant therein is as follows: At Clontarf—three Babcock and Wilcox boilers, steam pressure 150lb. per square inch; complete piping in duplicate ranged from boilers to engines and pumps and exhaust; two Worthington feed pumps; one Green's economiser of 160 tubes; a cast-iron water-tank; two M'Intosh and Seymour tandem compound horizontal engines, with direct-driven 150-kw. dynamo; two General Electric M.P. 6-150-200-type generators, 150 kw. capacity, direct connected to engine shaft, designed for 500 volts at 200 revolutions per minute; two generator panels suitable for above generators, consisting of polished slate slab with the various instruments; one crane, capable of carrying six tons, run on gantry rails (span 41ft.); one negative booster of 30 kw. capacity, with switchboard panel of polished slate and all necessary instruments and connections. At Ballsbridge—four central-valve engines by Messrs. Willans and Robinson, H.H. size, running at 380 revolutions per minute, and capable of giving 150 b.h.p. each continuously, and up to 175 momentarily; five 16in. Camel brand leather belts, 43ft. long each; four Babcock and Wilcox water-tube boilers; one Green's economiser of 192 tubes, with standard soot-cleaning gear; one two-ton Jessop's crane, 31ft. 6in. span, all motions worked by ropes from floor; two 120-kw. belt-driven 2,500-volt 30-cycle three-phase British Thomson-Houston generators, 600 revolutions per minute, 500 volts excitation, with one spare armature; one 300-kw. General Electric three-phase alternator, 2,500 volts, 150 revolutions per minute, 500 volts excitation, direct connected to McIntosh and Seymour cross-compound vertical engine; two high-tension feeder panels; three three-phase 2,500-volt generator panels; one Board of Trade panel and a large number of instruments; four 60-kw. three-phase motors—speed 600 revolutions per minute, volts 2,500, cycles 30, with one spare armature; one 30-kw. 500/100 motor-generator, with panel. Details appear in our advertisement columns, and further information can be had on applying to the secretary, 9, Upper Sackville-street, Dublin.

PROVISIONAL PATENTS, 1902.

MARCH 25.

7201. An improvement in electrically-lighted portable time-pieces. Mappin and Webb, Limited, and William Ernest Saunders, 158, Oxford-street, London.

7203. An electromagnetic arrangement for turning points at tramway crossings and on the permanent way. Joseph McKernan, 3, Bateman-street, Horwich, near Bolton.

7207. Improvements in and relating to the working of electric or other tramway or railway points. William James Stewart, 96, Buchanan-street, Glasgow.

7215. Improvements in insulating and protecting underground cables. Guy Clement Hurrell, 14, Haydon Park-road, Wimbledon, London.

7216. Improvements in pipes or conduits for electrical conductors. Guy Clement Hurrell, 14, Haydon Park-road, Wimbledon, London.

7257. Improvements in and connected with the manufacture of electric conductors for use as leading-in wires or strips in the manufacture of incandescent electric lamps, vacuum tubes, and the like. Sherard Cowper-Coles and the Cowper-Coles Inventions Development Company, Limited, 3, Clements-lane, Lombard-street, London.

7258. An improvement in holders for electric glow lamps. Amy Ashton Bence, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

7260. Improvements in and relating to electric incandescent lamps and to means for connecting the same in electric circuits. Henry John Leeves-Johnson, 322, High Holborn, London.

MARCH 26.

7314. Improvement in armatures for electric motors. Jacob Wilhelm Hacussler, 57, Barton-arcade, Manchester. (Complete specification.)

7321. Improvements in electric incandescent lamps. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

7322. Improvements relating to apparatus for testing telephone, telegraph, and the like lines. August Eckstein and Arthur Brooker, Peel Works, Adelphi, Salford, Manchester.

7323. Improvements in etheric telegraphy. The Scottish Wireless Electric Syndicate, Limited, and Walter Jamieson, 116, Hope-street, Glasgow.

7324. Improvements in etheric telegraphy. The Scottish Wireless Electric Syndicate, Limited, and Walter Jamieson, 116, Hope-street, Glasgow.

7348. Improvements in coin-freed meters for gas and electricity. George Browne Smith and Ernest William Smith, 33, Cannon-street, London.

7351. Improvements in electric time switches. William John Carter, Fife House, Kingston-on-Thames.

7361. Improved method of connecting continuous-current motors to the supply network on starting. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

7362. Improvements in electrical locking gear for railway signals. Siemens Bros. and Co., Limited, and Luiz Moraes Gomes Ferreira, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

7363. Improved electrical resistance and the application thereof to a switch. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

7370. Improvements in electric cables. Julius Henrik West, 46, Lincoln's-inn-fields, London.

7380. Improvements in electric arc lamps. Frank Proctor, 40, Chancery-lane, London.

7383. Improvements in electric arc lamps. Paul Högner, 18, Buckingham-street, Strand, London. (Complete specification.)

7365. Improvements in electricity meters. Charles Orme Bastian, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

MARCH 27.

7401. Improvements in and relating to tumbler and other switches and their terminals for electrical lamps and power installations. Hugo Hirst and Henry Bevis, 71, Queen Victoria-street, London.

7405. Improvements in conduits for electric cables and the like. Joseph Place and Sons, Limited, and William Henry Plaice, Commercial-street, Halifax.

7420. Improvements in and relating to electrical switches. George Sperryn and William Henry Wood, 104, Colmore-row, Birmingham.

7447. Improvements in electric transmission of power. Otis Elevator Company, Limited, 55, Chancery-lane, London. (Otis Elevator Company, Incorporated, United States.) (Complete specification.)

7475. Improvements in electric incandescent lamps. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

7477. Improvements in the means for conveying rail-ways and pipes and electric leads through towns and populous districts. Illius Augustus Timmis, 2, Great George-street, Westminster, London.

7478. Improvements in galvanic batteries. Phillippe Delafon, 53, Chancery-lane, London.

7486. Improvements in speed limiting devices for rotary machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Hermann F. T. Erben, United States.) (Complete specification.)

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7484. Improvements in apparatus for transmitting electrical impulses and signals. George James Hicks, 23, Southampton-buildings, Chancery-lane, London.

7487. Improvements relating to systems of electric railways. The British Thomson-Houston Company, Limited, and Hans Sigismund Meyer, 83, Cannon-street, London.

MARCH 29.

7510. Electric swing top. T. E. Price and T. Price, 20, Spencer-street, Birmingham.

7528. Improvements in electrical switches. John Tomlinson, Henry Lomax, and Ralph Lomax, 57, Barton-arcade, Manchester.

7536. An electric revolving brush. Alfred Ernest Thomas and Joseph Buckley, 6, Exchange-chambers, Birmingham.

7537. An improved safety guard for electric tramcars and the like or similarly propelled vehicles. Robinson Scaling Burn, 6, Finkle-street, Stockton-on-Tees.

7585. An improved method of utilising filaments which are of higher resistance when cold for electric lighting. John Frederick Wakelin, 5, Tottenham-street, Tottenham Court-road, London.

7590. Improvements in or appertaining to electric head-wheels. William Phillips Thompson, 6, Lord-street, Liverpool. (La Compagnie des Mines de Bruay, France.)

7592. Improvements in or connected with telegraph transmitters. Peder Frederik Vilhelm Pedersen and Julius Timm, Norfolk House, Norfolk-street, London.

APRIL 1.

7631. Improvements in continuous-current dynamos, motors, and converters. James Atkinson, Benavie, Marple.

7634. Improvements in and relating to globes or shades of electric, gas, and other lamps. Edwin Soutter and William Soutter and Sons, Limited, 36, Temple-street, Birmingham.

7642. Improvements in or in connection with brushes for commutators for electric machinery. Walter Kirk, 30, Park-row, Leeds.

7661. Improvements in and relating to the electrolytic refining of lead and lead alloys. Anson Gardner Betts, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

7665. An improvement in dynamo-electric machines and motors. Siemens Bros. and Co., Limited, and John Gordon Wilson, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

7670. Improvements in means for generating electricity. Robert Wichand, 39, Hillcrest-road, Acton, London. (Complete specification.)

7684. Improved electric arc light mechanism, applicable for rapid-exposure photography. Albert John Bonnella, D. H. Bonnella and Son, Limited, Ernest Edwin Robert Bryant, Charles Henry Bryant, and Edgar William Bryant, 322, High Holborn, London.

7689. Improvements in electric signalling. Jacob Baker Struble, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

APRIL 2.

7702. Improvements in or relating to electrical ignition apparatus for internal-combustion motors. Henry Thomas Dawson and Henry Alfred Dawson, 18, Hertford-street, Coventry.

7718. Improvements in and connected with electric punka motors. Alfred Zellweger, 4, Corporation-street, Manchester.

7736. Improvements in extinguishing electric arcs. Robert Hamilton Read, 83, Cannon-street, London. (Date applied for under Patents Act, 1901, April 3, 1901, being date of application in Japan.) (Complete specification.)

7760. Improved automatic system or method of preventing accidents caused by short-circuiting or breakage of electric overhead or trolley wires. Reginald Earle Raven, 173, Fleet-street, London.

7773. An improved process of oxidation by means of electric currents. Albert Nodon and Joseph Pietre, 45, Southampton-buildings, Chancery-lane, London.

7782. Improvements in electrically-operated locks. Oskar Könitzer, 18, Buckingham-street, Strand, London.

7783. Improvements in short-circuiters for high-tension electric cables or wires. Oskar Könitzer, 18, Buckingham-street, Strand, London.

APRIL 3.

7792. Improvements in electric cooking and heating apparatus. Ludwig Lutz, 6, Bank-street, Manchester.

7800. An improvement in the construction of machinery so as to avoid the use of a crank in obtaining rotary motion from steam, gas, electricity, explosives, or other sources of power. Edward Sloper Toomer, Preston House, High-street, Sandwich, Kent.

7809. An improved electric arc lamp. Henry Shadforth Scott, Henry Frederick Tyzack, and Thomas James Wright, 3, Beechwood-terrace, Gateshead-on-Tyne. (Complete specification.)

7834. Improvements in supports for incandescent electric lamps. Adolphe Romain and Jean D'Ayguesvives, 6, Lord-street, Liverpool.

7838. Improvements in electric switches. John A. Wright and William Fletcher O'Neill, 40, Chancery-lane, London.

7847. Improvements in and relating to electric traction for vehicles. Eugène Matthys, 45, Southampton-buildings, Chancery-lane, London.

7851. Improvements relating to electrical sterilising and preserving apparatus. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Louis D. Giroux and Louis E. Seddon, United States.) (Complete specification.)

7858. Improvements in and relating to electric vacuum discharge tubes. Michel Krouchkoll, 1, Queen Victoria-street, London. (Complete specification.)

7866. Improvements in and relating to coin-controlled machines for giving electric shocks. The New Polyphone Supply Company, Limited, and Karl Schmidt, 1, Queen Victoria-street, London.

7864. Improvements in or connected with secondary batteries. Hugo Korten, 1 and 4, Mitre-court-chambers, Fleet-street, London.

APRIL 4.

7921. Improvements in electrolytic condensers. Albert Nodon, 45, Southampton-buildings, Chancery-lane, London.

7922. Improved means of and apparatus for the distribution of electrical energy. Jean Renous and Albert Camille Leopold Turpain, 45, Southampton-buildings, Chancery-lane, London.

7923. An improvement in electrolytically coating iron with zinc. Emanuel Goldberg, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

7938. Improvements in splicing electric cables. Alfred Dever Shuter, 24, Southampton-buildings, Chancery-lane, London.

APRIL 5.

7952. Improvements in and connected with flexible electrical connecting cords. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actien-Gesellschaft Mix und Genest, Germany.)

7954. Improvements in electric water heaters. John William Ewart, 46, Dartmouth Park-hill, London.

7955. Improvements in electrical measuring instruments. Sydney Evershed, Woodfield Works, Harrow-road, London.

7957. Improvements in electrical switches. The Electric and Ordnance Accessories Company, Limited, and Robert Frederick Hall, 24, Temple-row, Birmingham.

7989. Improvements in and relating to distribution boards for electrical installations. Veritys, Limited, and William Pipkin, 165, Queen Victoria-street, London.

7995. Improvements in the production of metallic deposits by electrolysis. Peter Jensen, 77, Chancery-lane, London. (The firm of Dr. G. Langbein and Co., Germany.) (Complete specification.)

8014. An improved galvanic dry cell. Georges Schauli and Dolf Loewenstein, 173, Fleet-street, London.

8020. Improvements in or connected with controlling and engaging apparatus for railway points and signals operated by electricity. Alfred Neelemans, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

8021. Improvements in electric distributing systems employing rotary converters. The British Thomson-Houston Company, Limited, and Hans Sigismund Meyer, 83, Cannon-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published April 24.

1901.

4489. Electrolytic cells and electrodes therefor. Vogelsang.

6649. Heater cut-outs and holders for electrolytic incandescent lamps. Quain and Turnbull.

6780. Vessels for use with electrical liquid resistances or other electrolytic solutions. Hirst and Bevis.

7067. Electro-mechanical interlocking apparatus for the safe operation and control of railway signals and points. Sykes.

10743. Electrical engines for surgical and dental purposes. Mayer.

10888. Electric switches. Busch.

11307. Overhead trolleys or collectors for electric tramway or railway vehicles. Wilkinson.

15598. Printing telegraph machines. Shepard. (Date applied for under International Convention, Jan. 3, 1901.)

22183. Connections for telephone exchanges, with automatic switching off of the operator's telephone. Oppenheimer. (Actien-Gesellschaft Mix und Genest.)

24594. Electrically-operated presses for fixing capsules on bottles and the like or for similar purposes. Borie.

26748. Safety indicating and cut-out apparatus for polyphase electric circuits. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

1902.

303. Circuit closers for portable electrical apparatus. Roche.

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1027. Sectional conductor systems of electric railways. Farnham.

3248. Electric signal register and telephone systems. Jensen. (Yurgae Signalphone Manufacturing Company.)

4096. Dynamo-electric machines. Boult. (Hatch.)

4134. Revoluble telephone mouthpiece. Moenninghoff.

4368. Microphones for high-tension currents. Gaillard and Ducretet.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	Apr. 5	570	592	.. 22	31,381	29,283
Birmingham Tramways	—	—	—	—	—	—
Blackburn Corporation	,, 4	987	702	+ 285	8,708	6,943
Blackpool Corporation	Mar. 29	415	147	+ 268	2,351	1,883
Blackpool-Fleetwood Tramways	Apr. 5	718	384	+ 334	3,069	2,268
Bolton Corporation	Mar. 23	1,342	1,238	- 104	14,775	13,738
Bradford Corporation	,, 28	1,937	500	+ 1,407	24,275	9,668
Bristol Tramways Company	Apr. 4	5,467	4,027	+ 1,440	—	—
Carlisle Tramways Company	Mar. 15	122	123	- 1	1,282	1,192
Central London Railway	Apr. 5	6,635	5,654	+ 981	92,475	84,889
City and South London Railway	,, 6	2,862	1,800	+ 1,062	41,802	28,237
Cork E. T. and L. Company	,, 3	495	380	+ 115	4,833	4,621
Darwen Corporation	Mar. 22	169	154	+ 15	1,961	1,844
Darwen-Hoddlesden	,, 14	26	—	—	—	—
Dover Corporation	Apr. 5	249	221	+ 28	2,435	2,219
Dublin & Lucan Electric Railway	,, 6	126	97	+ 29	1,242	1,033
Dublin U. T., electric cars	,, 4	3,815	3,205	+ 610	—	—
Dublin S. District, Electric	,, 4	942	714	+ 228	—	—
Dundee Tramways Company	,, 2	670	532	+ 138	—	—
Glasgow Corporation	,, 5	11,532	8,547	+ 2,985	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 5	1,755	1,724	+ 31	1,755	1,724
Liverpool Corporation	Mar. 29	9,268	8,079	+ 1,189	114,073	101,734
Liverpool Overhead Railway	Apr. 6	1,620	1,607	+ 13	19,489	20,813
Newcastle-on-Tyne Corporation	,, 5	2,265	—	—	—	—
Portsmouth Corporation	Mar. 29	1,473	525	+ 948	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	Apr. 7	4,095	—	—	—	—
Southampton Corporation	Mar. 27	775	537	+ 238	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported :

Anglo-Argentine, £552 decrease.

Barcelona Ensanche y Gracia, £16 increase. Barcelona, £789 increase.

Brisbane, £335 increase (month of March, £10,934 ; increase, £1,789).

Buenos Ayres and Belgrano Electric (month of March, receipts £12,184 ; decrease £647), £278 decrease.

Calcutta, £20 decrease.

Cape Town (month of March), receipts, £17,888 ; expenditure, £7,343.

La Capital Traction and Electric, Buenos Ayres (month of Dec.), £1,394 increase.

Mexico Electric (month of March), receipts, £19,000 ; expenditure, £10,500.

Perth Electric, £505 increase.

Port Elizabeth (month of March), receipts, £3,818 ; expenditure, £1,947.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Tramways.—	£	£
Anglo-Argentine, 1-260,007	5 ..	3¼-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	124-127
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	2¾-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¾-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6¾-7¼
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	102-104 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13¼-14¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12¼-12¾
—— 5 per cent. Perpetual Debenture Stock	100 ..	124-127 xd
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1¾-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5¾
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2¼-2¾
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	102-105
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11¼-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	98-99 xd
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	102-104
New General Traction, Ordinary	5 ..	2¼-3¼
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	99-102
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	9¼-10¼ xd
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	10s. ..	¼
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	50 p.c. ..	50 p.c.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	½-¾
—— Ordinary, 1-125,000	1 ..	¾-⅞
British Insulated Wire, Ord., 1-70,000	5 ..	9-10
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¾-6¼
—— 5 per cent. Mortgage Debentures	100 ..	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5¾-6
Brush Electrical Engineering, Ordinary	2 ..	¾-1
—— Nos. 90,001-105,731	2 ..	¾-1
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-1¾
—— 4½ per cent. Debenture Stock	100 ..	101-104
—— 4½ per cent. 2nd Debenture Stock	100 ..	97-100
Callender's Cable, Debentures	100 ..	111-115
—— Ordinary	5 ..	17-18
—— 5 per cent. Pref.	5 ..	5¼-6
Crompton and Co.	3 ..	3-3¼
—— 5 per cent. Debentures	— ..	100-105 p.c.
Edison and Swan United, Ordinary	3 ..	¾-⅞
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	78-83
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	82-87 xd
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¾-1¾
—— 7 per cent. Cumulative Pref.	2 ..	2¾-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	98-101 xd
W. T. Henley's Telegraph Works, Ordinary	5 ..	17-18
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	99-102 xd
Parker, Thos., Limited, Ordinary	10 ..	15¼-16¼
Telegraph Construction and Maintenance	12 ..	34-37
—— 5 per cent. Bonds	100 ..	102-105
Telegraph Manufacturing, Ordinary	5 ..	10¼-11¼
—— 5 per cent. Cum. Pref.	5 ..	5¾-6 xd
Willans and Robinson, Ordinary, 1-30,000	5 ..	5-10
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	¾-⅞
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	100-104 xd
Bournemouth and Poole, Ordinary	10 ..	11-12 xd
—— 4½ per cent. Cum. Pref.	10 ..	9¼-10¼
—— Debenture Stock, Red.	100 ..	103-106
Brompton and Kensington, Ordinary	5 ..	8¾-9¼
—— 7 per cent. Preference	5 ..	8¾-9¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	8¼-9¼
—— Nos. 20,001-30,000	5 ..	8-9
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14¼ xd
—— ,, ,, £10 Ord.	6 ..	10¾ xd
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	106-108
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5¾
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5¼-5¾
—— 40,501-50,936	5 ..	5-5¼
—— 4½ per cent. Debentures	100 ..	110-113
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	102-105
County of London and Brush Provincial, Ordinary	10 ..	8-9 xd
—— 6 per cent. Cum. Pref.	10 ..	12-13 xd
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6-6¼
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	106-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4-4¼
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	6-6¼
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10-11
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	103-106 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-2
—— 6 per cent. Pref.	5 ..	4-5 xd
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	95-100
Metropolitan, Ordinary	10 ..	14-15 xd
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6¾
Notting Hill Electric Lighting	10 ..	14-15 xd
Oriental, 1879	1 ..	1¼-1¾
—— £5 Shares	5 ..	7¼-8
—— £4½ Shares, New	4½ ..	6¾-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	98-101
River Plate Electric Light and Traction, Deb.	100 ..	65-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	102-104 xd
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1¾-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2¼-2¾
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14-15
—— 7 per cent. Pref.	5 ..	8-9
—— 3½ per cent. Deb.	100 ..	98-101
Westminster, Ordinary	5 ..	11-12
Electric Railways.—		
Central London, Ordinary	100 ..	102-105
—— 4 per cent. Pref.	100 ..	103-106
—— ,, ,, deferred	100 ..	97-100
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-118
City and South London, Consolidated Ordinary	100 ..	65-68
—— Ordinary	10 ..	—
—— Nos. 60,001-70,000	10 ..	—
—— 4 per cent. Debenture Stock	100 ..	112-116
—— 5 per cent. Pref. Stock '91	100 ..	128-133
—— ,, ,, ,, '96	100 ..	123-126
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Telephones.—		
National Telephone, Preferred	100 ..	95-99
—— Deferred Stock	100 ..	60-64
—— 6 per cent. Cum. First Pref.	10 ..	13-15
—— Preferred, 590,001-790,000	3½ ..	3¼-3¾
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¾-5¼
—— 4 per cent. Deb. Stock, Red.	100 ..	93-96
—— 3½ per cent. Deb. Stock, Red.	100 ..	101-105
Oriental Telephone and Electric Company	1 ..	¾-1

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NOTES.

Institution of Mechanical Engineers.—The council of the above institution have arranged to hold a conversazione in the institution buildings on Friday, May 16. Invitations will be issued in due course.

Train-Lighting.—An attempt is being made in the States to light trains by electricity generated by storage batteries under each car. At the present time it is only possible for these batteries to supply lights for 12 hours, but improvements are said to be in progress which are expected to result in a 24 hours' illumination being obtained at a stretch.

Institution of Junior Engineers.—At the meeting of this institution held at the Westminster Palace Hotel on the 11th inst. the paper read was "Notes on Modern Lighthouse Construction," by Mr. G. Drysdale Sweetman, of Ryde. At the meeting on May 2 Mr. Lewis H. Rugg will present a paper on "Some Factors in Colonial Railway Construction."

A Large Induction Coil.—What is reported to be the largest induction coil yet made, and one which produces the longest spark for service in wireless telegraphy, is that recently brought into use between Japan and Korea. The spark it produces is, in fact, a miniature streak of lightning 45in. in length. When in operation the discharge of the spark is said to give off a sound similar to that of thunder.

Institution Arrangements.—Mr. W. E. Langdon announced from the chair on Thursday last week that at the next meeting of the members the Council list of nominations for the session 1902-03 will be introduced. After the adjourned discussion on the subject of electric railways has been concluded at this meeting, a debate will be commenced on "A Form of Model General Conditions for Electrical Construction," which has been presented to the Council by the representative committee appointed.

Lord Kelvin's Visit to America.—By the time these lines appear in print Lord Kelvin will be almost within sight of New York. He sailed last Saturday in the "Campania" for that city. On what mission is not exactly known, but it is stated that his visit to the States is in connection with Kodak, Limited. In any case, it may safely be said that Lord Kelvin's stay in that country will be made the excuse for many a demonstration in his honour, and among scientific men he is sure to be welcomed in that enthusiastic and kindly spirit peculiar to America, and especially New York.

Water-Power Development in England.—It is announced that a scheme is on foot to harness the waterfall on the River Eden, near Kirkby Stephen, Westmoreland, in connection with the generation of electrical energy in that district. The promoters of the enterprise are the North-Eastern Railway Company, who propose to generate electricity by water power for their own purposes. Current would in the first place be used for lighting their Kirkby Stephen station and neighbouring premises. An electric luggage lift is also in contemplation, and it is further proposed to utilise electricity for driving the machinery in the company's workshops at this place.

Thermo-Generator.—According to the Central News, Prof. Thwing, of Syracuse University, has succeeded in producing a thermo-electric generator which he claims will greatly reduce the cost of producing electrical energy. Being a thermo-electric generator, of course the energy will be produced directly from heat, as has been the dream of scientists for a great number of years. No previous investigator in this world has, however, been able to produce such a generator which will compare even approximately in efficiency and cost with the more indirect means now employed for generating electricity from coal. The report should be received with caution until actual figures are given by the professor.

Glasgow Local Section.—An ordinary meeting of the above section of the Institution of Electrical Engineers was held in Glasgow on Tuesday evening, 8th inst., when the chairman, Prof. Magnus Maclean, presented the list of nominations for the office bearers for the next session as follows: chairman, H. A. Mavor; vice-chairman, W. A. Chamen; hon. secretary and treasurer, E. George Tidd; ordinary members of committee, A. R. Bennett, M. B. Field, W. McWhirter, Thos. Young, W. B. Sayers, J. M. M. Munro, W. B. Pickstone, Prof. A. Gray, and David Stewart (representing the associates). Prof. Maclean then introduced Mr. M. B. Field, who read a paper on "Notes on the Testing of Tramway Motors and Investigations into their Character," which lasted about an hour and 45 minutes. Mr. W. A. Chamen opened the discussion with a few congratulatory remarks to Mr. Field, and it was then adjourned till the May meeting.

Manufacture of Steel Rails in Australia.—The manufacture of steel rails for railways and tramways at present does not number among the industries of the Australian Commonwealth or the New Zealand Colonies. Hence all orders for these goods have to be sent abroad, and now that the introduction of electric traction is being so vigorously undertaken by the principal Australasian cities, it is quite evident that the time has come for the manufacture of the rails in the country. We hear that the State of New South Wales is taking a lead in this direction. The Government have under consideration the offer of a private firm to set up a manufactory on the Parramatta River, near Five Dock, with the object of supplying the State with home-made rails. It is said that the proposal is likely to meet with the approval of the authorities, which is not surprising in view of the increasing demand for steel rails in that country, which will undoubtedly become very much heavier as time goes on.

A Tramway Telephone.—A report has reached us of some interesting tests which are now being made in the city of Grand Rapids, Mich., of an electric tramcar telephone, which is said to work successfully whether the car is stationary or in motion. The arrangement includes a couple of copper telephone wires strung parallel with the trolley wire and about 6in. from it on both sides. Connection between these wires and the telephone on the car is effected by a double trolley, and at a point along the track is located a private exchange, through which connection may be made on the cars with the local exchange of the Citizens' Telephone Company. The operator at the sub-exchange can ring up the different cars along the line by the use of a code of long and short signals, and any subscriber of that company may be reached from the cars. Induction defects, due to the proximity of the trolley line, are said to be eliminated by the method of running the telephone wires equidistant and parallel to the trolley wire.

Electricity in Steelworks.—There will shortly be put into operation at the steelworks of Messrs Gilbertson and Co., at Port Talbot, an electric power plant for supplying motive power to the machinery used in the steel process. The works in question cover about 12 acres of land, and when complete are expected to be capable of producing 1,500 tons of steel per week. The electrical installation is being carried out by Messrs. Scott

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and Mountain, of Newcastle, and at present consists of one generating unit of 600 h.p., which besides furnishing energy for power purposes will also supply current for lighting the works. In the millhouse will be installed three 38in.-cylinder horizontal engines, aggregating 1,200 h.p. The boilers are of the Babcock-Wilcox type; there are six batteries of these of 150lb. working pressure each. The hydraulic installation consists of a pair of pumping engines giving 700lb. pressure to the square inch. The cupolas, of which there are three, are capable of turning out 10 tons of molten metal per hour each. They are driven by four Root's blowers. The steel process which will be adopted at these works when they are put in operation, is known as the Bertrand Hill continuous process.

Electricity in British Honduras.—Work has just been begun on the first telegraph line in this British colony. The line will extend from Belize to the Rio Hondo, a distance of 100 miles, and communication with the outside world will be established by a connection with the overland line through Mexico at the Hondo River. It is further proposed that a telephone service should be set up at each of the offices along the line of route, and that the one circuit should be used for both purposes, the telegraphing being discontinued for two hours each day to accomplish this object. We understand that the consent of the home Government has been obtained to the above proposals, and an appropriation of £2,000 voted. Electrical progress in British Honduras is not, however, to stop at this point. A Bill is now before the Colonial Councils by which the district authority are seeking powers to contract for the establishment of an electric light plant in the town of Belize. In the event of such powers being granted, of which there is little doubt, the gloomy oil lamps which at present supply the town with illumination will make way for the electric lamps. The next thing we may expect to hear from this quarter is that the town is going in for electric trams.

Electrical Phenomena in Cosmogony.—Mr. M. I. Skvortzow contributes an interesting paper to a recent issue of the *Revue Scientifique*, in which he discusses the influence of electrical phenomena in cosmogony. He considers that electrical energy has originally played a most important part in the past history of the earth, and that heat energy has become more and more important in proportion as the earth has assumed a more material form, so that the more its energy has passed from the dynamic to the static form, the greater has been the absorption of dynamical energy in overcoming resistances. The author attributes the heat of the earth to electric currents circulating mostly near the surface; the interior of the earth, on the other hand, he thinks may be as cold as the greatest depths of the ocean. Changes in the aspect of the earth, as well as meteorological phenomena, he attributes to electric currents induced by solar influence. With regard to the temperatures of different planets, the author holds that these depend less on their distance from the sun than on their reserve of energy, and on the currents which the sun induces on them by virtue of their axial and orbital motions. We are afraid that Mr. Skvortzow's heterodox views will not bear comparison with known facts.

Reduction of Tantalic Acid in the Electric Furnace.—Tantalic acid has always been regarded as infusible and non-reducible by carbon, and it has remained for Prof. Henry Moissan, the French experimenter, to discover that not only is it reducible in the electric furnace, but that the metal tantalic, or, as it is more commonly called now, columbium, is thereby obtainable in a nearly pure state. To this end the tantalic acid is agglomerated into cylinders with sugar-charcoal, and after calcining is placed in a graphite crucible, which is heated in the electric furnace. The temperature must be very high in order to melt the metal after it has been reduced. A current of 800 volts and 60 amperes is used, and after the mixture has been heated for about 10 minutes the metal is separated in a fused state, and upon cooling has the appearance of a brilliant metallic mass with a crystalline fracture. It is said to be nearly pure, and in some cases contains only 0·5 per cent. of carbon. The cast metal is quite hard, and will easily scratch glass and quartz. It is not fusible in the oxy-hydrogen blow-pipe, but in this case is transformed into tantalic acid. To melt it in the electric furnace requires the use of a very powerful arc. The density of tantalum has been found to be 12·79, while powdered specimens have shown a density of between 10·08 and 10·78.

To Diminish Earth Currents.—In a recent issue of the *Elektrotechnische Zeitschrift* there appeared an interesting article by Ziehl of experiments in which he examined the system, proposed by Kapp, of inserting negative boosters at different places along an electric road in order to diminish the earth currents. We gather from an abstract of the same that with alternating current, such a booster is a simple transformer, the two windings of which are bifilarly wound—*i.e.*, their ampere windings act against each other. The experiments were made in the laboratory, the rails and the earth being represented by suitable non-inductive iron resistance. By varying the number of turns in one winding of the transformers, and hence also the ratio of the numbers of turns of both windings, the author obtained the following interesting result. According to the value of the ampere windings acting against each other, the E.M.F. induced in the transformer winding may be positive or negative—*i.e.*, producing or consuming volts; volts are always produced in that winding the ampere windings of which are overcome by those opposed. It follows that by properly choosing the ratio of the turns of both windings, it is possible to make the earth current either positive or negative or zero. The author concludes that such transformer boosters, as they need no attendance, would be very suitable for alternating-current railways.

Books Received.—We have received from Messrs. Longmans, Green, and Co. a new addition to the Badminton Library, entitled "Motors and Motor-Driving," by Mr. Alfred C. Harmsworth, with contributions by some well-known motorists, including the Marquis de Chasseloup-Laubat, the Hon. J. Scott-Montagu, M.P., Sir David Solomons, Bart., the Hon. C. S. Rolls, and others. The book is not a technical work; it is written in a popular strain, and will be found very entertaining reading to those interested in the subject. It is fully illustrated, and is published by Messrs. Longmans at 9s. We have also to acknowledge the receipt of Dr. J. Livingstone R. Morgan's work, entitled "The Elements of Physical Chemistry." This book is now in its second edition, having been carefully revised and enlarged since its first introduction to the notice of the public. The work is published in London by Messrs. Chapman and Hall, Limited, at 8s. 6d. Uniform with his other manuals, Mr. Ulrico Hoepli, of Milan, has just published an excellent little handbook, replete with diagrams, photographs, and drawings, entitled "Magnetismo e Elettricità," by Prof. F. Gussi. This is really a third and revised edition of the handbook formerly edited by Profs. Poloni and Gussi, and, like its predecessors, deals very exhaustively with the subject, from first principles up to its application to telephones, telegraphs, electric light, and traction.

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Successful Device for Driving Exciters.—A novel method of driving exciters has been successfully adopted in the power-house of the Bay Counties Power Company, which is engaged in the generation and transmission of electrical energy over a very large district in California. It is common knowledge that exciters driven from the main generator are open to the objection that any drop in speed of the latter causes the exciters to drop in voltage, and this in turn lowers the voltage delivered by the generator exactly at the time when, if any thing, increased voltage is needed. The method above referred to, which effectually gets rid of this objection, is described in the *American Electrician*, and is as follows: A 50-h.p. exciter is driven by a 50-h.p. impulse wheel. Coupled directly to the other end of the water-wheel shaft is a 50-h.p. inductor motor. This motor is directly connected to the 2,400-volt 'bus bars of the station. The water-wheel of the exciter is run with its valve open as for full load at all times. When less than full load is on the exciter, the induction motor acts as a generator, delivering energy to the main 'bus bars. If the water-wheel for any reason is interrupted on the exciter water-wheel, the induction motor drives the exciter as though nothing had happened. This method of driving exciters is said to have proved very satisfactory.

University College, London.—A specially appointed committee of the above-named college are making an appeal for funds in aid of higher education and research in London. By the new statutes of the University of London a teaching university has been created. It is impossible, however, for the university to exercise its proper functions with regard to teaching and research until it has capital funds and adequate buildings at its disposal. In order to aid the policy of incorporation, the Drapers' Company have offered £30,000 to the university, and for the same purpose a former student has offered an equal sum to University College. A further sum of £110,000, however, is necessary to free the whole of the existing college buildings for university purposes and render incorporation possible, and it is estimated that over a million sterling will be required in order to perfect and complete the college and to render incorporation fruitful by placing at the disposal of the university funds sufficient to complete the college equipment for higher teaching and research. A public meeting has been arranged to take place in support of the scheme at the Mansion House on May 9, and the Lord Mayor has kindly consented to preside. A detailed statement of the needs of University College, London, with some account of its previous history, and the part it has already played in the increase of knowledge, has been drawn up in support of the appeal, and may be had on application to the secretary at the college. Donations and subscriptions should be sent to the treasurer, Sir R. Farrant, at the college.

A New Paris Station.—On the 4th inst. the new electric supply station of the Compagnie d'Electricité de l'Est-Parisien opened its new station at Alfortville, from which a supply of electrical energy at 5,000 volts will be distributed by means of three-phase currents to a large number of districts in the east of Paris. The more important of these which may be mentioned are Charenton, Saint-Maurice, Vincennes, Saint-Maudé, Saint-Maur-les-Fossés, Ivry, Gentilly, Arcueil-Cachan, Maisons Alfort and Alfortville. At the time this new station was decided upon, the company was already supplying a certain number of the districts independently. Thus, the first supply was for the Saint-Maur-les-Fossés, where an alternate-current single-phase system at 3,000 volts was used to supply transformers to which groups of consumers were connected. In another division semi-portable engines were used to drive dynamos, which, assisted by accumulators, gave a supply on a three-wire system with 200 volts across the outers. In another section, still, there was actually a two-wire supply at 110 volts. As the company extended its sphere of action it was bound to collect its generating plant into one convenient centre, which was selected at Alfortville, on the banks of the Seine, so that the cost of coal was decreased, and also there was the advantage of condensing water. The energy transmitted at 5,000 volts is transformed down in sub-stations placed, as a rule, in the older works, from which secondary networks are fed. The first stone of the new works was laid on Nov. 15, 1900, and on April 6 last three groups of 720 kilo-volt-ampere capacity were completely ready for use. We gather from our contemporary, *L'Industrie Electrique*, that the works are exceedingly well organised throughout.

Multiple-Control System.—Another patent has recently been granted in the States to Mr. H. Ward Leonard relating to the application of his system of motor control to electric traction, the car or train being supplied either with alternating or direct current. Assuming that the line supplies polyphase currents, these currents drive a motor on the car, upon the same shaft of which is a direct-current generator, which in turn supplies current for the car motors. In the case of a train, only one of a number of cars may be supplied with such a motor-generator, or two or more as may be desired. In any case, a line of either three or four conductors extends throughout the train, and all the car motors can be controlled in an extremely simple manner from any car of the train. In the simplest form, a small exciter is attached to the shaft of the motor-generator, and supplies the fields of the car motors and the control circuit, the car armatures deriving their currents from a circuit supplied by the direct-current side of the motor-generator. In this case there are four conductors, two of which supply the motor fields and two supply the generator field. In each of the cars of the train—and, if desired, at each end of each car—is a rheostat across the control line. When the train is at rest all of the rheostats are at the neutral point, and when it is to be put in motion the control of the entire train is effected by means of the rheostat at the point selected, the other rheostats remaining neutral. In describing the patent our contemporary, the *Electrical World*, mentions one arrangement whereby the number of train conductors is reduced to three. A description is also given of the application of the system when a direct-current source of supply is employed, in this case the inventor's counter E.M.F. system of control being used.

The Explosion at Tunbridge Wells.—Mr. M. White, of the Marine Department of the Board of Trade, has now issued his report on the recent explosion of a steam superheater cap at the electric light works, Tunbridge Wells. This explosion was of a violent nature, the cap breaking into a number of pieces, and the connections to the boiler and to the main gauge were broken, displacing the surrounding brickwork. As a result of his investigation, Mr. White finds that the explosion was due to the structural strength of the casting being insufficient to withstand the stresses to which it was subjected. He has, however, no reason to suppose that the ordinary working pressure of the superheater was exceeded. But evidence was forthcoming at the enquiry from the engineer to the effect that the method of working the superheater prior to the accident had been far from satisfactory, especially during the time steam was

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being raised in the boiler. It is said to have been the practice at the Tunbridge Wells works to fill the boiler with cold water before commencing to raise steam, and the inspector finds that this treatment could scarcely fail to have a prejudicial effect on the material, especially when the superheater is hot, owing to the fires being banked. The safety valve was not found after the explosion, but the design shows it to have been of most defective construction. A similar vessel to the one that failed was tested to destruction at the maker's works, and burst under a cold pressure of 350lb. per square inch, so that there is little reason for doubting that the superheater was of insufficient strength for the pressure at which it was worked. In concluding his report, Mr. White expresses the opinion that a more ductile material than cast iron should have been employed for the purpose for which the exploded vessel was used.

The Factory Act, 1901.—We have received a copy of a new book dealing with the Factory and Workshops Act of 1901, by Mr. C. Willoughby Williams, B.A., and Mr. Chas. Musgrave, which we would commend to those electrical engineers who wish to know what their obligations are under the new Act. It will be remembered that under this Act electrical generating stations are for the first time included in the list of factories and workshops, and that by an electrical station is meant "any premises or that part of any premises in which electrical energy is generated or transformed for the purpose of supply by way of trade, or for the lighting of any street, public place, or public building, or of any hotel, or of any railway, mine, or other industrial undertaking." The book is more valuable because the Act in question is a definite advance on any previous legislation of a similar kind, and it confirms and consolidates the bulk of the old law on the subject by largely extending the State regulation of industry as regards health, sanitation, safety, hours of labour, and other matters. The authors have endeavoured to make their expert knowledge on the subject of service to others by inserting at the end of each clause of the new Act, which is gone through in detail, a note as to any alterations which that clause has made in the previous legislation on the subject. Whatever may be the disadvantages of the Act—and it is considered by some that for the electrical industry it has many—we think it is generally of advantage to the community as a whole. It is certainly a good thing to have the whole of the active legislation of the country, as far as factories and workshops are concerned, gathered together in one comprehensive Act. The book, which we recommend to our readers, is published by Messrs. Effingham Wilson, 11, Royal Exchange, E.C., at 3s. 6d.

A Turbine Installation. Our American contemporary, the *Engineer*, in its issue for April 1 illustrates an interesting turbine installation at the Shawinigan Falls, Quebec, which is leased from the Shawinigan Water and Power Company by the Royal Aluminium Company, which now employs electricity in the production of aluminium. The power-house is situate at the base of a hill, and the water is carried from the bulkhead at the top of the hill to the bottom, through a penstock 9ft. in diameter. The penstock passes under the floor of the power-house, and has outlets 6½ft. in diameter opening upward, in which is placed a hydraulic valve; to this is connected the inlet of the turbine flumes. The installation at present consists of two sets of turbines, each in a steel flume. The wheels are of 1,600 h.p. each, or 3,200 h.p. to the unit, and are mounted on a horizontal shaft 10in. in diameter and 30ft. long. After passing through the wheels the water is discharged by cast-iron piping into the tail race below the penstock. At each end of the turbine shaft is direct connected a 930 kw. Westinghouse direct-current generator. An extremely simple method of coupling is employed to connect the wheel shaft with the generator shaft. The coupling has a plate between its faces, so that either generator can be connected by removing two bolts and withdrawing the plate. This leaves 1in. space between the coupling faces, allowing the one generator to be out of service while the other on the opposite end can be utilised. The wheels make 250 revolutions per minute under a head of 125ft. According to the specification, they were required to develop an average efficiency of 80 per cent. from three-fourths to full gate Under test, however, they showed an average efficiency of 82·73 per cent. between seven-tenths and full gate, and an efficiency of 85·38 per cent. at full gate, a remarkably good record for a high head wheel.

Electrical Heating.—The electrical heating of trolley cars has been largely practised in the United States, especially in those places where the electrical energy has been obtained from waterfalls. It is also a common practice to make the rheostats used when starting up heat cars to a limited extent. We understand, however, that La Compagnie des Chemins de fer de L'Ouest has laid down electrical heating plant on a larger scale in the rolling-stock which is being experimented with on their electrical line to Versailles. This line, as has been mentioned before in our columns, is being supplied on the third-rail system. The equipment of each of the coaches consists of 10 heaters let in the floor and covered over by wooden grids, through which the heat rises. The heaters consist of resistances supported in copper for the length of 2ft. 7in. and a breadth of 4¾in. They are connected up five in series, and supplied at the ordinary line pressure of from 550 to 600 volts. Thus the voltage on each of the heaters is about 110. The current taken is one ampere, so that the watts consumed in each carriage come out at 1,100. Assuming that the electrical energy costs 1·44d. per kilowatt-hour, the cost for a day's journey of 16 hours comes out at 2s. 1½d. This energy for heating is for a carriage occupied by 40 passengers. From the information given in our contemporary, *L'Electricien*, the railway company finds this to be a cheaper way of heating than any other it has tried. With heating with hot water replaced every two hours, the cost for the same journey came out at 3s. 9d., with the thermo-cyphon system to 3s. 7d., and with the electric heating to 2s. 5d. In these figures 13 per cent. on the capital expenditure is included for interest and depreciation. Thus the electric heating shows an economy of quite 33 per cent. The mean temperature as measured at the surface of the heaters is 70deg. when the external temperature is at freezing point, and 75deg. with an external temperature of 12deg. The method of construction of these heaters is such that by automatic regulation the temperature of the resistance coils will not rise beyond a certain predetermined maximum.

Electric Haulage in Coal Mines.—The *Electrical World* for the 29th ult. publishes a well-illustrated article by Mr. W. B. Clarke, dealing with the important question of electric haulage in coal mines. As an instance of what can be done in this direction the author quotes the case of the mines of the Berwind-White Coal Mining Company, at Windber, Pa., which embrace a radius of about three miles. Altogether there are seven power-houses for supplying electric energy, the aggregate generating capacity being 2,550 kw. There are 75 miles of underground trolley line, on which 43 locomotives are working. These represent an

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aggregate horse-power of 4,300. In the design and construction of the electric mine locomotive, street railway practice is followed very closely with one notable difference—*i.e.*, the absence of the series-parallel controller in the mine locomotive, rheostats being used in its stead. It is found in locomotive service that a greater load can be started and hauled with the motors in parallel, since the drivers are entirely independent and the slipping of one pair of wheels has no effect on the other. If the motors are in series the counter E.M.F. of the motor driving the slipping wheels limits the current in the other motor and decreases the potential across its terminals, thereby reducing both its torque and its tendency to accelerate. In order that the motors may be operated in series on light service, a commutating switch is incorporated in the reverse cylinder of a modern type of mine locomotive controller. The reverse lever has four "on" positions, two for each direction, one with the motors in series, and the other with the motors in multiple. With regard to what voltage is best adapted to mining operations, the author points out that there is a difference of opinion, some using a potential of 500 volts, while others prefer the lower voltage of 250. Another useful point is the statement that the induction motor with "squirrel-cage" armature is pre-eminently suitable for use in mines, principally on account of the absence of the commutator and of armature insulations. In one case which the author quotes a mining company is using direct current for mine haulage only. For all other purposes alternating-current induction motors are employed and the generators of both types are installed in each of the power-houses, from which current is obtained. From his experience in these matters, no doubt, the writer predicts the frequent use of the double-current generator in mining work.

Dublin Tramway Figures.—A very interesting table of results has been issued by the Dublin United Tramways Company, from which the progress made by the undertaking in the past five or six years may be clearly traced. In this period the lines in the city have nearly all been converted from horse to electric traction, the electric cars being first put on the roads in the last half-year of 1896. In the first six months of that year part of the present system was in the hands of the Dublin Southern District Company, and horse traction was used on the rest, the number of miles run was only 1,526,546, as compared with 3,283,896 in the corresponding six months of the year 1901, or 3,803,353 miles in 1896, against 6,664,914 in 1901. In a space of five years this must be regarded as a very satisfactory increase, due, of course, mainly to the introduction of electric traction. Again, in the first half of the year 1896, with horse traction, the number of passengers carried was 11,866,534, as compared with 21,696,650 in the corresponding period of last year. The total number of passengers carried in the 12 months ending December, 1901, was over 45 millions. At the first-mentioned date the percentage of working expenses to receipts was 65·64, while to-day this has been reduced to 53·45. Working expenses per mile run have also decreased in the same period from 8·24d. to 4·728d., but the traffic receipts per mile run have gone down from 11·50d. to 8·70d. at the end of 1901, which is the natural consequence of the lower fares which have been universally adopted in the last few years by all electric lines. The average receipts per passenger when horse traction only was used stood at 1·47d., and these, too, had gone down at the end of 1901 to 1·23d. The number of miles run per car per day is at the present time almost double what it was in 1896, having increased from 58 to 90·2. Dealing now with the results obtained with electric traction, we find that the consumption of current at the end of last year was 0·913 kilowatt-hour per car mile, as compared with 1·004 at the beginning of the year, while the consumption of coal per kilowatt-hour has decreased from 6·22lb. in the first half of 1901 to 6·02 at the end of the year. Also the cost of coal per kilowatt-hour has been reduced in the same period from 0·550 to 0·376d. Although the active development of the undertaking in the past five years has had very good results for the travelling public of Dublin, it will be seen from the above figures that the company are not as yet, relatively speaking, making larger profits. This, of course, is due to the enormous capital expenditure required for the extension and electrical equipment of the old system. At the present time the company have over 46 street miles of tramways in operation as compared with under 34 street miles at the beginning of 1896.

Wave Propagation over Non-Uniform Conductors.—Dr. M. J. Pupin contributes an admirable article to a recent issue of our American contemporary, the *Electrical World*, in which he discusses the general problem of wave propagation over non-uniform conductors. The author shows that the mathematical solution of the problem is the most general solution, because every other case can be deduced from it. His results may be summed up as follows: A non-uniform wave conductor is a conductor made up of periodically recurring sets of preferably equal parts, which may be called its component parts. Each component part has definite reaction constants—that is, definite resistance, capacity, and leakage conductance—and corresponds, therefore, to a definite part on the corresponding uniform conductor. Any two consecutive sections on the non-uniform conductor have, therefore, a perfectly definite angular distance. The paper demonstrates that the rule of equivalence between any non-uniform conductor and its corresponding uniform conductor can be expressed mathematically in terms of this angular distance by the same equation which was established in previous papers by the author for the particular cases discussed there. This mathematical rule translated into English says that the length on the uniform conductor corresponding to any two consecutive sections of the non-uniform conductor must be small in comparison with the wave-length. One-sixteenth of the wave-length is a close approximation. Smaller approximations permit larger sub-divisions. Four sub-divisions per wave-length is a worse approximation. For any sub-division consisting of between four and sixteen sections of two component parts per wave-length, the approximation can be calculated by the mathematical rule just cited, with an accuracy which will be sufficient for all practical purposes, particularly if the number of sub-divisions is not too near four. When this rule is fulfilled, then it does not matter how the reaction constants of any one of the sections are distributed within that section; they may be lumped or uniformly distributed. This principle has long ago been recognised in all engineering practice dealing with alternating-current transmission of power over distances which are small in comparison with the wave-length on the transmission wire connecting the transmitting and the receiving apparatus to each other. In all such cases the inductance and resistance of the transmission wire was replaced by a coil of the same inductance and resistance, and the capacity and leakage conductance of the transmission wire was replaced by a condenser of the same capacity and leakage conductance, the condenser being connected between a terminal of the coil and the ground. The theory of wave propagation over non-uniform conductors, in its most general aspect, is, therefore, nothing more nor less than an extension of this well-known engineering practice.

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LONG-DISTANCE TELEGRAPHY AND MARCONI'S LATEST EXPERIMENTS.

BY LIEUTENANT FERNAND PONCELET.

The emotion caused throughout the world by Marconi's latest experiments is not nearly subsiding. All the same, the now and hereafter famous letter "S" telegraphed from the Lizard through the ocean—this simple message which Marconi is supposed to have received at Newfoundland—has already caused much ink to flow. Electricians, scientists, cable company shareholders still hurriedly read the newspapers, technical or otherwise, in which Marconi's name is mentioned. Love of progress, jealousy, pecuniary interest, these noble and monetary sentiments clash with one another in the Press. Words such as "bluff" and "charlatan" are met together with that of "indefatigable experimenter." A conscientious reader cannot therefore make head or tail between the various statements. A little commonsense, however, would put each statement into its proper value. This is the task we have undertaken in this article. After making ourselves well acquainted with what happened at the Lizard and in Newfoundland, we will perceive if the problem which Marconi has tried to solve can be stated in the present state of our knowledge in this matter, then examine the various solutions which the matter contains, and, knowing the facts, be able to extricate the truth and judge what will be the future of wireless telegraphy over the ocean.

I.

It was proposed seriously for the first time to establish communication between the Old and New World in 1899.

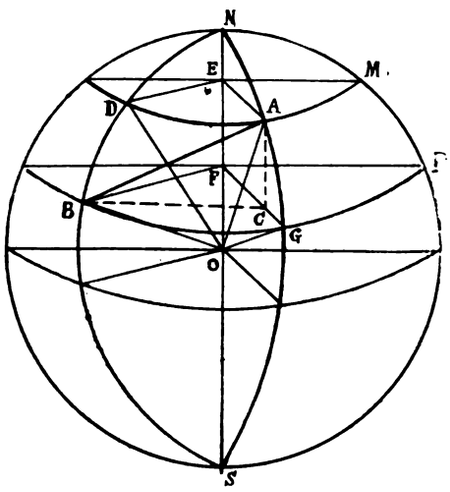

FIG. 1.

In that year M. Guarini proposed the establishment of automatic relays (first Belgian patent of May 27, 1899; first British patent, No. 25,591, of Dec. 27, 1899) on the Azores Islands, the Bermuda Islands, and on boats and buoys anchored in the middle of the ocean at convenient intervals. Reference will be made later on to this proposition. We will now mention the prematureness of this idea at that time; during the same year Marconi's experiments across the Channel showed that electromagnetic waves could reach a distance of 32 miles only. It would, therefore, have been necessary to establish too great a number of intermediary posts. It, however, remains a fact that M. Guarini first gave the means of communicating through the Atlantic without wires. But since, the distances attained by Marconi have become longer and longer. We will here only mention the English experiments of 1899 between a cruiser and an ironclad 70 miles from each other, those of 1901 between France and Corsica (108 miles), and those between the Lizard and the Isle of Wight (186 miles). A man of Marconi's temperament could not stop after such good results. He then thought himself sufficiently strong to try direct communication between England and America. The experiment was a bold one; it might not succeed. Accordingly it was with the greatest secrecy that Marconi undertook it. Already, in the beginning of 1901, he had put up a station at Cape Cod (longitude W. of Greenwich 70°, latitude N. 42°), in Massachusetts, and made numerous attempts at communicating between this station and that at the Lizard (longitude W. 5° 15′, latitude N. 50°), in Cornwall. Nothing has yet been disclosed concerning these experiments, which were unfortunately stopped on account of bad weather. The installations were broken up in September. Everything leads us to believe that the experiments were fruitless, and that the £1,400 were spent without return, for science at any rate.

Let us see what the distance is between the two stations. An important factor to deal with being the distance when it is intended to communicate from one continent to the other, the following is one way to form an approximate but sufficiently exact idea of the goal in view. Let us represent a terrestrial globe (Fig. 1), the meridians, N A G S, N D B S, and the parallels, M A D, P G B, of the respective stations A and B. Let us draw the radii of the meridians A O, G O, B O, D O, and of the parallels A E, D E, G E, B F, and draw A C parallel to E F and join C A and C B. Thus we form a rectangular triangle, A B C, the hypothenuse of which, A B, represents the rectilineal distances of the two stations. One can calculate very exactly, taking into consideration the longitude and latitude of each station, together with the difference of the resulting radius of the flatness of the earth. The shortest way between A and B on the surface of the globe is a transcending curve, the exact calculation of which is rather long. It is, however, easy to obtain this, without being too much out, in considering the slight difference of latitude between the two posts: it is only necessary to replace the transcending curve by an arc of a circle. R_1 is equal to the mean terrestrial radius, O A and O B. The depth at the centre of curve is M N (Fig. 2); it is equal to R – O N. In this way we have found that the rectilineal distance from the Lizard to Cape Cod is 2,986 miles, the

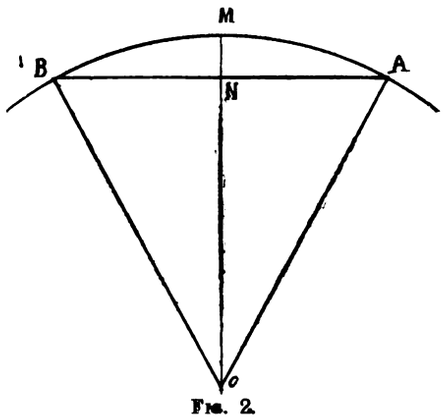

FIG. 2.

curvilineal distance 3,110 miles, and the depth of earth at the centre of curve 292 miles.

Not having been able to overcome this enormous distance and the importance of the earth's curve, Marconi decided to bring the two stations closer together. He retained the post at the Lizard for transmission, and chose Newfoundland for the receiving post, where he adjourned with two assistants, Mr. Kemp and Mr. Paget. The rectilineal and curvilineal, as well as the depth at centre of the curve, now become respectively 2,077, 2,101, and 140 miles.

In a previous number (*Electrical Engineer*, Dec. 20, 1901) some particulars concerning this experiment having been given, we will only give a few additional details. The transmitting post at Poldhu, Lizard Point, comprises, in addition to the generating buildings necessary for the experiments, about 20 masts 210ft. high (Fig. 3), fitted with a complete set of wires capable (to use Marconi's expression) "of determining electric waves of high power." The transmitting apparatus was probably furnished the same way as those employed in April, 1901, at Biat and Cahr, the outlines of which are given in Fig. 4. It will be seen that the induction coil is double, the primaries, p_1 and p_2, being fitted in series, and the secondaries, s_1 and s_2, in parallel. A single coil could not give the needful power, and he probably used at Poldhu several induction coils arranged in a similar fashion. A single interruptor, I, with condenser, C, were inserted with the manipulator, M, in

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the circuit of primaries, p_1 and p_2, and accumulators, A. Both balls of the oscillator, O, were inserted in a circuit comprising a condenser, L, composed of several Leyden jars and a transformer, T, the secondaries of which were joined to the antennæ, *a*, and to the earth, E. The isolated conductors which formed the Poldhu antennæ were very numerous, and joined in parallel at their top and base. An opportunity will come later on to refer to this antennæ.

The Signal Hill station receiving post at St. John's, Newfoundland, did not contain an automatic recorder; a simple telephone was adapted to the apparatus, which permitted of a clearer perception of the signs, but which had the great disadvantage of doing away with the checking.

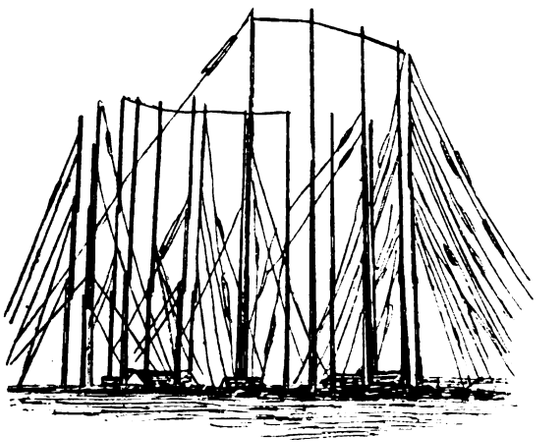

FIG. 3.

Marconi was alone at Signal Hill with Mr. Kemp; no controlling commission had been appointed. We are far from doubting Marconi's good faith: the reasons he gives for carrying on his experiments in secrecy are plausible; but here we examine with calmness and impartiality the scientific side only, and, seeing this, we can only regret the absence at Signal Hill of a controlling commission, or, at any rate, the paper tape of the automatic receiver—*Verba volant, scripta manent.* This recalls to our mind an incident which had previously occurred and deceived us (M. Guarini and I) during the experiments—Brussels-Malines-Antwerp—with automatic repeater. It was during

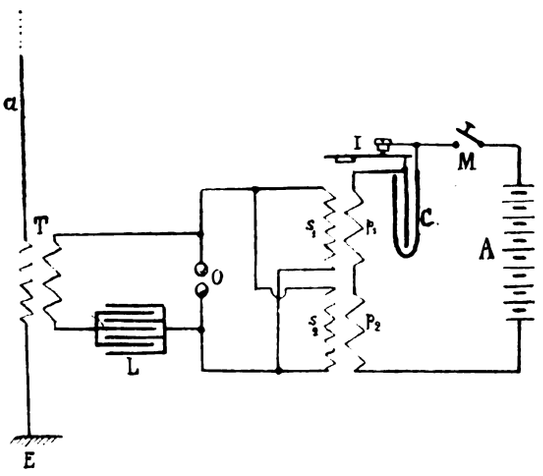

FIG. 4

the first stage of these experiments: we were trying the direct communication between Brussels and Malines (14 miles). Everything was working according to our wishes until then, and we were on the point of trying another system of receiver—the telephone. We were busy fitting this installation at Malines when one of us heard signals at the telephone. We noted the time, and judged that the assistant at the Brussels post was gone. Whilst waiting for the reply of the telegram we had sent to Brussels, we continued noticing these signals, short, like those produced by the dots of the Morse alphabet. The reply reached us: "Nobody at the Brussels post"; and the telephone continued talking. We had not noticed that our antennæ (302ft.) formed a veritable lightning conductor. Sundry checkings we made convinced us that the atmospheric electricity played us a trick. It was necessary in the future to take many precautions to keep our telephonic receiver away from the action of atmospheric electricity, as it would have then been difficult to distinguish signals coming from the Brussels station from those coming from the atmosphere when these signals were in the form of dots. The papers since communicated to the Paris Academy of Sciences by M. Tommasina, especially that one of Dec. 9, 1901, on the detection of far away storms by means of the electro-radiophone, also M. Berthelot's paper to the same body on Nov. 12, 1900, concerning silent atmospheric electricity, have led us to be more prudent concerning our observations by telephone. M. Tommasina might have heard in his electro-radiophone storms which were happening in a radius of more than 250 miles. On the other hand, by means of the Thomson-Mascart electrometer installed on a tower of 92ft, M. Berthelot has made observations from which he has observed the following: "The potential oscillated between mean values ranging between 600 and 800 volts during mild weather. The fall of the slightest rain carried this potential towards 12,000 and 15,000 volts and more pressures, at which small sparks were observed at the electrometer. Air potential is, as we know, about proportional to the altitude over the earth of the atmospheric layer under notice, which gives 20 to 30 volts per metre in mild weather. We would even have 400 to 500 volts and more during rain if the condition of the air traversed by rain could be compared to that of air without rain—which I do not pretend, by the way. In any case, it is very high in that condition." If M. Berthelot already found such a difference of potential for a difference in height of 92ft., what difference of potential would not Marconi find between the two extremities of his antennæ in Newfoundland, which would be taken up in a kite to a height of 400ft? A man so full of experience as Marconi certainly made arrangements to guard himself against the influence of atmospheric electricity on his apparatus at Signal Hill. But what we have just said explains why certain *savants*, not relying on Marconi, attribute to atmospheric electricity the signals received at Newfoundland in the shape of dots of the Morse alphabet.

Whatever the case may be, landing on Dec. 6 at St. John's, Newfoundland, Marconi had begun his installation on Dec. 9. It was finished at the end of three days, and the telephone began to talk on Dec. 12. After having received authority from his company, Marconi made known the success of his trials to several governments. To the Italian Ministry of Marine especially he cabled: "I have been successful in receiving at Newfoundland directly-transmitted signals from England by wireless telegraphy." To which M. Morin replied: "I thank you for your courteous communication, and admire the marvellous result."

Can we share this sentiment of admiration? Were messages able to cross the Atlantic direct? This is what we will examine by trying not to forget any admissible hypothesis.

II.

Let us first try to find the power necessary for this operation. Marconi admits in his discussion of May 15 last having used a power of 150 watts to communicate from the Lizard to the Isle of Wight stations, 186 miles distant. The electromagnetic waves spread according to the law of the square of the distance, as Maxwell proved it theoretically and Henry Hertz by experiments. The rectilineal distance between Newfoundland and the Lizard Point being 2,077 miles, we therefore obtain $\left(\frac{2,077}{186}\right)^2 \times 150 = 18,691{\cdot}5$ watts, or 25·4 h.p. This energy is high, one would think, but it is not more than can be practically dealt with.

At the beginning we said that a second means of communicating at long distance without wires existed. It is the indirect process—*i.e.*, that which utilises Guarini's automatic repeaters. We know (see the *Electrical Engineer* of July 12 and 19, 1901) that at the extreme corresponding limits obtained by Marconi, M. Guarini places one of his automatic repeaters having an equal power to that of

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Marconi's transmitter. This allows the electromagnetic waves to traverse a second distance equal to the first. And so on, from post to post, the waves, sapping a new energy at each Guarini stage, will finally go round the earth. Let us suppose that communication is performed this way between the Lizard and Newfoundland, and let us start from the Isle of Wight-Lizard Point experiment. The curvilineal distance, 2,101 miles, between Poldhu and St. John's, Newfoundland, will have to be divided into 12 equal distances $\left(\frac{2,101}{186} = 11{\cdot}26\right)$; which corresponds to 11 intermediary stations, each utilising 150 watts. We will, therefore, have to use as energy, in the case of transmission by stages

$$150 + 11 \times 150 = 1,800 \text{ watts, or } 2{\cdot}44 \text{ h.p.}$$

As we see, we are far off the 25·4 h.p. necessary in Marconi's direct transmission. We have $\frac{25{\cdot}4}{2{\cdot}44} = 10{\cdot}4$, which corresponds to about $\frac{3,388}{300} = 11{\cdot}26$; that is, with Guarini's system, the power required increases with the distance; in Marconi's system, as the square of the distance. In any case, not taking into consideration the question of cost, and only from a standpoint of the power to be used, we can say that the problem of communication across the Atlantic is possible. And more, we can now say with a degree of certainty that a solution to this problem is possible with Guarini's indirect transmission.

III.

Once in possession of its energy, the transmitter produces an electromagnetic perturbation losing itself into

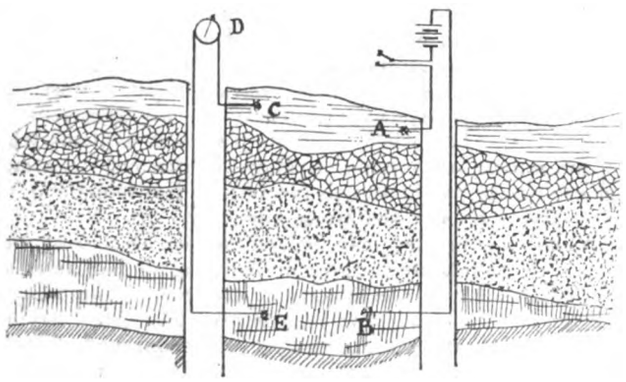

Fig. 5.

space. How is this propagation accounted for, and how do the waves reach the receiver? Knowing the answer to this question, we might say that Marconi's direct transmission is equally possible to Guarini's indirect transmission from one continent to the other. Unfortunately, we here enter into the domain of hypothesis. Leaving Marconi on one side, who prudently remains silent on this question, we may say that there are as many theories as there are experimenters. On going through them we will know if each theory furnishes the solution to our problem; at least we will thrash out the most plausible theory, that which takes into consideration all facts observed to this day. The various hypotheses put forward to explain the transmission without wires of electromagnetic waves at the present time number three:

I. The conduction theory: according to which the waves are propagated through the earth, or water in the case of seas, rivers, or lakes. Those who maintain these theories are M.M. Willot, Collins, Popp, Pilsoudski, Armstrong, and Orling. The description of it which Mr. Willot gave at the Paris Congress in August, 1900, states that a geological stratum would do for the outward wire and another for the return wire (Fig. 5); in the case of Hertzian waves, a single geological stratum would be sufficient for the transmission (Fig. 6). Special soundings having revealed the presence of an interruption of the stratum in use, a metallic conductor would be employed to unite them (Fig. 7). Without dwelling on the great cost of these soundings and the joint mentioned in this last figure, two important observations must be made concerning the arrangement of Fig. 5, and one concerning the arrangement of Fig. 6. If this conduction theory is right, we have, in the case of Fig. 5, two conductors in short-circuit at all points. On the other hand, who does not know that by putting to earth the two poles of a supply of electricity, we give them the potential of the earth—*i.e.*, no potential at all, or one very slight? Therefore, in order to establish a current between two points, there must necessarily be a difference of potential between them; between A and B the circuit A C D E B cannot, therefore,

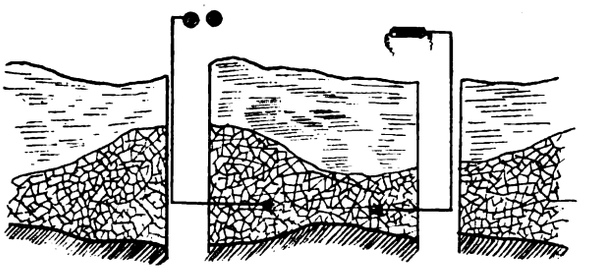

Fig. 6.

be run by a single current. In the case of Fig. 6 (Hertzian currents) there can only be question of one conductor or one capacity, which the electrical power travels till it equalises the potential. But the earth has a capacity much too large for its electrical state to be modified by an appreciable quantity between two points far from each other; moreover, is not equilibrium established as soon as a coherer electrode and a ball of the oscillator are put to earth? Experience confirms this continually. We will only mention Mr. Lecarme's balloon experiments,

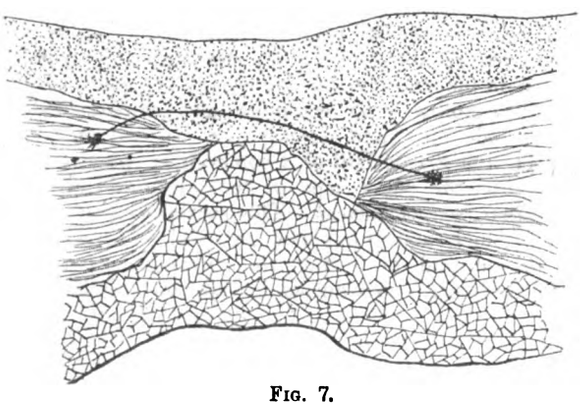

Fig. 7.

and that we have repeated ourselves with M. Guarini (see *Electrical Engineer* of July 12 and 19, 1901). We must conclude that if messages have really been transmitted over the Atlantic, they could not have been done by means of conduction by earth or water.

II. The second theory which we meet is that of the *incurvation*, according to which the waves curve themselves round the obstacles (Fig. 8), and are propagated, for instance, in equipotential layers, as advanced by M. Blochmann (Figs. 9 and 10). The defenders of this theory are Sir W. H. Preece and Messrs. Blondel, Ferrié, Slaby, Blochmann, etc.

Fig. 8.

Henry Hertz's classical experiments on the stoppage of waves by a metallic screen (Fig. 11) proved the rectilineal propagation of Hertzian waves. It is true that a coherer behind a metallic screen may sometimes be affeeted, but this case can be easily explained. In a note presented to the Paris Academy of Sciences in September, 1900, we explained, with M. Guarini, an experiment concerning this fact. We then concluded that the Hertzian waves induced

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currents in the metallic screen. The screen in turn, acting as a new radiator, affected the coherer. As we see, the coherer remains unaffected as soon as the screen is put to earth, and we thus effected the flow to earth of the induced

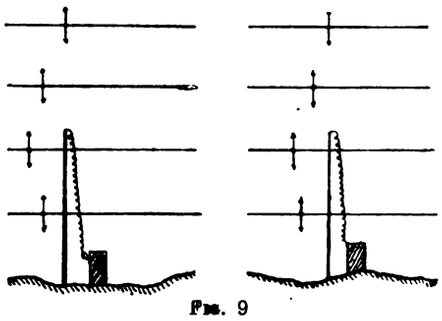

FIG. 9

currents. Guarini's numerous writings prove that the electromagnetic waves are propagated in straight lines and normal to the surface of the antennæ. These writings have been confirmed by M. Tommasina, who was able to photograph the discharge produced from a radiating

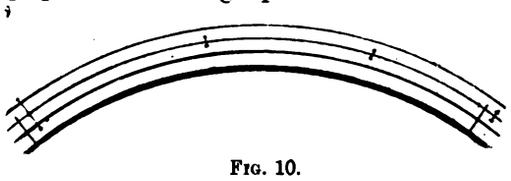

FIG. 10.

antennæ (see the *Compte-rendus* of the Paris Academy of Sciences meeting of May 28, 1900). Fig. 12 is a reproduction of one of the photographs. The normal ramifications of the wire radiator can easily be seen. "It would seem," concludes M. Tommasina, "that the wire of the radiating

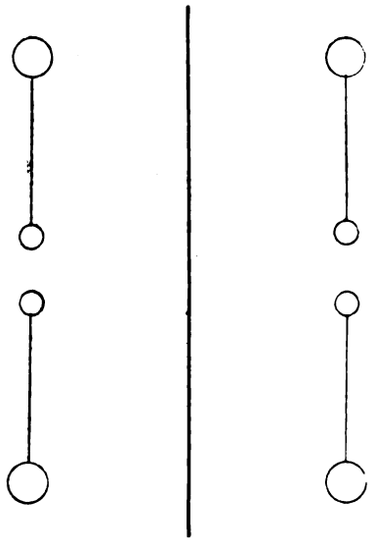

FIG. 11.

antennæ of the Hertzian waves really plays the part of a capacity of which all the molecules form its surface, and propagate one to the other the oscillating movement produced by the discharges. This movement propagates itself

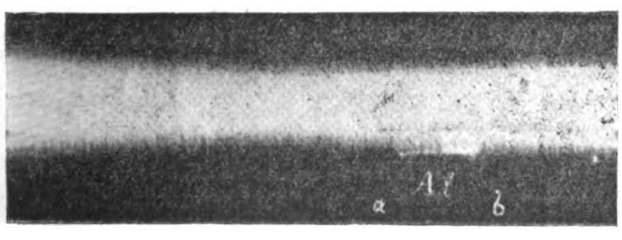

FIG. 12

at the same time to the molecules of the ambient element of space—*i.e.*, ether—*according to the radiating lines of the wire on an infinitely large number of parallel planes between them and the perpendicular axis of the wire.*" As to M. Blochmann's particular hypothesis of equipotential layers, it is not less inadmissible. According to him, if both antennæ are in the same equipotential layer—*i.e.*, if the radiating antennæ is horizontal and at the same level with the collecting antennæ—transmission is impossible. In a conference which we gave in 1899, and reproduced in the *Revue de l'Armée Belge*, twentieth year, tome iv. and vi., we said: "In uniting the advantages of syntonisation, the *horizontality* of the antennæ, and the parabolic mirrors, it then might be possible to communicate a little forward of the line of forts of a stronghold. It would be interesting to see experiments carried out in that line." These experiments have been made often since. M. Marconi in his paper on May 15, 1901, to the Society of Arts, London, declares having received good results at considerable distances, thanks to the use of cylindrical horizontal antennæ. From what precedes, we conclude that the theory of *incurvation of the waves* is not exact, and that if the transmission of messages has been effected between the Lizard and Newfoundland, it cannot have been done by the waves following the curvature of the earth between these two stations.

(To be continued.)

ELECTRIC LIGHTING AND POWER IN THE STEEL AND TINPLATE WORKS, LIMITED.

In June last year the Upper Forest and Worcester Steel and Tinplate Works Company, of Morriston, near Swansea, sent out enquiries to several firms of electrical engineers asking for a scheme suitable for electric lighting and power at their works, and in due course received the same. After careful examination of the different schemes the managing director and the mechanical engineer visited many of the large steelworks in the North of England and the Midlands, and also the Glasgow Exhibition, so that they might see the most up-to-date methods for their special requirements, the result being that in September they placed the order, after open competition, for the whole of their electrical plant with Messrs. Handley and Shanks, electrical engineers, Birmingham. It was found that the boilers supplying the bar mill engine could provide plenty of surplus steam for the electric lighting plant, and hence the power-house was built as close as convenient to the bar mill boilers. The pressure from these boilers on the main steam column is 100lb. to the square inch. The power-house is built of stone, and measures 53ft. 4in. long and 34ft. 10in. wide inside, and is gable-roofed. At the dynamo end of the power-house a recess 18ft. long and 5ft. wide was provided to accommodate the switchboard, which is erected flush with the main end wall of the engine-room, the recess being entered by a glass-panelled door on either side of the switchboard.

The present plant installed consists of a pair of Marshall's high-pressure compound condensing engines, with cylinders 11in. and 19in. by 30in. stroke, of the L.C.H. class. Between the engines is fitted a 10ft. flywheel running at 110 revolutions per minute, transmitting its power to the generator by nine 1¼in. three-strand Kenyon ropes. The valves on both steam and exhaust are of Marshall's latest double-beat type, and are set for working at a pressure of 100lb. to the square inch. The dynamo is of Parker's standard compound-wound two-pole type with three bearings, capable of an output of 360 amperes at 250 volts when running at a speed of 480 revolutions per minute. The driving pulley is 26in. diameter, and is carried between two bearings; the groves are made to the same template as the grooves on the engine flywheel, so as to ensure a perfectly even wear on the ropes.

The main switchboard is built up in six panels of Sicilian marble, and is so arranged that it will take another plant of exactly the same size as the one already installed. The marble slabs are erected on angle-iron standards, the top panels right and left being positive and containing circuit and main switches and all instruments. The middle panels right and left are negative, containing circuit and dynamo switches, the two lower panels containing the two paralleling switches and the shunt rheostats. At the same time

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the two boards can be made distinctly separate so that one generator can run on one board and the second generator on the other side of the board, as the positive and negative 'bus bars of each board are joined across at the back. Each of the dynamos have a voltmeter and ammeter with 10in. dials fixed on the top of their respective panels. Each of the 10 circuits are provided with an ammeter having 6in. dials.

On the recess built to accommodate the switchboard is erected a square angle-iron gantry (similar to a telephone exchange gantry), and from the top of this, which is about 35ft. from the ground-level, the bare copper mains run to the different points of distribution in the works. Bare solid copper mains have been used throughout, the largest being ·5in. in diameter, and the smallest being No. 12 B.W.G. The whole of the bare copper mains are carried upon iron standards or brackets, no timber being used where deterioration from weather would take place. The arms carrying the insulators are also of iron, and a layer of hardwood is inserted between the insulator and the iron, so that should a wire break loose from its insulator, it would still be partially insulated from the ironwork of the carrier. The whole of the incandescent wiring is carried out on the distribution-board system, the distribution boards being of enamelled slate, the fuses having exceptionally long break for 250 volts. The number of incandescents installed is approximately 450 of 16 c.p. and 32 c.p., special fittings having been designed for the different departments throughout the works. The arc lighting is arranged two in series, seven-ampere standard Jandus type lamps with clear globes being used. Each pair of lamps are wired direct from a distribution board, and Braulik patent arc lamp couplings are used throughout (with the exception of the casting pit). This means of connecting the arc lamp to the circuit is most convenient; it obviates loose hanging wires, which eventually break off by swinging about, and it makes it absolutely safe for the attendant to examine and trim a lamp when the pressure is on the mains, as immediately the lamp leaves the coupling it is disconnected from the circuit. The coupling also

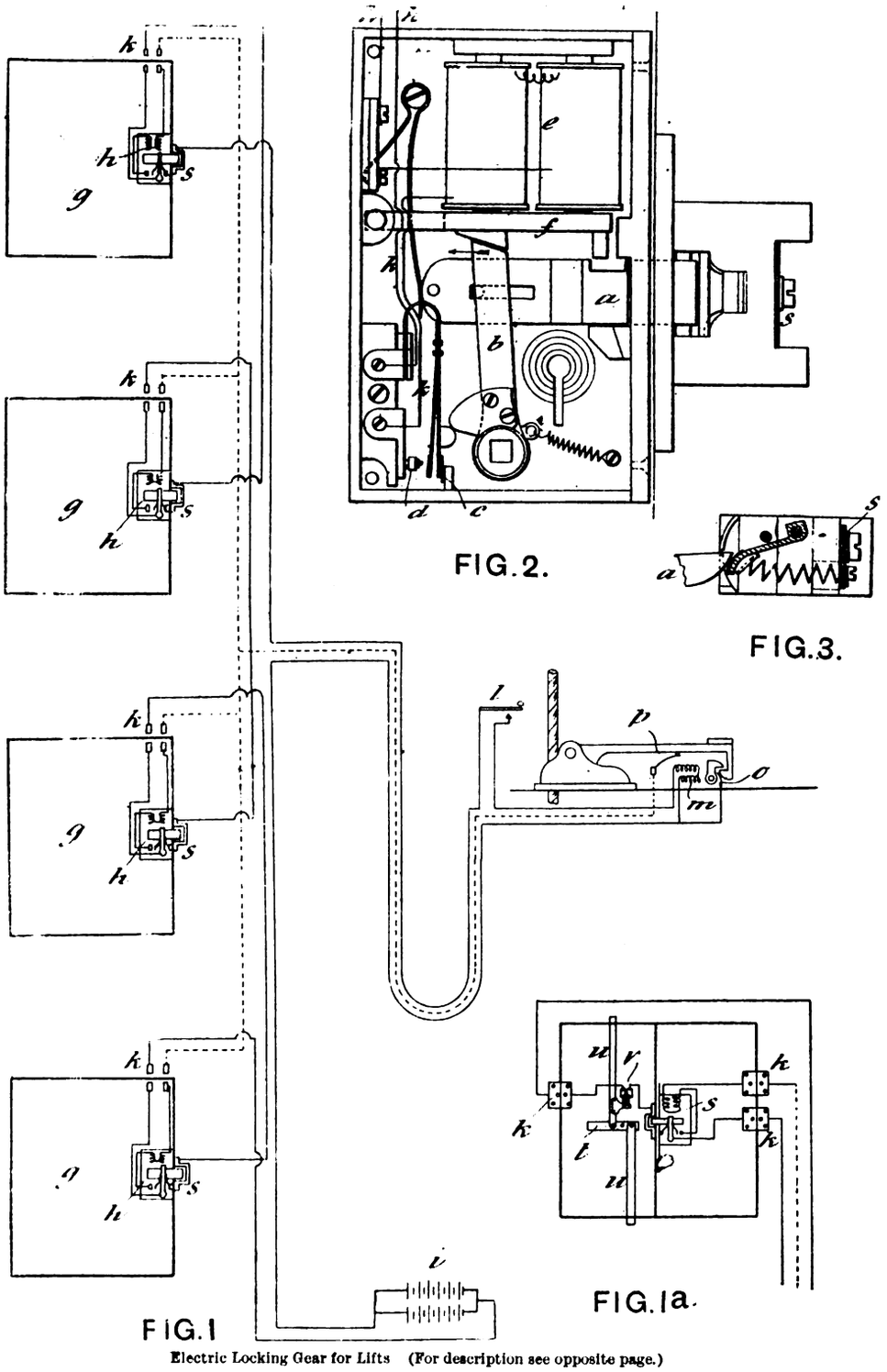

FIG.1

FIG.2.

FIG.3.

FIG.1a.

Electric Locking Gear for Lifts (For description see opposite page.)

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does away with switches, which in a steelworks are a constant source of trouble. The outside lighting is carried out with arc lamps suspended from iron poles, and it is somewhat interesting to note that these poles are made from Great Western Railway bridge rails, two rails being riveted together by the flanges face to face, one of the rails being cut off 2ft. 6in. shorter at the top than the other. From the short end spring two angle-iron half circles at a radius of 3ft., and from the end of the half circle the arc lamp is suspended, being connected to the circuit by one of the patent couplings. All arc lamps (with the exception of those over the casting pit) are counterbalanced, no winches being used. The present installation consists of 60 arc lamps, 14 of which are erected in the steelworks.

The plant was inaugurated in February, having been completed in quick time, and it is probably one of the most successful light and power installations in South Wales.

The management have expressed great satisfaction at the manner in which the installation (which was designed by Mr. W. M. Furniss, chief engineer to Messrs. Handley and Shanks) has been carried out, and add their appreciation of the services of Mr. Furniss, who was ably assisted by Mr. A. E. Jones, mechanical engineer to the Upper Forest Works.

ELECTRIC LOCKING GEAR FOR LIFTS.

Through the courtesy of Mr. F. T. Hollins, the telegraph engineer of the Great Eastern Railway, we are able to give the following particulars of an electrical system of lift locking devised by him with the assistance of his co-patentee, Mr. H. C. T. Amendt. The object of this system of locking is to prevent accidents in connection with lifts in hotels or other buildings in which the public have access to the lifts, and in which, unfortunately, fatal accidents are by no means uncommon. A large number of these accidents are due to lift doors being left unlocked, and to would-be passengers falling into the lift well in consequence. Another class of accidents is due to the lift being started before the passengers are all into the car, with the result that one gets jammed between the lift and the next floor. The system we have now to describe completely prevents all these classes of accidents. It secures, by means of the connection seen in Fig. 1, that the lift cannot be worked at all unless the doors are shut, otherwise the grip, *p*, which secures the starting rope, is securely held by the electric lock, *c*. This is effected by means of a combined electric and mechanical lock to each of the lift doors, and these locks cannot be operated mechanically unless the cage of the lift is stationary and the grip on the starting rope made fast. This also ensures that while the cage is travelling no door can be opened even by an exactly similar key as is used by the lift attendant. The connections shown in Fig. 1 need no further explanation, but the following description of the locks used on the lift doors as illustrated in Figs. 2 and 3 will be of interest. These show the construction of a lock for a hinged door. The spring latch, *a*, has above it an electromagnet, *e*, having an armature, *f*, supported on the end of a lever, *b*, which can be moved in the direction of the arrow by a key or handle inside the lift shaft. When the parts are in the positions shown, one of the wires, *k*, leads through a spring to a contact, *c*, and this through the metal of the lock and the striking plate connects to *s*, whence a wire leads to the *k* contact and the next higher door. The other wire, *k*, is connected through the coil of the magnet, *e*, to an adjustable contact, *d*, but as here contact is broken, the magnet is inert. On moving the lever, *b*, it first breaks the contact at *c*, thereby opening the circuits for the other door locks, and it then makes a contact at *d*. If, then, the circuit of the first wire, *k*, be closed, which is the case only when the governing rope or rod is clutched, then the magnet, *e*, is energised, attracting its armature, *f*, and the latch, *a*, can be withdrawn. If, however, the governing rope or rod be unclutched so that the circuit of the wire, *k*, is open, then the magnet, *e*, is inert, and its armature, *f*, falls, catching in a notch of the latch, *a*, so that it cannot be withdrawn.

Mr. Hollins has also worked out details of other locks for folding doors to give exactly the same results. We recently had an opportunity of inspecting the lift at the Great Eastern Hotel at Liverpool-street, which is equipped on this system, and found that the locking as arranged gave practically absolute safety. It placed the control of the lift entirely in the hands of the lift attendant, and he could leave the same at any floor without any fear of it being tampered with by another member of the staff. We understand that this electric locking apparatus is being put on the market by Messrs. R. Waygood and Co., of Falmouth-road, Great Dover-street, S.E., and this firm have already installed it on a number of lifts in London hotels.

RAILWAY BLOCKS AND TELEGRAPHS—RECENT PRACTICE.*

BY A. T. KINSEY, ASSOCIATE.

I feel that I am at some disadvantage in introducing this subject to the institution, as I am neither to talk of thousands of volts nor yet of kilowatts, and I have no imposing mathematical array. I have thought it best to deal with matters of which I have first-hand knowledge, and also some experience, and matters which I think have not previously been brought before the Dublin Local Section. The Irish railways have, however, an enviable freedom from accidents which have almost entirely disappeared since the introduction of block working on all lines. The cost of the block signalling is a very considerable factor in the working expense of a railway, and the railways of none of the countries in the world spend so large a proportion of their earnings in this manner as those of the United Kingdom.

When I responded to your committee's invitation for a paper, it was my original intention to outline the gradual changes in the electrical equipment of the Irish railways, due mainly to the passing of the Regulation of Railways Act of 1888. But I have since felt that it would be best to confine myself almost entirely to the extension of block signal working where double lines of rails exist, and to the introduction of the train staff block instrument where—as in the majority of Irish lines—there is only a single line of rails.

Prior to the gradual operation of the Act mentioned, there was usually a telegraph circuit of the omnibus type calling at all the more important stations, and the more it served the better, as transmission was thus avoided. The commercial telegraph circuit usually connects two places, and the less busy circuit may possibly take in several places, at the most four or five. This is the ordinary telegraph circuit, and, whatever type of instrument may be employed, five offices is usually considered a limit. But the conditions and demands of Irish railway telegraphy are quite different. I know of a double-current sounder circuit on one of the "Great" railways of Ireland, which has no less than 13 stations spread over 80 miles of line upon it; the relays are all differentially wound, of Siemens's make, with their coils joined in multiple for economy in primary cells; and, strange as it may seem to an ordinary telegraphist, this circuit works year in year out almost without a complaint, and excellent signals are obtained at all stations. I only mention it to show how far we have upon the railways wandered from the beaten track, and satisfied what not long ago would have been considered impossible conditions.

The block signal method of controlling the traffic on a line of railway puts a *space*-distance between each train. It therefore follows that one train cannot overtake or meet another, as one train only is permitted to enter a block section at a time. The space and distance is determined by the amount of traffic to be dealt with on the section. It may be a space-distance of miles on one section, and of a fraction of a mile only on another. The usual conditions of traffic are known beforehand, and the signal cabins disposed accordingly; and as their maintenance is such a considerable item of the working expenses, the fewer of them to be maintained, and the better for the dividend, provided that the traffic be smartly handled. It must not be assumed that the cost of block working on double lines of rails is all loss, to be tolerated only on account of its absolute safety. It has rather, I think, tended also to some economy, as a driver knowing that he has a "clear road" until he reaches the next section can make the most of it.

The earlier types of block signalling instruments were designed to represent the actual semaphores on the line—miniature signals, in fact—and the reversing switch was a facsimile of the lever in the signalman's lever frame, which pulled the semaphore "on" and "off," with a loud bell in addition to make these movements heard as well as seen. Time has tended to modify these parts, and to reduce them. The reversing switch has disappeared, and the plunger has united with the semaphores in the one case. There are plenty of the block instruments designed by Mr. (now Sir William) Preece still in use in Ireland, and they continue to do excellent work. They consists of three separate parts: a plunger (or key), for signalling; a reversing switch, for putting either pole of the battery to line; and a block containing a semaphore arm raised and lowered by the current, a second semaphore showing by means of a disc whether the signal arm was "off" or "on" at the distant station, and the indispensable bell. This apparatus has, however, been gradually displaced in Ireland by "Harper's" block, which I understand is cheaper in first cost and its after maintenance; the minimum voltage employed for Harper's instrument being five volts, as against a minimum for Preece's of 20 volts—a considerable difference. As Harper's instrument now holds the field almost to itself, perhaps I should describe it more closely.

* Paper read before the Dublin Local Section of the Institution of Electrical Engineers, April 17.

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The apparatus is identical in each signal cabin. It consists of two electromagnets, one in the sending circuit and one in the receiving circuit. Attached to the open ends of the cores of these electromagnets are four steel extension pieces, operating induced needles of Spagnoletti's design, brazed in the centre so as to prevent the formation of a closed magnetic circuit. The pivots of these needles extend through the face of the instrument and carry the miniature semaphore arms, which move up and down according to the direction of the current through an angle of 45deg., remaining either in the horizontal or drooping position until a reversal is sent. There are two internal sets of key-springs for sending the reversals to line operated by a single plunger, the position of which over one or other set of the key-springs is determined by a rotating disc. This disc at the same time gives the signalman a visual coloured indication of the signal he is sending—viz., "All clear" (on a white ground); "Train on line" (on a red ground); and "Train off, but section blocked" (on a green ground). The warning colours of the disc guide him mechanically, and if the disc is in its true position a wrong signal cannot be sent. Every signal is marked on the bell at the distant cabin. This bell is operated by a relay, and not by the line current direct. Experience has proved that these instruments are exceedingly reliable and satisfactory, as there is no adjustment beyond that of the relay and bell ever necessary.

The length of the block section is determined, as I have previously stated, by the number of trains passing, and as this quantity may be very variable over the 24 hours, it becomes necessary to vary the length of the sections themselves so as to accommodate it. It is usual to vary the length by means of switches to suit three conditions—*i.e.*, day, night, and Sunday. These may be represented diagrammatically as in Fig. 1. These changes are made by means of the switches at times specified. There are, of course, rules laid down for the guidance of the signalmen, each of whom cannot switch out and close his cabin until the section of line which he controls is clear of traffic. This arrangement, which admits of indefinite expansion as the traffic expands, or contraction if it lessens, has worked very well upon the whole. The switches in use have been of differing forms, but my own experience has gone to show that there is nothing to beat the bar tumbler type of switch with rubbing contacts, the bars being arranged to work vertically so as to admit of easy inspection and burnishing of the contacts from time to time. The merit of Harper's instrument in such a section as that displayed in Fig. 1 is that although the amount of current passing through the coils may vary within considerable limits, it is quite unnecessary to use compensating resistances

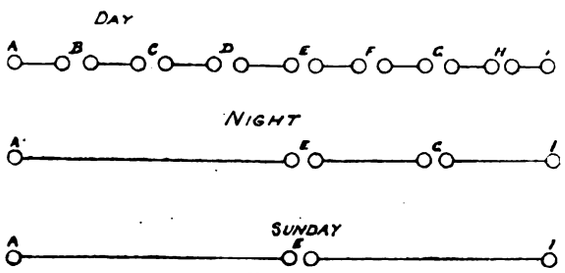

FIG. 1.

in any of the circuits. The electro-magnets respond equally well to the heaviest as to the lightest current without any adjustment of the arms or bell relay. In the diagram given the distance between A and B is only one mile, whilst the distance between A and E is about 12 miles, and the current varies accordingly, but the arm in A's sending circuit rises and falls equally well without adjustment. A daily working test such as this is a severe one, but the working has continued satisfactory for years. There is, moreover, no difficulty in a contingency in working a Preece's block at one end of a circuit and a Harper's block at the other end, but this will readily be understood after what I have said as to "Harper's" adaptation to a much heavier current than the normal one. There are working circuits with Preece's blocks and day and night arrangements comparable to those in Fig. 1, but it is necessary to use compensating resistances in the shorter line circuits, and shunts in the circuit controlling the disc. If, however, these points are carefully considered when the circuit is established, almost as smooth working is obtained as with Harper's blocks, and considering the trouble of their initial adjustment it is surprising what constancy is obtainable afterwards with Preece's instruments. This leads me to say that railway working demands as its first and last condition an absolute freedom from interruption, or the nearest thing to it And the arrangement figured satisfies these working conditions, and gives a very small annual percentage of faults per instrument.

Some special modification is, of course, necessary for junction working, and this is provided for in Harper's instruments mechanically by placing the two block instruments of the converging lines of railway inside one case, and so arranging the discs that the "All clear" signal can only be sent to one side at once, and not then unless the other disc is showing green—viz., "Train off, but section blocked." In addition to the block and the telegraph circuit it is desirable to give each signal cabin some means of speaking to the adjacent cabin on each side. Of course, this could be done by means of a separate circuit, but the question of the cost of erecting miles of wire, and its maintenance afterwards, has to be looked at. Except, however, on very busy sections a second circuit is not necessary, as there is usually but one signalman in a cabin at a time to work whatever number of instruments may be in it. It is, therefore, sufficient to enable him to use the same line for speaking or for block working at will; the exacting conditions before mentioned demanding that, whatever may happen to the speaking circuit, it shall in no case disturb the block circuit. A simple switch putting the line either to the block instrument, or to the telephone, would appear to satisfy the conditions, but experience has found it to be a faulty arrangement, both instruments having at times been inadvertently left cut off from the line. To obviate this contingency, condenser working was resorted to for the telephone circuit, and by this method the block circuits are left intact and attention can be gained upon the block or bell in all positions of the switches. I append (Fig. 2) a diagram of a cabin having two blocks and a telephone to be used on either circuit, but a similar arrangement is employed at junctions having more than two blocks. By using separate line leads from the open conductor on the outside insulator to the two-way switch an independent condenser circuit is obtained, having nothing in common with the block circuit but the open conductor, and this is a further safeguard against risk of total failure of communication. The block signal is used for calling to telephone. The speaking is not free from noises due to inductive disturbance. It would hardly be expected that dead silence could be obtained with a single untwisted conductor run in along with (in some cases as many as 20) telegraph circuits, but it gives telephonic speech which appears to satisfy railway requirements fairly well, and I hear of no proposal to spend money to improve it. Telephone transmitters of the Deckert granular type are used, and a condenser capacity of one microfarad, but I have not been able to observe any difference in speaking when half a microfarad has been used instead. This method of providing a speaking circuit is also used on train staff block sections, and it has stood the test of experience there also. It is extremely reliable, and a fault to either circuit under decent maintenance is unheard of. These circuits have lightning arresters of the comb, or saw-tooth, type, and their advantage is that they do not stop the circuit after an ordinary discharge. Their blackened condition shows, however, how silently and well they perform their office.

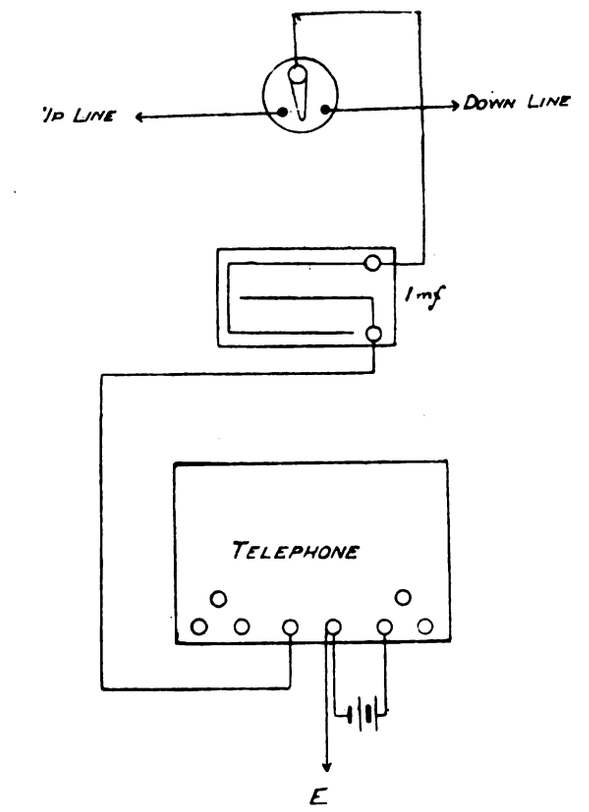

FIG. 2.

I now come to the blocking of single lines of railway by means of Webb and Thompson's train staff instrument. On single lines the conditions are more complex, as provision must be made for trains to proceed in either direction on the one set of metals, and it is not an uncommon thing for the traffic first to be all in one direction, and then to reverse and to be all in the opposite direction, as, for instance, engines and wagons going empty to a fair and afterwards returning as loaded trains. The older method of working was for there to be one "staff" of wood or metal for each section, and no driver could proceed unless he carried it on the engine as his authority. This was all well and good so long as the trains were alternately up and down, as the staff from A would be carried to B and left there, the next train taking it up again at B and leaving it at A. But it is obvious that in the case of the fair, it would have to be modified. One method was to send a driver on with a ticket issued by the station holding the staff, tickets to be continued until the last train had arrived, which went forward carrying the staff. This mode of working—dispensing as it did with the space-distance—had the obvious defect that one train might possibly overtake another with disastrous results, especially at night. It had also the disadvantage that the staff might be at the wrong end for the train. These difficulties were designed to be overcome by Tyer's tablet instruments, which are still in use, and by Webb and Thompson's train staff instruments. The latter having been almost exclusively adopted in Ireland, I propose to describe it only. This instrument, patented in 1889, was designed for use with a metallic circuit of two lines, but the cost of the additional conductor led to the experimental use of the earth as the return, and it has been proved that it may safely be used instead of the second line, which has thus been dispensed with

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Webb and Thompson's train staff instrument consists essentially o a magazine to contain any given number of metal staffs. Entrance to this magazine is obtained through an opening in the head of the instrument and at a right angle to it. When a staff is inserted it cannot pass directly to the magazine, as there are five circular iron discs (free to rotate together on a central spindle) between them, a quadrant of each of the five filling the rectangle. The effort to push the staff downwards into the magazine causes all the discs to revolve, and when a quarter revolution has been made their mechanism again locks them. Any number of staffs can thus be inserted into either of the connected instruments, but they cannot be withdrawn. And I will explain why. The central member of the five discs is shaped (Fig. 3) with four deep indentations, and in some one of these lies the principal lock, which carries a soft-iron armature, and its electromagnet rests normally upon it. As will be seen by the figure, this centre disc and armature is practically a mechanical ratchet arrangement, permitting of the turning movement in one direction only. Hence in normal conditions any number of "staffs" can be placed in the magazine, but once there they are securely locked. The electromagnet controlling the principal lock has four coils, one pair being connectable at will to the line by means of a switch, which by the same operation puts the local battery through the pair of coils fixed on the other yoke-piece. The cores of these electromagnets have common iron connecting pieces, *x x*, Fig. 4, which extend downwards and rest on their armature in the centre disc, locking the whole five discs as stated. When all the staffs are in the magazines and it is desired to release one at either end, the station wanting the staff signals his request, which, as in the case of other blocks, is audible upon a bell. The distant station

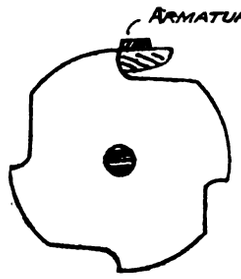

FIG. 3.

holds down his signalling key, sending a current to line, and the calling station seeing this by means of the galvanometer in his line circuit turns his switch to "For staff," which diverts the incoming line current through the "line" coils of the electromagnet, and at the same time puts his "local" battery through the other pair of coils. Strong magnetic fields are excited at *x x*, Fig. 4, and the armature is held fast to the electromagnets. The staff at the top of the magazine is lifted to the head of the instrument by hand and then drawn evenly towards the left. In its passage it first meets the projecting tailpiece, which is pivoted centrally and carries on its upper extremity the electromagnets, and this it pushes upwards out of its way and towards the right, as will be seen from Fig. 5. This results in a tendency to lift the electromagnets, and with them the armature forming the electric lock. This then enables the rings on the staff to engage the pawls of the other locks and to lift them also, and the whole of the discs are thus released together and describe a quarter circle (in the opposite direction to that when a staff is inserted), travelling now in the same direction as the hands of a watch. The switch which deflects the line and local currents through their respective electromagnets is restored to its normal position automatically, and this is the function of the first disc (Fig. 6), which, in making its quarter turn to the right, pushes back the switch lever to the vertical position, breaking the local battery circuit, thus preventing the waste of the local battery, which otherwise might be useless when wanted if the switch had not been restored. The action of the fifth disc is of the greatest importance. On its periphery rests a lever pivoted near its other extremity.

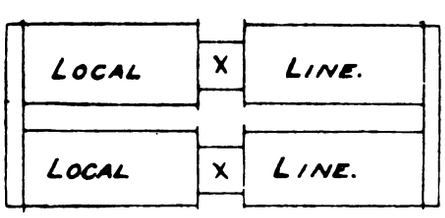

FIG. 4.

The configuration of this disc causes the lever to rise on one quadrant, and to fall on the next alternately, and its free end thus reverses the line and earth connections on two switch levers. It will be seen that the withdrawal of a staff has thrown the instruments out of phase with each other, and it is thus not possible to energise the electromagnets at either end until the staff is returned to one of the instruments—it does not matter which—as the line electromagnet and the local electromagnet oppose each other at both stations. The direction of the local current through the coils does not vary, but flows always the same way. If the staff should have been withdrawn for siding operations, and is afterwards returned to its own magazine, the discs make a quarter turn in the reverse direction, and the instrument then takes its original position. If, however, the staff be inserted in the magazine at the opposite end of the section, then that instrument is reversed, and both instruments are in phase, the discs in each having made a quarter turn, but in reverse directions, and being relatively as they were originally. The return of the staff to the magazine is acknowledged on the bell, and either station can then get out another staff. It will be observed that from the construction of the instrument one staff only can be obtained at any time, and that even if the circumstance be overlooked and the necessary signals exchanged, it is quite impossible to release another staff at either end so long as one staff is out. I have not described the functions of the other two discs. They have mechanical locks merely—the fourth disc having two—and cannot be

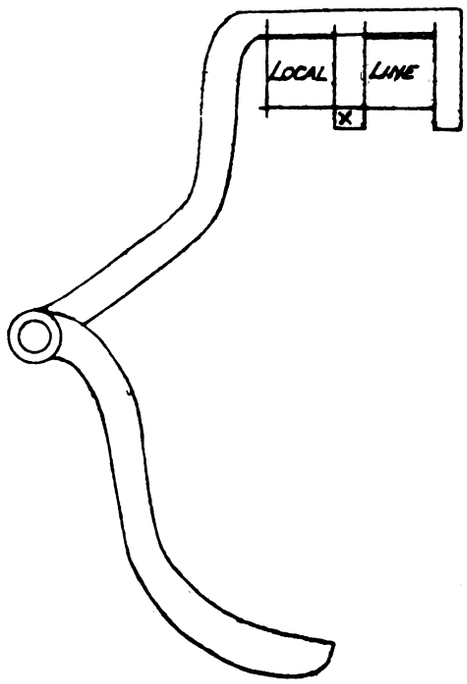

FIG. 5.

operated until the electromagnetic lock has been released. It will be observed that with such an instrument great possibilities of handling traffic are presented, it being no longer necessary to carefully arrange the points at which trains shall pass each other. Sixteen "staffs" in most cases are sufficient for any section, and these if placed at the up end would distribute themselves, but if by any contingency they all got to one magazine they could be withdrawn mechanically in pairs, but not singly, and restored to the other instrument. It is possible to have double magazines made for as many as 30 staffs in a section; all that is necessary is to have the magazines both coming to the one slot under the discs in the head. It is a detail, but I should perhaps mention that there is a disconnecting switch and galvanometer in the line circuit of each instrument which are used to show that the staff has been obtained. This switch also is self-restoring. There are also various kinds of safety devices, but as they do not affect the principle of working I need not dwell upon them further. The "staffs" are made so that they cannot be placed in a wrong pair of train staff instruments, a slight alteration in mechanical detail being all that is necessary The staffs are, I need not say, properly labelled also.

The question of "switching out" a train staff block section, as is done on double lines controlled by means of Harper's or Preece's blocks, is, therefore, out of the question, as the staffs if over-carried would not fit the more distant instrument, and when such a switching-

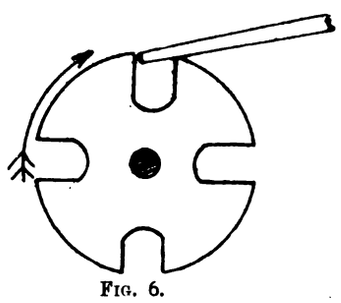

FIG. 6.

out arrangement is essential additional train staff instruments must be fixed. The alternative is to fix a separate loud bell, say, on the station platform outside, where it can be heard by anyone employed about the station on other duties. One bell could be used to indicate the call from all the staff circuits. In some very exceptional cases it may be that a suitable bell is placed in a stationmaster's house or bedroom. By the use of this instrument any number of trains can be sent in either direction and in any order. If there is an intermediate siding in the section, a key is fitted on to the end of each staff, and the siding is thus absolutely controlled beyond any possibility of accident.

I have stated that one conductor only was used to connect the two instruments—instead of two conductors for a metallic circuit, as originally specified in 1889—but by means of the condenser method this solitary conductor is available also for telephone working, and each signal cabin can thus speak to its nearest neighbour on each side without any fear of risk to the block working, a single conductor thus

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sufficing for absolute staff block and telephone working. It may, however, happen that there is between the stations, and out of sight of both of them, a movable bridge, such as those over the Shannon, having a span lifting from the horizontal to the vertical position, thus cutting out a section of the bridge and of the rails to enable the navigation of the river to proceed without limiting the height of the masts and funnels. Whilst such a bridge is open and the rails not continuous, train staff signalling ought to be impossible, and this has been very ingeniously arranged by locking the bridge electrically from the two train staff instruments controlling the section. At the bridge cabin itself the lever in the signal frame which operates the ponderous bolt locking the bridge is itself locked electrically, so that the lever cannot be drawn. This electrical lock consists of two pairs of electromagnetic coils mounted exactly as in a train staff instrument, one pair being joined by means of a switch to the up side and the other pair to the down side of the staff circuit, and their opposite ends earthed. In ordinary circumstances A works to B through the switch at the bridge cabin without touching the electromagnet coils there, but when it is desired to open the bridge and the usual preliminaries have been gone through, the signalman at the bridge cabin turns his switch, and so

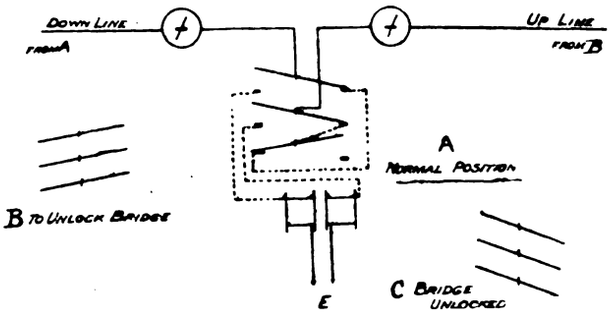

FIG. 7.

deflecting the current from A through one pair of the electromagnet coils and to earth, and the current from B through the other pair of electromagnet coils and to earth. The electrical lock is thus released and the lever can be drawn. This, of course, supposes that the "staffs" belonging to the section are all in the magazines and the instruments in phase, otherwise it is not possible to take off the electric lock. The lock having been taken off, the circuit between A and B becomes disconnected, as shown in the diagram (Fig. 7, C), and must remain so until the bridge has been restored and locked mechanically from the lever frame, when the line circuit between A and B can again be completed by the switch. A and B then on being requested lock the bridge electrically from their staff instruments, and the section over the bridge is again open for train staff working. It will be observed that the man actually in charge of the bridge is powerless for mischief, whether wittingly or not. He can do nothing if the staff is out at either end. It is often the case that there is an intermediate station in a staff block section without any block or telegraph, and it may be most desirable to give it communication with the two signal cabins controlling the staff section. This can be done by leaking-in a telephone set, using condenser working for speaking and a magneto generator for ringing (Fig. 8). The ordinary working of the staff would thus not affect the intermediate apparatus in any way, nor would their telephone working by the condenser method be affected by it, as when the terminal stations wanted to speak to each other they would use the train staff instrument and bells for calling purposes, and so not disturb the intermediate bell, which would respond to alternators only. A choking coil is used in the block bell circuit. It will be understood that a

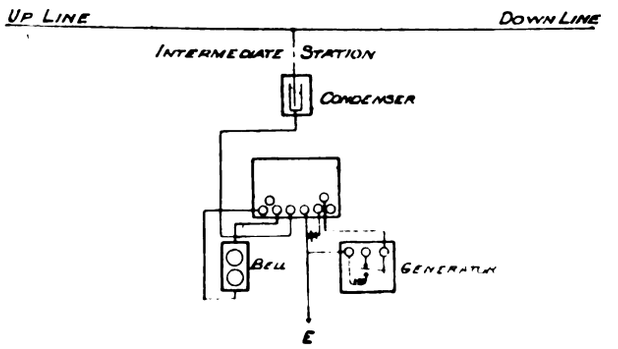

FIG. 8.

single conductor could thus be used for: (1) block signalling; (2) telephonic speech—condenser method; (3) bridge locking; (4) telephonic speech intermediate station—magneto ringing; and that each of these circuits would practically be independent of the other, and the whole having as the first consideration absolute safety and freedom from breakdown.

In all these block circuits it is usual to employ Leclanché batteries both for the line and the local circuits, and they have proved exceedingly reliable and trustworthy under very indifferent housing and in all conditions of weather. The difficulty as to their being accidentally left in short-circuit on the train staff having been provided for by the first disc cutting off the local battery from the coils the moment it has completed its duty Fig. 6). Earthenware jars of quart size are used with zinc plates bent into the form of a cylinder. These plates were originally 4in. in diameter and 6in. in length, but the present practice is to use a shallow zinc of the same diameter and hang it from the top of the earthenware cell. The greatest depth of zinc is 3in. and the plate tapers to ½in. The weight of zinc in each plate is only one-third of the former quantity. whilst in all essential respects the cell is the same. No difficulty is found in the maintenance of these modified cells. The shallow zincs wear gradually until they resemble the blade of a pocket-knife, the lower edge of the zinc becoming quite sharp.

Unusual conditions have arisen in the maintenance of the train staff instruments, partly on account of the current being several times as large as that used on telegraph and telephone circuits, 150 milliamperes being usually allowed, and also partly on account of its case and supports being of iron. It is quite possible that in drier climates than this such difficulties have not been felt, but originally a deal of trouble in some localities was caused by disconnections in the electromagnet coils due to leakage through the case to earth. Drier battery accommodation has, however, been provided, and a much higher standard of insulation obtained in the coils themselves, so that this difficulty, which was excessively local and not general, has disappeared, and these instruments are causing very little interruption to traffic from failures of any kind. They have so increased the capacity of a single road that we shall probably see no new double lines of railway track in Ireland in our time.

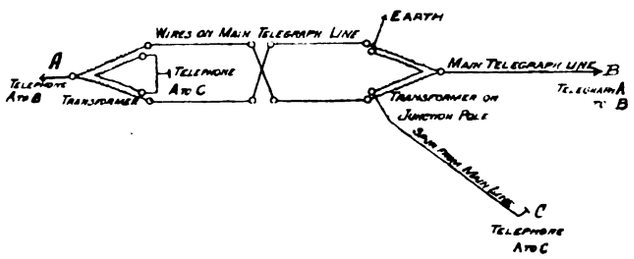

FIG. 9.

Before I conclude, perhaps I ought to mention the introduction of superimposing—*i.e.*, a telephone circuit being superimposed on a Morse telegraph circuit in order to obtain freedom from inductive disturbances on the former without using more than the two conductors for the two circuits. Such circuits exist on our main lines of telegraph which run along the railways. There is more than one method of superimposing, but I am illustrating one only (Fig. 9). The Morse circuit is joined to the centre of the "inner" ends of the primary coils of a transformer, and after passing through them in multiple is taken off again and passed over both conductors until the point is reached where superimposing is no longer necessary. The two conductors are then joined to the two "outer" ends of the primary coil of a similar transformer,

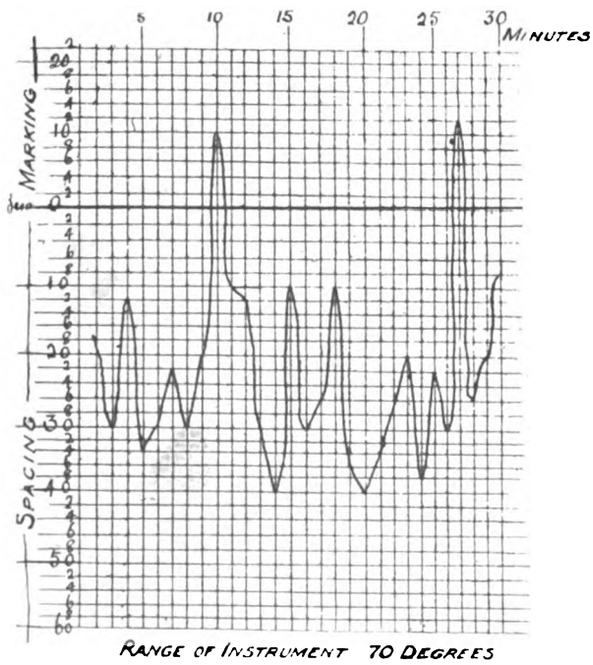

FIG. 10.

and taken off from the centre of the "inner" ends, and so made one conductor once more. The telephone circuit goes continuously through both secondary coils in the same direction, and is then earthed, where it joins the single conductor. The ringing is by magneto generators and magneto bells. In order to get perfect silence it is also necessary to resort to the usual method of crossing the conductors until the noise from the adjacent circuits is got rid of, as the conductors used for the Morse circuit are on the same arm and run straight, and not twisted. I have been more than surprised personally with the result so far as freedom from induction is concerned. It will require to be heard to be fully appreciated.

And one other matter I would like to mention, and that is our common struggle to live, continuing to use the earth as everyone's return for all sorts of circuits, irrespective of their working conditions, power, or length. It seems to me to be only yesterday since

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conductor-resistance tests were readily made from this city to "earth" at any point in Ireland and readings taken quite easily by means of a Wheatstone bridge. Alas! the galvanometer needle will not now stand still for a fraction of a second. "Earths" in parts of Dublin quite away from any tramlines—even some of them in the centre of the yards of railway termini, with many surface lines of steel rails on each side of them—and "earths" 30 miles away show constant difference of potential. I suppose if the telegraphs were worked as "closed" circuits without any battery, it would be a case of stealing current.

Fig. 10 may be taken as an actual record typical of a telegraph circuit at rest. The diagram is made in the actual degree values of a "lineman's detector," and not in volts. I thought this might interest us all, as we see it from different points of view, and interpret it from totally different premises. And on this common ground I will conclude. I hope I have not been tedious.

THE DISTRIBUTION OF MAGNETIC FLUX IN LARGE ELECTROMAGNETS.*

BY W. M. THORNTON, M.SC. (MEMBER).

(Continued from page 528.)

To test the correspondence between the theoretical logarithmic and the observed initial throws, the voltage E was changed, and the following induced voltages obtained:

TABLE V.

E.	$e = E/S$.	Throw, cms.	e (observed).
104	·0047	12·0	·0043
80	·00334	9·2	00330
56	·00233	6·25	·00224
30	·00125	3·5	·00129
6	·00025	·68	·000244

The agreement is close, and goes to prove that the presence of the iron does not affect the amplitude of the first throw (within the limits of experimental error).

The steepness at which the curves start to descend may also be calculated for constant permeability, for

$$de/dt = -\frac{Er}{10\,S\,L}e^{-\frac{rt}{L}},$$

and at zero time this is the tangent to the curve at its maximum.

Thus
$$de/dt = -\frac{Er}{10\,S\,L} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

This varies as E, so that the secondary curves should start to descend at a tangent proportional to the primary voltage.

TABLE VI.

E.	de/dt.	Tan θ_0 calculated.	Tan θ_0 observed.
104	·00842	2·35	9·25
80	·00648	1·808	4·5
56	·00453	1·263	2
30	·00243	·675	·7
6	·000486	·135	·10

This shows the difference between the logarithmic and actual values to be considerable. The true tangents should be from equation (5):

$$de/dt = \frac{i}{10\,S}\frac{d^2L}{dt^2} + \frac{1}{10\,S}\left(\frac{dL}{dt} - r\right)\frac{di}{dt},$$

which rapidly approximates to

$$de/dt = -\frac{r\,E}{10\,S\,L}e^{-rt/L}$$

Equation (3) applies equally well to short-circuit as to make. The curve of fall of current in a circuit of constant permeability short-circuited is the inverse of the make curve. The equation is then

$$L\,di/dt + ri = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

$$i = i_0 e^{-\frac{rt}{L}}$$

and
$$\frac{di}{dt} = -\frac{i_0 r}{L}\epsilon^{-\frac{rt}{L}} = -\frac{E}{L}\epsilon^{rt/L}$$

$$L\,di/dt = -E\epsilon^{rt/L},$$

and
$$e = -\frac{E}{10\,S}e^{-\frac{rt}{L}} + \frac{i}{10S}\frac{dL}{dt}.$$

Thus, since μ is constant,

$$e = \frac{E}{10\,S}e^{-\frac{rt}{L}},$$

the negative sign showing that the direction of galvanometer throw is reversed.

When $t=0$, $e = -\frac{E}{10\,S}$, as in the make curves. The initial throws should then be the same in both make and short circuit. Also

$$\frac{de}{dt} = -\frac{r\,E}{10\,S\,L}e^{-\frac{rt}{L}}.$$

Thus the make and short-circuit curves should be in every way identical. By comparing them in Plate I. it is seen that they are not, the latter being invariably lower than the make, the average ratio for the set there given being 1·245.

Equation (3) applies to both equally well provided the values of $\frac{dL}{dt}$, etc., are taken from the curves of decreasing magnetism of Plate (5). It is seen that the rate of change at short-circuit of L—*i.e.*, of μ, is exceedingly rapid, the flux density slipping back over the knee of the iron curve in a quarter of a second. In the make curves, the inductance decreasing accelerates the growth of the current; in these short-circuit curves, it is increasing and retarding the current. That is, the greater $\frac{dL}{dt}$ is, the *greater* i will be. Substituting $-r\,i$ for $L\frac{di}{dt}$ in equation (3),

$$e = \frac{i}{10\,S}\left(\frac{dL}{dt} - r\right)$$

the equation of the short-circuit secondary curves. Here i is a maximum when $t=0$, and if L is constant it reduces to the form $e = -E/10\,S$. That it is always less than this shows the retarding change, dL/dt, to be very rapid, and if it is numerically greater than 9·7, the voltage may be momentarily reversed. This reversal was observed when the oscillograph was used, but was so exceedingly rapid that it could not be photographed. The flick in the reverse direction was at first thought to be some effect of the damping oil until the above theory explained it. From Plate V. the time-constant changes to 3·2 henries in ·25". Thus, L is 31 henries, and dL/dt is 122·4. There should be then a reversal in the first quarter of a second. Then dL/dt drops to ·5, and remains at a nearly constant value of ·25 for seven seconds; dL/dt equals 9·7, somewhere between ·25" and ·3" from the start, and by taking points on the curve as before, e is found to reach its negative maximum as soon as the induction knee is rounded. At that moment $i=9$ amperes, and $dL/dt = ·3$.

Therefore
$$e = \frac{9}{23{,}930}(·3 - 9·7) = ·0035 \text{ volt.}$$

Now, the initial throw at make for 104 volts is ·0043. The ratio of the throws should therefore be 43/35 = 1·255, which may be compared with the actual value recorded by the galvanometer, then unifilar, of 1·245.

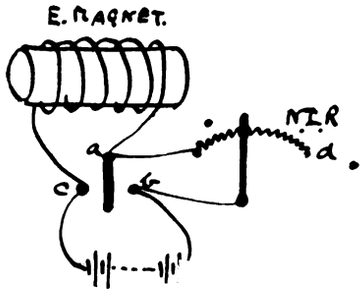

FIG. 1.

Superposing the curves corresponding to the two cases, the short-circuit ones always cut the make, as shown on Plate V., for the magnetising currents and below for the induced voltages, the areas here being unequal by reason of the residual magnetism.

The average value of the time-constant from Plate (5) is 5·36. The value found by taking the record to be exponential, and calculating L/R from the time taken by the current to reach ·95 of its full value, is 5·4. Thus, since the measurement was made with the coils cold—*i.e.*, $r = 9·7$, L = 52 henries.

The mean length of the circuit is 284cm., its area 1,290 square centimetres. Hence the permeability corresponding to the mean value is 158·5, and this is for the whole circuit, including the air-gap. The theoretical rise of current with $\mu = 158·5$ compared with the actual rise is shown in Plate VII.

The total magnetomotive force on the circuit at no load is 32,300 C.G.S. units, the core flux then being $19·6 \times 10^6$ lines. The reluctance is thus ·00165, and $L = \frac{4\pi t^2}{R}$, t being the turns and R the reluctance of the machine.

Thus $L = \frac{12·56 \times 2{,}393^2}{·00165 \times 10^9} = \frac{72}{165} = 43·5$ henries with the permeability corresponding to full excitation. The value obtained above, 52 henries, includes the variation of permeability over the range of exciting current used.

§ 3. APPENDIX.

The Influence of Electromagnetic Damping on the Readings of a Dead-Beat Moving-Coil Galvanometer.

Let I be the moment of inertia of the moving system—*i.e.*, coil and mirror;

k the retarding torque due to the damping alone for unit angular velocity;

a^2 the torque caused by unit twist of the suspensions.

* Abstract of paper read before the Newcastle Local Section of the Institution of Electrical Engineers, March 24.

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The equation of motion under the influence of an applied torque, $b\,f(t)$ is

$$I\frac{d^2\theta}{dt^2}+k\frac{d\theta}{dt}+a^2\theta=b\,f(t) \quad . \quad . \quad . \quad . \quad . \quad (i.)$$

Assuming $f(t)$ of the form $\left(1-\epsilon^{-\frac{rt}{L}}\right)$, the solution is

$$\theta=A\,\epsilon^{mt}+B\,\epsilon^{-mt}+\frac{b}{I}\left(\frac{I}{a^2}-\frac{\epsilon^{-at}}{a^2-\frac{k}{I}a+\frac{a^2}{I}}\right) \quad . \quad (ii.)$$

where $$m=-\frac{k}{2I}\pm\sqrt{\frac{k^2}{4I^2}-\frac{a^2}{I}}.$$

If the damping is so great that $k=2a\sqrt{I}$, the motion is dead-beat. k being $>2a\sqrt{I}$ the deflections are retarded, and are not proportional to the applied torque at every instant. The moment of inertia of the coil in the Pitkin-Holden D'Arsonval galvanometer is 4·4 C.G.S. units, determined by calculation from the mass and dimensions. a^2 is determined by measuring the deflection caused by a steady current. Thus let i be the current in amperes due to inserting a storage cell (standardised before and after by a Crompton potentiometer, and during the passage of the current) in circuit with the coil and a known high resistance. The torque produced is then

$$\frac{B\,i\,l\,t\,w}{10}\text{ dynes,}$$

where B = the flux density in the air-gap of galvanometer;
l = the length of the gap, allowing for stray field at end;
w = the width across coil—from gap to gap;
t = the number of turns in the coil.

Thus $$a^2\theta=\cdot1\,B\,i\,l\,t\,w.$$

Let the scale reading at a distance d be s. Then, provided this is small,

$$a^2=\frac{\cdot2\,B\,i\,l\,t\,w\,d}{s}.$$

By measurement with a bismuth spiral and with an exploring coil, B was found to be 1,100 lines per square centimetre, and w is 2·4cm.,

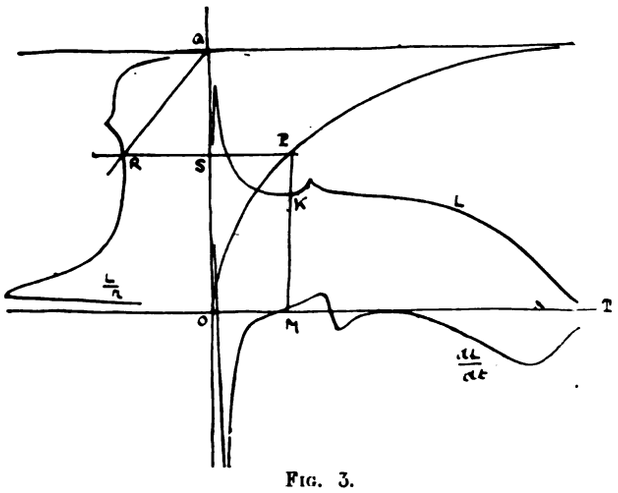

FIG. 3.

l, 4·2. The turns were given by the makers as 100. The deflection produced by two volts through 100,000 ohms, including the galvanometer resistance of 144·3 ohms, was 7·4cm. at 71cm. distance. From these

$$a^2=38{\cdot}6.$$

The coil was wound upon a short-circuited copper former, the circumferential length of which was 13·4cm., and the cross-sectional area ·015 square centimetre, the resistance being ·0014 ohm. The current in the former is due to the voltage induced by the motion of the coil. Thus let the number of lines threading the coil when the the deflection is θ be N. The distribution of magnetism in the soft-iron armature being practically uniform, $N=B\,w\,l\,\theta$ for small deflections. Thus

$$e=\frac{dN}{dt}=B\,w\,l\,.\,\frac{d\theta}{dt},$$

and the current in the former $=\frac{B\,w\,l}{\cdot0014}10^{-8}\,.\,d\theta/dt.$

The retarding torque caused by this at any instant:

$$k\frac{d\theta}{dt}=\frac{B^2\,w^2\,l^2}{14\times10^8}\,.\,\frac{d\theta}{dt}\text{ (dyne-cms.).}$$

Thus $k=72{\cdot}57$ C.G.S. units.

For perfect dead-beatness, $k=2\sqrt{a^2\,I}$, or $k=26$.

The damping was thus much too great, and the curves obtained with the galvanometer in this state of adjustment cannot be taken as a record of the instantaneous voltage in the exploring coil. The magnitude of the distortion may be seen by tracing the Curve ii.

Here $$m=-8{\cdot}24\pm\sqrt{59{\cdot}23}.$$

Hence $$m=-\cdot54,\text{ or }-15{\cdot}94.$$

Thus

$$\theta=A\,\epsilon^{-\cdot54\,t}+B\,\epsilon^{-15\cdot94\,t}+\cdot227\,b\left(\frac{4{\cdot}4}{38{\cdot}6}-\frac{\epsilon^{-at}}{a^2-16{\cdot}49\,a+8{\cdot}77}\right) \quad (iii.)$$

Here b is the constant coefficient of the current in the expression for the torque applied to the galvanometer coil, and $\frac{1}{a}$ the time constant of the windings on the generator. The latter was obtained by observing the time taken for the magnetising current to reach ·95 of its full value. Knowing the resistance—*i.e.*, 9·7 ohms—the inductance is 52 henries, a being ·185.

The complete expression for the right-hand side of equation (i.) is

$$\cdot1\,B\,l\,t\,w\,i_0\,(1-\epsilon^{-\cdot185\,t}), \quad . \quad . \quad . \quad . \quad . \quad (iv.)$$

when i_0 is the steady galvanometer current in amperes. This was observed to be 10 micro-amperes. Hence (iv.) becomes $(1-\epsilon^{-\cdot185t})$, the coefficient accidentally reducing to unity.

Thus $$\theta=A\,\epsilon^{-\cdot54\,t}+B\,\epsilon^{-15\cdot94\,t}+\cdot227\left(\cdot111-\frac{\epsilon^{-\cdot185\,t}}{5{\cdot}554}\right).$$

That is, $$\theta=A\,\epsilon^{-\cdot54\,t}+B\,\epsilon^{-15\cdot94\,t}+\cdot0252-\cdot0408\,\epsilon^{-\cdot185\,t}. \quad . \quad (v.)$$

To determine the constants; when $t=0$, $\theta=0$.

Hence $$A+B=\cdot0156 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (vi.)$$

Also since the initial angular impulse is proportional to the initial current, and this is zero at $t=0$, then $\frac{d\theta}{dt}=0$, at $t=0$.

That is, $$-\cdot54\,A-15{\cdot}94\,B+\cdot00756=0 \quad . \quad . \quad . \quad . \quad (vii.)$$

Therefore $$A=\cdot01566\,;\ B=\cdot00006.$$

The second term may thus be neglected, the high negative index, together with the low constant, bringing its value to a relatively insignificant figure.

Thus $$\theta=\cdot0252+\cdot01566\,e^{-\cdot54\,t}-\cdot0408\,e^{-\cdot185\,t} \quad . \quad . \quad (viii.)$$

To see the effect of damping this must be compared with

$$\theta=(1-\epsilon^{-\cdot185\,t}) \quad . \quad . \quad . \quad . \quad . \quad . \quad (ix.)$$

These curves are plotted on Plate VII.

Considering the effect of damping on the early records the solution must be found in two parts, that for the straight rise and that for the

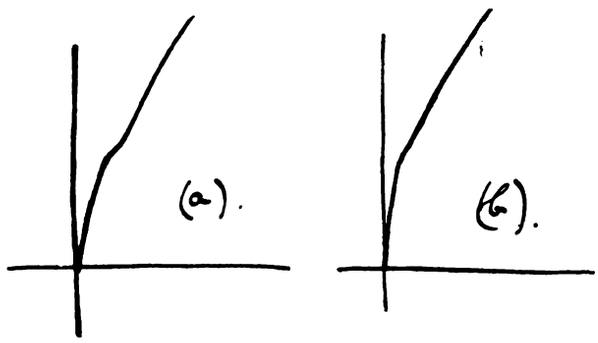

FIG. 4.

approximately logarithmic fall. The time taken to reach the maximum e_0 is ·45″, and if the galvanometer current is then as in the make curve, 10 micro-amperes, the coefficient b is unity. At any time t during the first part of the motion $i=i_0\frac{t}{t_1}$, i_1 being the maximum galvanometer current corresponding to e_0. The equation for the first part of the curve is then

$$\theta''+\frac{k}{I}\theta'+\frac{a^2}{I}\theta=\frac{t}{It_1} \quad . \quad . \quad . \quad . \quad . \quad (xi.)$$

Of this the solution is

$$\theta=C\,e^{-\cdot54\,t}+D\,e^{-15\cdot94\,t}+\cdot1162\,t-\cdot227.$$

When $t=0$, $\theta=0$. Thus $C+D=\cdot227$. Also, $\frac{d\theta}{dt}$ is constant for all values of b so long as θ is small.

The maximum scale deflection in the curve which corresponds to $i_0=10^{-5}$ amperes is 22cm. at 71cm. distance, not quite 9deg. of the coil. It starts off to reach this in ·45″. Thus $d\theta/dt=\cdot18$ radian per second. (One sees here how the initial angular velocity, which depends on the amplitude of the curves, modifies the constants C and D, so that with a heavily damped instrument, where the exponential terms are of importance, no two unequal curves are described under quite the same conditions.)

Hence $$\cdot54\,C-15{\cdot}94-\cdot227=\cdot18,$$

and $$C=\cdot275\,;\ D=-\cdot048.$$

Thus $\theta=\cdot275\,e^{-\cdot54\,t}-\cdot048\,e^{-15\cdot94\,t}+\cdot1162\,t-\cdot227$. This is plotted at (1), Plate VII. . . . . (xiii.)

For the second part of the motion $i=i_0\,\epsilon^{-at}$, and a may be taken as constant corresponding to the average value of μ. The equation is now

$$\theta''+\frac{k}{I}\theta'+\frac{a^2}{I}\theta=\frac{\epsilon^{-at}}{I}$$

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and the solution

$$\theta = A\, e^{-\cdot 54\, t} + B\, e^{-15\cdot 94\, t} + \cdot 0408\, e^{-\cdot 185\, t}$$

Now, $\theta = \cdot 155$ radian when $t = 0$, the time being reckoned from when the drop begins in the coil; and at this point $d\theta/dt = 0$, since the spot came to rest.

Hence $$A + B = \cdot 0408$$

and $$-\cdot 54\, A - 15\cdot 94\, B = \cdot 00756.$$

(These give the motion for $\theta = 0$, at $t = 0$; thus the ordinates must be read downwards.)

Thus $$A = -\cdot 0418\,;\quad B = +\cdot 001.$$

Therefore

$$\theta = \cdot 001\, e^{-15\cdot 94\, t} + \cdot 0408\, e^{-\cdot 185\, t} - \cdot 0418\, e^{-\cdot 54\, t} \quad \text{(xiv.)}$$

This is plotted as the descending part of (1), Plate VII. With these are plotted the curves which would be obtained under the same forces by a perfectly dead-beat instrument.

For the straight-line part of the motion $\theta = \dfrac{t}{b^2\, t_1}$, and for the second $\theta = \dfrac{-at}{a^2}$. These are plotted at (ii.), Plate VII., and one sees that the damping not only shears the curve over, but its area compared with the theoretical is much greater.

It was not possible to reduce the relative influence of the damping by tightening the suspensions more than a small amount of that required to overcome the large difference between the elastic and damping torques. There were then two changes which might be made—either the field reduced, or the suspensions made bifilar. The damping varies as the square of the field, and the elastic control directly as the field strength. There will thus be one strength of field which will make the motion perfectly dead-beat. Both of the above methods were tried in turn, and the first was eventually discarded because of the uncertainty introduced into the field distribution by the soft-iron shunt which was placed across the poles touching the armature. The shunt itself was made of thin soft iron plates, and the damping varied by changing their number, until for any particular throw the top of the curve showed neither rounding nor overshooting. To find the particular field at which the instrument will be dead-beat, write the damping coefficient $k = \alpha\, B^2$, and the torsional control $a^2 = \beta\, B$.

Then when $$\frac{k^2}{4\, I^2} = \frac{a^2}{I}\,;$$

$$\frac{\alpha^2 B^4}{4\, I} = \beta\, B\,;\ \text{or,}\ B^3 = \frac{4\,\beta}{\alpha^2}\, I.$$

Thus $$B = \sqrt[3]{4\frac{\beta}{\alpha^2}\,.\,I} \quad \text{(x.)}$$

From the data of the instrument given before

$$\beta = \cdot 0386\,;\quad \alpha = 72\cdot 57 \times 10^{-6}.$$

Hence $$B = 100\, \sqrt[3]{129}.$$

That is, B = 505 lines per square centimetre, or half the normal flux in the gap.

This method does not reduce the relative importance of the inertia of the coil, and the change to bifilar suspension was therefore made at a loss of sensitiveness, which was not of importance since the power available in the exploring coil is practically unlimited so far as the galvanometer is concerned. The bottom suspension loop was cut through, and to each of the free ends a phosphor-bronze strip soldered, one of which carries the current, the other being merely in tension. The wires can be adjusted any convenient distance apart at a, and at b are wedged into the circular hole of the nut by a long taper soft-wood wedge. The dead-beatness is adjusted by varying the distance apart at a, and also varying the tension by means of the adjusting screw at the top, c. The motion is thus under complete control.

As a guide to the instrument maker, the thickness of the copper former may be calculated, knowing the strength of the field and of the torsional control, in order that the motion may be dead-beat.

For $k^2 = 4\, I\, a^2$, or $k = 2\, a\, \sqrt{I}$. Here $k = \dfrac{B^2\, w^2\, l^2}{10^8\, r}$, r being the resistance of the former frame.

Thus $r = \dfrac{B^2\, w^2\, l^2}{10^8\, k}$; also $r = \dfrac{2\, w\, l\, \rho}{s}$, where s is the cross-sectional area of the former and ρ its specific resistance. But the moment of inertia is combined of the constant mass of the winding and the unknown former weight, and the latter is $2\, w\, l\, s\, \sigma$, σ being the specific gravity of copper. Thus $I_f = 2\, w\, l\, s\, \sigma\, k^2$, k being the radius of gyration.

Hence $$\frac{2\, w\, l\, \rho}{s} = \frac{B^2\, w^2\, l^2}{10^8\, 2\, a\, k\, \sqrt{2\, w\, l\, s.\sigma + m_c}}$$

where m_c is the mass of the coil alone, say 2 grm. Therefore

$$\frac{4\, \rho\, k\, a}{B^2\, w\, l} = \frac{s}{\sqrt{2\, w\, l\, \sigma\, s + m_c}}$$

or, $$B^4\, w^2\, l^2\, s^2/10^{16} - 32\, \rho^2\, k^2\, a^2\, w\, l\, \sigma\, s - 16\, \rho^2\, k^2\, a^2\, m_c = 0.$$

Let $B = 1{,}000$, $\rho = 1\cdot 65 \times 10^{-6}$, $\sigma = 8\cdot 95$, $a^2 = 38\cdot 6$, $k^2 = 1\cdot 25$, $w = 2\cdot 4$ $l = 4\cdot 2$.

Then $9\cdot 95\, s^2 - \dfrac{1\cdot 58}{10^4}\, s - \dfrac{1\cdot 74}{10^5} = 0$. Therefore $s = \cdot 0013$ square centimetre. The actual cross-sectional area is $\cdot 015$ square centimetre.

(To be continued.)

TRADE NOTICES AND NOVELTIES.

Solid Filling-in System for Underground Mains.

The tendencies of modern industries is all in the direction of extreme specialisation, and the firm devoting itself to the supply in bulk of a few special articles is much more likely to succeed than the general supply agency which was so common in electrical engineering 10 years ago. This fact is clearly shown by the business of Messrs. Rowland Carr and Co., of Lime-street-square, E.C. The specialities of this firm are the materials used in connection with the laying of underground cables on the solid filling-in system. For this purpose they have standardised a variety of sizes of cast-iron troughings to contain the cables, and obtained from their foundries uniformity in these troughings, which conduces to ease of laying. The great speciality, however, of the firm is the bitumen used to fill in the troughing after the cables have been laid in place. The firm have supplied us with a number of expert reports which have been made by chemists and electrical engineers on this bitumen, which show conclusively that it has enormous advantages over any casting in compound which contains coal-tar pitch. The first of these is that the bitumen is more stable, and does not contain solvents which can be washed out by water, as coal-tar pitch does. That this is the case with pitch can be gathered by an inspection of the earth within 10ft. or 20ft. of a stack of pitch after it has been exposed to the weather. The action of water renders the pitch more carbonaceous and friable, and hence it is not so well suited for protecting the cables. Another point is that the bitumen is a much better insulator. Thus from tests made in the Westminster testing laboratories it was found that a pressure of 30,000 volts alternating was required to break down a layer of bitumen $\frac{1}{16}$in. thick, whereas an equal thickness of coal-tar pitch allowed a spark to pass at 4,800 volts. The insulation resistance of a 1in. tube of the two materials at 72deg. F. were respectively 6·4 megohms for the coal-tar pitch and 27,000,000 megohms for the bitumen. In light of the recent explosions in the city of London the bitumen has still further advantages over the *pitch compound* which was used to protect the cables at the point where the trouble arose. This is that the bitumen supplied by Messrs. Rowland Carr and Co. does not contain any benzole, naphtha, or other hydro-carbons of low boiling-point. It is found by experiment that vaporisation with this bitumen does not begin until a temperature of 265deg. to 275deg. F. is reached These temperatures are much higher than is required to be used when filling in the cables, as the bitumen flows sluggishly at 208deg. F., and freely at 228deg. F. To show how much this bitumen is appreciated, we would mention that the firm have already supplied 3,000 tons to the Charing Cross and Strand Electric Lighting Corporation, Limited, for their new mains in the city and West-end of London, and have in hand large orders for over 30 cities and towns in the United Kingdom and abroad. In conclusion, we would remark that this bitumen, while preventing the salts from the soil entering the lead covering of the cables, contains no acids which would harm the metal. It is, therefore, one of those substances with which, according to our poet "H. J. C. B.," cables can be buried without a funeral service.

In their long and narrow bed,
They were laid at early morn,
They were buried with the dead,
That will lie till Gabriel's horn;
Not a note of "Saul's" solemnal,
Nought of crape was worn.

Not a bearer stopped to sorrow,
As the earth was shovelled o'er,
For we knew that on the morrow
They would be alive once more;
And their lights should shine before men,
Lighting up the golden shore.

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At the ordinary general meeting on April 10 the following were the candidates balloted for:

Members.—Sir Douglas Fox, 28, Victoria-street, S.W.; A. Lazenby, care of Messrs. Willans and Robinson, Limited, Victoria Works, Rugby.

Associate Members.—C. A. Blascheck, Electricity Works, Canterbury; J. B. Clarke, Dudley-street, Wolverhampton; C. Garnett, Corporation Electricity Works, Darwen; G. J. Gibbs, 76, Heslington-road, York; F. J. Mars, Broken Hill, New South Wales; H. J. Robertson, 5, Castle-gardens, Gourock, N.B.; G. F. Whipple, 70, Huntingdon-road, Cambridge; W. A. Wilkinson, care of J. H. Holmes and Co., Examiner-buildings, Strutt-street, Manchester.

Associates.—J. B. Bingham, 6, Bertram-road, Sefton Park, Liverpool; J. P. Crowther, Potter-street, Worksop; A. McAlpin, 4, Portland-terrace, Leicester; E. A. Mansfield, Moorgate Station-chambers, E.C.

Students.—C. Dally, 149, Derby-road, Southampton; C. J. Greene, Faraday House, Charing Cross-road, W.C.; F. V. Harrap, The Elms, Norbury, S.W.; E. Pink, Neatham, Winchester; G. A. Tucker, Rockleaze, Osborne-road, Portswood, Southampton.

Students' Section.—Arrangements have been made for the students to visit the works of Messrs. Easton and Co., Erith, on Saturday, April 26, at 9.15 a.m.

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STAFF ORGANISATION.

The success or failure from a financial point of view of any engineering undertaking, whether of the manufacturing or public supply order, is intimately connected with the organisation of the staff. As the financial success is the ultimate criterion of the length of existence of such undertaking, it follows that too much attention cannot be paid to this question of staff organisation. The best system of control of any such concern is that of an autocratic head, and the more intimate this head is with the details of the work to be done the better. Unfortunately, a large proportion of our electrical engineering undertakings have, by reason of their size, to be nominally under the control of either a board of directors or a municipal committee. This tends against the undertaking being run by a single autocrat, and hence against the most efficacious management. This was not the case in the earlier years of engineering undertakings, when the successful engineer was able to build up a large personal business as a manufacturer. Even now, in spite of boards of directors and of electric lighting and tramways committees, there will be usually found a controlling personality in the most successful undertakings, who, perhaps unconsciously, guides matters in the right way, and prompts the ruling body of directors or committeemen to deal effectually with weak points in staff organisation. It is essential, however, that there should be only one controlling spirit of the type we mention in the undertaking, and that he should have a strong personal interest in the success of the business. When, of course, the business is his own, this interest is paramount, and it results in the giving of prompt rewards to the useful members of the staff, and the equally prompt dismissal of those who show themselves unfitted for the positions they are in. In such a case, an active working staff is got together by the gradual system of the survival of the fittest. Faults in management, on the other hand, especially if the one powerful autocrat is replaced by a collection of would-be chiefs, result in a demoralised staff, and in every member of the same devoting some of his energies to the maintenance of his own position. Such a case is that revealed by the history of the Brush Electrical Engineering Company, whose thirteenth annual general meeting was held last week. The position of this company is not an enviable one, in spite of the large number of years during which it has been at work. The chairman in his speech referred to the reorganisation of the works at Loughborough which he stated was commenced by the late Mr. Slater Lewis, who, unfortunately, died before he had completed it, and it is now being continued by others. A glance, however, through the reports of the company for previous years will show that this question of reorganisation of works and of staff is by no means a new theme, and that large sums have been paid with this object without appreciably improving the financial results of the undertaking. Although the chairman did not state it in his speech, we believe that the present reorganisations have involved the dismissal of a large number of the technical staff of the company. The wisdom or otherwise of removing these gentlemen, who have had the supervision of the manufacturing and contract work of the company for some years, can only be proved by subsequent events. Assuming that the large number of dismissals were necessary, it follows that the control of the company by the directors has been faulty, as it would have been better to make the changes more slowly. Our view of the case is that the reorganisation has now been begun too low down, and that it is the board of directors and their system of doing business that needed

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prior attention. If the Board were responsible to one autocratic head, and were called upon individually to show reason why they should continue to hold office, we fancy the reports would be interesting reading. The excuse of inefficient work or staff would not hold, as for both of these they are directly responsible. The fact is that the members of the Board attempt too much personally, as we find that the four members who have most electrical experience have between them eighty-two directorships. This averages over twenty per head, so that the time devoted to each must be too small to be useful to a manufacturing concern. At the meeting of the company last week the chairman said: "The prospects of the Brush Company are good; closely associated, as we now are, with the most prominent electrical undertakings in this country, the demand for our manufactures must be constant and increasing, and we hope that by exercising strict economy and employing the best men available, we shall be able to earn the full dividend on the preference shares and a fair dividend on the ordinary shares." This hopeful statement represents the old and faulty policy of the company since its inception. If the company will not so organise its business as to earn profits in the open market, we are afraid its dealings with "associated undertakings" will be as disastrous in the future as in the past.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ESTIMATING.

SIR,—Although some of the questions raised by "A Beginner" in your issue of April 11 can hardly be met with a direct answer, they are of very general interest and merit some attention:

(*a*) On this point get in touch with the leading advertisers and procure their price-lists, etc.; these will be found to contain much valuable information. I am not aware of any one book treating directly on the subject, but published lists of tenders should be carefully watched.

(*b*) The work of replacing lamps, fuses, etc., is often done by a handy man about the premises when current is obtained from a central station. For a plant of 50 lamps labour would cost about £60 per annum. This is, of course, only a rough estimate; some of your older readers will doubtless have recollections of a gardener who once did some wonderful things in this direction.

(*c*) A 50-light plant with battery, wired complete, would cost about £500.

(*d*) (1) say 10s.; (2) say 5s. to 7s. 6d. for casing. For Simplex tubing prices would be somewhat less.

(*e*) Wood casing would cost rather more than iron tubing; but as to repairs, more depends on the conditions of the installation than on the materials used.

(*f*) 30 to 50 per cent.—Yours, etc., M. M.

THE UNDERGROUND RAILWAY "COMBINE."

It cannot be said that the announcement of the formation of Mr. Yerkes's new company, under the title of the Underground Electric Railway Company, has caused much surprise in well-informed circles, for it was generally known some months ago that he had secured the controlling interests in the District Railway and the proposed new lines included in his new enterprise. Mr. Yerkes, however, has apparently bided his time, and although he had this gigantic scheme in view then, it was not until the difficulty between the Metropolitan and the District Railways had been definitely settled that he was able to complete the amalgamation of the District lines with the partly-constructed Baker-street and Waterloo Railway and the projected tubes of the Great Northern and Strand Railway, the Brompton and Piccadilly Railway, and the Charing Cross, Euston, and Hampstead Railway. In this great enterprise Mr. Yerkes has secured the support of Messrs. Speyer, of London and New York, and the Old Colony Trust Company of Boston, who are to find the money for converting the present steam lines of the District Railway to electricity, and for constructing the proposed new railways. These old-established banking firms, although their names have not previously been mentioned in connection with Mr. Yerkes and his plans for providing London with a comprehensive system of rapid transit, are reported as being of the highest financial standing, and there can no longer be any doubt as to the ability of the promoters to carry their scheme through to the end. During the past week interviewers have been very active in getting as much detail as possible from Mr. Yerkes, who, be it stated to his credit, is ever willing, where possible, to give the fullest information as to his plans. In the course of one of these interviews Mr. Yerkes explained that it was necessary before his proposals could be carried out that the District Railway should join in, and this having now been effected, it is his intention to proceed with the execution of the scheme as rapidly as possible. The general details of the routes which the various new lines will follow have already appeared in print in many instances, and it is unnecessary to do more than call attention to the fact that it is proposed to join up the various London districts and make it possible to go from any part of the Metropolis to another. To this end it is intended to apply to Parliament for sanction to build little connecting lines to "round off" the lines already passed. Of course, one great central terminus for all the lines in question would be impracticable, but the idea is to connect the outer lines with the inner ring, which is represented by the District Railway, so that they will all touch the heart of London. Nor would it be advisable to choose the City as the centre of traffic, for, as Mr. Yerkes has explained, the travelling public to and from the City proper, except in the morning and early evening, is comparatively small, whereas to the area about Charing Cross and Piccadilly it is continuous practically all day. As Mr. Yerkes puts it, "the new lines will bring passengers east, west, north, and south to the District system, and the District will do the rest." In fairness, however, it must be pointed out that with the exception of the new line to the Elephant and Castle—*i.e.*, the Baker-street and Waterloo Railway—no provision is made in his scheme for South London. This may come in time, but in the meantime the travelling public in South London will practically be shut out from the facilities offered to the North of London by the proposed system. It may be that larger profits are anticipated from lines in the North, but surely such considerations should not be allowed to stand in the way of making the scheme complete by serving all districts alike. A word must be said on the important question of fares. Mr. Yerkes promises that outside the District lines there shall be a system of uniform fares. Thus a passenger will be able to travel between two points on any of the lines included in the scheme for one fixed charge. The Brompton-to-Piccadilly and the Great Northern and Strand tubes are to be made practically one railway, so that a man will be able to travel, for example, from Finsbury Park to Earl's Court—a distance of eight miles—for the same amount as he would be charged for any shorter distance. In Mr. Yerkes's own words—"we are going to see if we cannot encourage the working-man to get out to the green fields"—and the short-distance passenger will be relied upon to make up the deficiency consequent upon carrying the working-man a long distance at a loss. It is a matter for some regret, perhaps, that the Metropolitan Railway is not included in this great scheme. Mr. Yerkes's remark, "We have nothing to do with the Metropolitan further than the physical conditions compel us," does not give much hope of a fusion of the two concerns in the near future, but it is satisfactory to learn that the same conditions which now apply on the underground railways with regard to intercommunication will hold good, and it will be possible to travel from a Metropolitan station to any one of the other stations. As to the present position of the four proposed new lines, it

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may be stated that the Brompton and Piccadilly Railway is now under construction, and is expected to be finished in about two years' time. The central power-house in Lots-road, Chelsea, will then have been completed. As is generally known, the Baker-street and Waterloo line is in a half-completed state, and another two years will be required to finish it. Everything is ready for a start with the Great Northern and Strand tube, and a contract has been made for the Charing Cross to Hampstead Railway. It is hoped to have the whole scheme in operation in three or four years' time.

Turning now to financial considerations, it is not to be supposed that the promoters are going to carry out their great work with the five millions of capital with which the company has been registered. In point of fact the scheme is expected to cost quite 16 millions sterling, the company which has been registered being in the position of a guarantee company. As the work of construction proceeds additional money will be advanced by the financiers who are at the back of the enterprise. It is intended that Mr. Yerkes shall be chairman of the guarantee company, and under the articles of association there are to be eight other directors, the majority of whom will be elected by the banking houses mentioned above for a period of 10 years. It was provided that the capital of the company shall consist of 500,000 ordinary shares of £10 each, of which 100,000 credited with £5 paid will be allotted in exchange for their assets to the shareholders of the Metropolitan District Traction Company, which was originally formed to carry out the electrification of the District lines. By the new arrangement, however, that company will become absorbed in the larger concern. There will be no public issue, a syndicate having been formed which will at once provide £2,000,000 working capital, while the company itself will also have cash, or the equivalent in cash, for the shares allotted to the old traction company. Thus, the whole 500,000 shares of £10 each will be allotted, and half the capital paid up. There are also to be 2,500,000 "certificates of interest in contingent profits," which it is intended to increase to 5,000,000 should the ordinary shares be called up in full. These contingent certificates, the creation of which, it is explained, is to facilitate the apportionment of the profits which the company may make out of financing any subsidiary companies, will rank for dividends of 3 per cent., after the ordinary shares have received cumulative dividends of 5 per cent. per annum, and when the 3 per cent. has been paid, both classes will rank equally in any surplus. Of the contingent certificates, Mr. Yerkes receives 1,125,000 as the pioneer and promoter of the scheme, the old traction company 400,000, the bankers 175,000 for their services as managers, and the subscribers of the new money for the company will receive 800,000. This is really adopting the principle of payment by results, and the details we have given above are of interest as showing how the financial operations of an enormous concern such as the one in question are carried out.

LIVERPOOL CORPORATION TRAMWAYS.

The general manager of the Liverpool Corporation tramways, Mr. C. R. Bellamy, A.M.I.C.E., has reported to his Council in a most comprehensive and exhaustive manner as to the position of the tramways for the year ending Dec. 31, 1901, being the first year of complete electric traction in the city. A series of appendices added to the report contains much interesting information connected with the routes and fares, the accounts and by-laws, as well as diagrams of an exceedingly interesting character. The map given herewith shows a plan of the tramway routes, and must be carefully studied by anyone who desires to investigate the excellent organisation initiated and controlled by Mr. Bellamy. We have no hesitation in extracting largely from the report. The following paragraphs will probably be found to contain the larger portion of the report appealing directly to our readers:

The transfer was made from the Liverpool United Tramways and Omnibus Company on Aug. 31, 1897, when the lease of the lines in the city, which were the property of the Corporation, had upwards of 17 years to run, the purchase price being fixed by agreement at £567,375. At that time the total length of single track was about 68 miles in the city, 6 miles in Bootle, and ¾ mile in Litherland, and the number of vehicles in service 267. The total annual mileage was 6,013,182, the number of passengers carried 38,409,084, and the traffic receipts £290,743. The question of the reconstruction of the lines for electric traction was at once considered, and after careful enquiry the overhead trolley system was adopted experimentally on the Dingle route, which was opened on Nov. 16, 1898. The early objections which were raised to the overhead system passed away with a few weeks' experience, there being a consensus of opinion in favour of its general adoption, and it was at once decided to proceed with the reconstruction and equipment for electric traction of all the existing tramway routes in the city; also about 46 miles of additional track, for which parliamentary powers were being sought, the whole comprising a length of about 114 miles of tramways. The work of reconstruction was commenced in January, 1899, and about 30 miles were completed in that year; and by October, 1900, nearly 100 miles of line were laid, the last horse car within the city being taken off the North Docks route on Dec. 15, 1900.

The permanent way for the electric tramways consists principally of 60ft. girder rails, weighing 95lb. per lineal yard, and having a tread of 2¼in. in width, with a groove of 1in. by 1in. Several types of joints have been tried, including the patent joint of Messrs. Dick, Kerr, and Co., in which a portion of the fishplate comes through the top surface of the rail; the well-known Falk weld joint; the Cooper patent rail joint, in which a short section of rail is placed flange to flange below the joint, and riveted with 12 rivets at the side through the flanges; and also the ordinary fishplate joint with six 1in. bolts. Where the fishplate joint has been adopted, the method of electric bonding has been by means of two ·0000 crown flexible Chicago bonds coming through the fishplates, and riveted into the web of the rail.

The paving in all cases has been laid upon a Portland cement concrete foundation 6in. in thickness, the setts being granite from North Wales quarries, with the exception of a length of about four miles where Australian hardwood blocks (Jarrah and Karri) have been adopted, and a length of about one mile laid with prismatic oak blocks.

The construction of the whole of the permanent-way works has been carried out by workmen employed by the Corporation, under the direct supervision of the city engineer, and no doubt the very satisfactory progress of these works has been largely due to the fact that much of the special work has been prepared locally by Corporation workmen. Some of the special work has, however, been supplied by the Lorain Steel Company. The junction at Lime-street and London-road, which has been supplied by this company, comprises 16 points, and is among the most complicated pieces in the United Kingdom.

The overhead electric equipment has been satisfactorily carried out by Messrs. R. W. Blackwell and Co., Limited, in accordance with a specification prepared by the joint engineers for this work (Mr. John A. Brodie, city engineer, and Mr. A. B. Holmes, city electrical engineer).

The overhead conductor in narrow streets is on the span-wire system, supported by rosettes attached to buildings on either side of the street, where satisfactory arrangements can be made; but where this cannot be done, side poles are erected, these poles being kept as far as possible close up to the building line, this arrangement giving the best appearance, while at the same time interference with pedestrian traffic is reduced to a minimum. Where the streets, however, are sufficiently wide to permit of it, centre poles have been fixed.

The electrical energy for the tramways is supplied at a pressure of 500 volts from the electric power stations of the Corporation, which also afford a supply for lighting and power. The Pumpfields and Lister Drive stations will, when completed, each contain plant of 15,000 h.p. The steam is obtained from Lancashire boilers, 30ft. long by 8ft. diameter, working at a pressure of 160lb. per square inch, and arranged at each station in four groups of seven boilers each. The feed-water supply passes through an economiser.

The unit of plant adopted in these stations consists of a Willans engine of 1,200 h.p., directly connected to a Siemens dynamo giving an output of 550 volts and 1,450 amperes.

The supply of electrical energy in each station is distributed from two switchboards, one for the tramway service and one for the lighting service. The dynamos are so connected to the switchboards that any machine may be used at will for either service. The feeding mains for the tramways are run from the switchboards to the distributing boxes on the tramways underground on the Callender's solid system. The switchboards are fitted with the usual measuring instruments and safety appliances, and with the testing apparatus necessary to conform to the Board of Trade regulations.

A battery of accumulators is fixed at each station, and is used in parallel with the generating plant. The stations have been designed and equipped by Mr. A. B. Holmes, city electrical engineer.

Overhead Equipment.—The fixing and maintenance of the overhead equipment, which are entirely in the hands of the tramways department, are carried out by a staff, consisting of an assistant electrical engineer, district works superintendent, 10 linesmen, 10 assistant linesmen, and 26 drivers, painters, and labourers. There is one motor wagon, six horse tower waggons, and one pole waggon in use by the department, two of which are kept exclusively during traffic hours to attend to emergency calls, one being devoted to the continuous work of inspection of the overhead equipment, and the remainder to the work of fixing and maintenance. This department has been completely reorganised within the last few months, and the work of periodic inspection of every fitting and point of suspension and attachment in connection with the overhead equipment carried out under a close supervision, which has resulted in a most satisfactory diminution of breakdowns and failures. As an illus-

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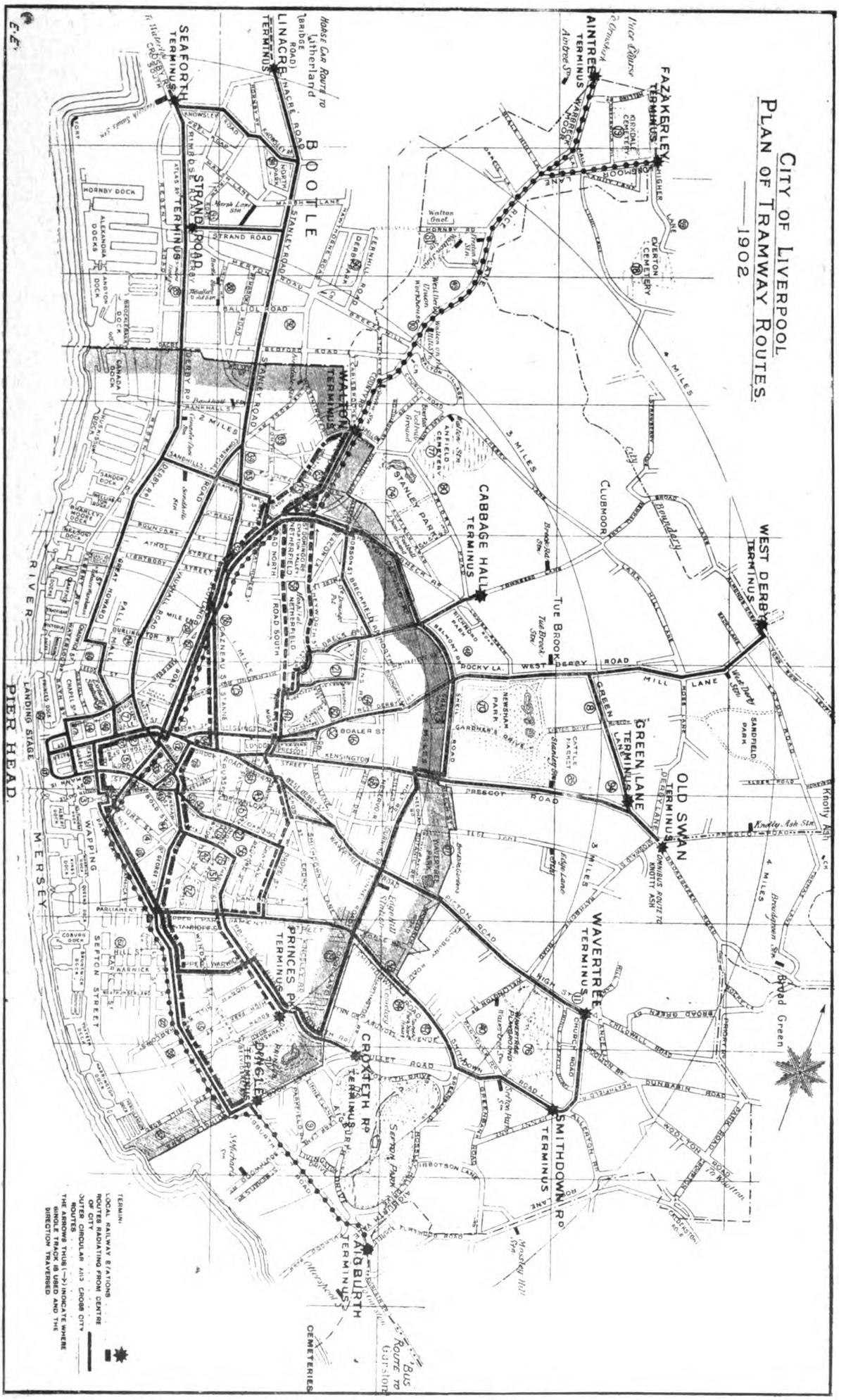

tration of the extent of this improvement, it may be mentioned that the emergency calls in December were 122, as against 206 in June, although it will be readily understood that in the former month the liability to accidents was very much greater than in the

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latter. The motor tower wagon, which was equipped experimentally for overhead line work, has given considerable satisfaction, and with a few further modifications, which are in hand, is likely to prove its general superiority to horse wagons, among its principal advantages being that it cannot be overturned or moved unexpectedly to the danger of the workmen, several accidents of this character having happened with horse wagons. During the year the total emergency calls amounted to 2,320. In every case the work in connection with these calls has been carried out expeditiously, and with the minimum interruption to traffic. As illustrating the strength and reliability of the overhead work, the following three incidents may be cited: On March 21 a telephone junction pole of the heavy square wooden type was being hoisted in Wavertree-road, near Botanic-road, when it slipped from its slings and fell across the trolley wires, bending six steel tramway poles. The telephone pole was held in position by the trolley wires, and was reslung without accident. On Sept. 23 a horse drawing a London and North-Western Railway Company's lorry, laden with timber, bolted down Upper Parliament-street, but was arrested by colliding with a centre tramway pole opposite No. 8. The force of the collision was such as to bend the pole to an acute angle, and to twist both bracket arms, but the trolley wires sustained the strain and remained intact. The third instance, which occurred on Jan. 15 last, and will be fresh in the minds of the committee, is that in which a girder, weighing about two tons, which was being hoisted by a crane in connection with the new offices in course of erection for the Royal Insurance Company, at the corner of North John-street and Dale-street, fell across the trolley wire, where it was held sufficiently long to permit of the vehicular and pedestrian traffic clearing in safety. The strain on the wires bent the steel pole 6ft. out of perpendicular, and the only portion of the equipment giving way was the trolley wire where it had been nicked by the falling girder. Following the lamentable accident in Pembroke-place, in which two men were killed, on Feb. 4, 1901, in consequence of a fall of telephone wires, in which they became entangled, being charged with electricity from the trolley wires, steps were taken with the National Telephone Company for the removal, diversion, or cabling of all telephone wires crossing trolley wires by June, 1901, the entire removal to be completed by September, 1902. A large number of telepraph wires have, in addition, been removed, and arrangements are in progress with the postal authorities for dealing with the remainder. Private wires belonging to railway companies and others are also being dealt with where necessary. Experience makes it manifest that no system of guarding the trolley wires can be entirely effective, and safety lies only in the removal of all overhead wires crossing tramway trolley wires.

Electrical Energy.—The energy supplied to the Liverpool electric tramways is delivered into the tramway feeding boxes by the Electric Power and Lighting Committee, at an inclusive cost of 1·2d. per unit. The total energy used during the year 1901 was, for haulage, lighting, etc., 13,679,222 units.

Cars.—The Liverpool car was designed as a result of experience with the various types of cars available in 1898 and 1899, and has been supplied by Messrs. Dick, Kerr, and Co., Limited. It is a double-deck car 27ft. 4in. in length over all, and on a single truck, having a wheel base of 6ft. It has seating capacity for 56 passengers, 22 inside and 34 outside. The staircase has been reversed to render it safe for passengers using it while the car is in motion. The cars are mounted on Brill trucks, with Walker motors and controllers. Each car is fitted with a hand brake and an electric brake. An emergency box is attached to the staircase of each car, containing a section-box key, a pair of wire cutters, a pair of rubber gloves, and a short length of rope. The ventilation of the whole of the cars was also altered during the year, and inside destination boards fixed. These and other minor alterations have been charged to the maintenance of the cars.

Lifeguards and Fatalities.—During the year a new type of lifeguard has been adopted, specially designed to meet the Liverpool requirements, after careful investigation of the various forms available. Its principal features are that it is dissociated from the spring movement of the car, which ensures its running with a fixed minimum clearance from the road surface. It is of the plough shape, and is so designed to shear a body clear of the car wheels.

Routes, Stages, Fares, and Service.—Of the total Liverpool population of 684,947, 531,005 are resident within the 1d. area, which is etched pink on the plan, and 153,942 beyond. Of the latter figure it is fair to assume that one-third resides sufficiently near the 1d. stage to avail themselves of it, and, therefore, not more than 100,000, or 14·6 per cent. of the total population are affected by the 2d. fares. The average length of the 1d. stage throughout the city is 2¼ miles, and the 2d., 3d., and 4d. stages are practically multiples of this. The average passenger fare for the year amounted to 1·111d. The average fare per passenger carried during 1897 (the last year of the company's management) amounted to 1·82d. The same average fare during the 12 months under review would have increased the revenue by £298,358, which indicates the advantage to the public of municipal management.

Traffic.—The percentage increase of 1901 over 1897 is as follows: passengers, 163·2; mileage, 82·4; receipts, 61·1.

Tramway Traffic in the Centre of the City and at Important Street Intersections.—The number of cars arriving at and leaving the pier head on the different routes in the busy season is 5,362 per day; South Castle-street, 1,262; Old Haymarket, 1,496; crossing St. George's-crescent, 3,725; passing the town hall, 3,038; crossing the junction of Old Haymarket and Dale-street, 3,527; crossing the junction of London-road and Lime-street, 2,597; crossing Paradise-street and Lord-street, 3,607.

Climatic Conditions.—For the purpose of comparing traffic conditions with corresponding days in previous years, an arrangement was made with the Mersey Docks and Harbour Board for the mean daily temperature between 9 a.m. and 9 p.m., and the barometrical pressure and the rainfall to be taken out for each day and supplied to the department.

Snowfalls.—The readiest means which have been found for dealing with snowfalls is an early application of salt. For this purpose a salt wagon has been specially designed to meet the requirements of the city, having regard to the many difficulties in dealing economically and expeditiously with the salting of so great a mileage. It is constructed for attachment to a motorcar, and has a capacity of about eight tons. There is a central hopper fed by one man. A roller, working in the bottom of this hopper geared to an axle, is set to discharge the salt evenly over the track at the rate of 12cwt. per mile. It is satisfactory to note that during the recent heavy snowstorm not a journey was lost in consequence, and although the department has had experience under electric traction with some fairly heavy falls of snow, on no occasion has it been seriously hampered. There are also an American snow brush and some snow ploughs available for use, but it has been found desirable to prevent the snow getting ahead to such an extent as would make the use of these necessary. The construction of 10 salt wagons, which number will probably have to be somewhat increased, will enable the department to salt the 100 miles of track in 40 minutes from the time the order is given, and will effect a great economy, as previous to the introduction of these salt wagons 24 horse wagons and 72 men were required for the purpose, the time taken for salting the track being 2½ hours.

Accounts.—The following is an analysis of the cost of working under electric traction for the year 1901:

Working Expenses—Electrical Traction.	£	s.	d.	Cost per car mile. d.
Maintenance and renewal of cars and fittings (including new lifeguards, ventilators, emergency boxes, etc.)	38,355	12	9	·855
Maintenance of tools and machinery	1,117	3	8	·025
Maintenance of sundry stock	1,077	15	1	·024
Repairs to sheds, etc.	3,517	13	5	·079
Electrical energy—Haulage, lighting cars, etc.	72,352	16	10	1·612
Road and traffic expenses—				
Salaries—Wages to drivers, conductors, inspectors, etc.	108,976	14	7	2·428
Gravelling, etc.	2,472	11	5	·055
Cleaning, etc., of cars	8,622	0	6	·192
Cleaning and lighting sheds, etc.	1,724	7	7	·038
Lighting routes	96	12	10	·002
Tickets and punches	2,522	16	4	·056
Repair, etc., of knee aprons	204	10	9	·004
Licenses	309	10	0	·007
Printing and stationery	1,057	7	11	·024
Uniform clothing, bags, etc.	3,840	10	7	·086
Sundry charges	2,360	11	0	·053
Maintenance and renewal of lines	10,202	6	4	·227
,, ,, electrical equipment	8,955	3	6	·199
Acknowledgments for privilege of fixing rosettes	170	3	1	·004
General charges, including rates and taxes, rental of tramway lines, Bootle, management and office expenses, compensation and law charges, etc.	36,347	19	1	·810
	304,284	7	3	6·780
Interest and sinking fund	94,064	7	6	2·096
	£398,348	14	9	*8·876

* The car mile earnings under electric traction amounted to 10·32d. for 1901.

The gross profit for the year amounted to £147,057, and the net credit balance to £52,822, out of which is to be provided a sum for special depreciation and renewals. It is now proposed to obtain powers to enable the Corporation, after setting aside annually for the purpose of a renewal or reserve fund, or for any of the other purposes mentioned in Sub-Section 5, Section 38, of the Liverpool Corporation Tramways Act, 1897, a sum of £30,000, to carry any sum exceeding the said sum of £30,000 to the credit of the general rate, provided that in no year up to Jan. 1, 1912, shall more than one-third of the total surplus be carried to the credit of the general rate.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

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QUESTIONS.

473. There is in a shipyard here a hydraulic accumulator worked by three pumps driven by a gas-engine. The distance between the accumulator and the pumps is approximately 150 yards. The accumulator formerly automatically stopped and started the pumps as required, there being levers on the side of the tower which opened or closed valves at different positions. These valves were connected with hydraulic striking gear on each pump. The small pipes from the valves on the accumulator to the striking gear on the pumps have been a considerable source of trouble during frost. Is there any satisfactory method of working the striking gear electrically and controlling it automatically from the accumulator tower? There is electric power at 220 volts available.—M. K. R.

474. Two dynamos on test, one 75 kw. and the other 150 kw., both identically of the same four-pole type (and by the same makers), except the larger machine has a pole ring, the smaller has not; they are both fully loaded up on artificial load. The full load is then switched off the 150-kw. machine without so much as a spark being observed at the commutator; the 75-kw. machine is tested in the same way, and immediately the brushes spark violently, and before the lead can be shifted the machine had flashed over—this test was tried repeatedly, and every time the machine flashed over. What is the cause of this, and how can the machine be remedied to pass the test successfully?—R. M.

ANSWERS.

Question No. 468.—To alter the direction of rotation of a three-phase motor, the rule is to change any two of the leads connected to the stator terminals. This rule implies that the motor may be connected up in six different ways, three of which will cause it to run in one direction and three in the opposite direction. Supposing there are a number of motors run off the same mains, and that the generator supplying those mains be relieved by another, is it possible that while some motors continue to run in the same direction as before, others might change their direction of rotation?

Best Answer to No. 468 (*awarded* 10*s.*).—If there is no fault in either the motors or the alternator, the mere changing of the mains from one alternator to the other could not cause different motors to behave differently.

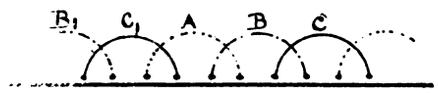

FIG. 1.

Either all will run as before, or all will be reversed. This can be seen from Figs. 1 and 2. Fig. 1 represents an element of the stator of a three-phase motor; and Fig. 2 the curves of current in the three phases of the alternator. If the alternator phases are so connected to the motor stator that the current in coil A reaches its maximum value before the current in coil B, which itself is ahead of the maximum current in C, the rotary field, and, therefore, the rotor of the motor, will rotate from left to right (Fig. 1).

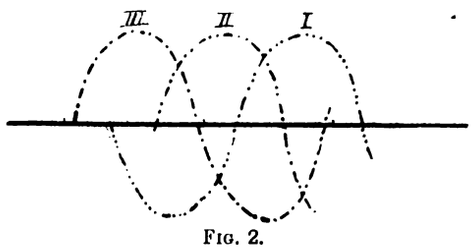

FIG. 2.

If, now, the two mains connected to the B and C coils of the stator are interchanged so that the current in C reaches its maximum before that in B, the rotary field will travel from A towards C_1 (connected in the same phase as C), and then to B_1 (connected to B)—*i.e.*, the direction of rotation will be reversed. The six different orders in which the maximum current can travel from coil to coil are:

A to B to C
B „ C „ A
C „ A „ B
B „ A „ C
C „ B „ A
A „ C „ B

of which the first three would cause the motor to run in one direction and the last three in the opposite direction. Suppose six motors were in use, connected to the mains in the above six orders. If, now, the alternator were replaced by another, in which two of the phases (say those connected to the coils in the first and second vertical columns) were interchanged, the order of maximum current in the six cases would become:

B to A to C
C „ B „ A
A „ C „ B
A „ B „ C
B „ C „ A
C „ A „ B

i.e., the direction of every motor would have become reversed. In the same way any other change in the connections of the alternator to the mains would affect all the motors similarly.

There is, however, a case in which a change of alternators might cause some of the motors to reverse and others to continue to rotate as before. If one or more of the motors (having mesh-coupled stator windings) were defective through a burn-out or similar accident in one of the phases, so that only two of the phases were in use, such motors would continue to work fairly satisfactorily as two-phase motors, but the interchange of two of the alternator mains would no longer necessarily reverse the direction of rotation. Thus, suppose the order of maximum currents in a particular motor were A to B to C, and that phase B became cut out, the order of currents would then be A to C. If the alternator leads connected to A and B were interchanged, the order of maximum currents would still be A to C (though the phase difference between the currents in A and C would be different), and the direction of rotation would remain unaltered.—Q.

Answer to No. 468 (*awarded* 5*s.*).—Let us consider a case where one alternator is working a motor. This is repre-

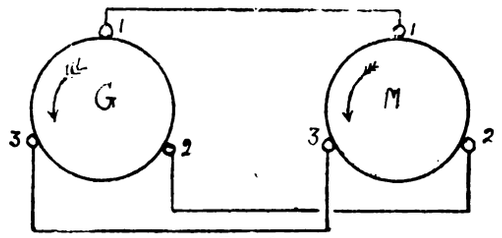

FIG. 1.

sented diagrammatically in Fig. 1, where G is the alternator and M is the motor, and the three coils are represented by

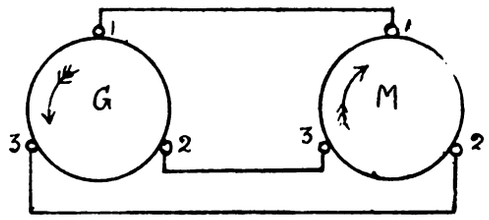

FIG. 2.

1, 2, and 3; also that when a coil is in position 1 G, that it has a maximum value if the armature is rotated in the

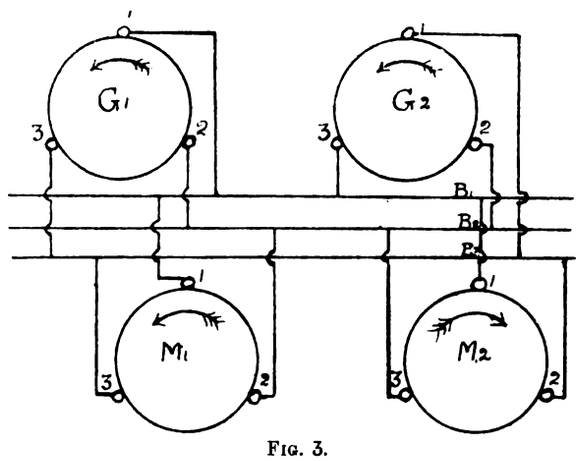

FIG. 3.

direction of the arrows; the coils will reach their maximum in the order 1, 2, 3, consequently the coils on M will have a maximum value in the order 1, 2, 3, and we will suppose it rotates as shown. By changing any two leads (Fig. 2) the direction of rotation is altered. It will now be observed that coils on M receive their maximum value in the order

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1, 3, and 2. It can therefore be seen that if any two leads of the alternator are changed, the rotation of the motor will be changed. We can now consider a case where two alternators are supplying current to 'bus bars from which motors are supplied.

Fig. 3 represents such a case. Suppose G_2 is not running, and is switched off the 'bus bars, B_1, B_2, B_3, these 'bus bars will receive their maximum value in order B_1, B_2, B_3 from G_1, so motor M_1 will have maximum values 1, 2, 3, and M_2 1, 3, 2, and will rotate in opposite directions. If G_1 be stopped and G_2 switched in, the 'bus bars will now receive maximum values in the order B_3, B_2, B_1; so now M_1 and M_2 will rotate in the reverse direction to what they did when supplied from G_1, but they will never rotate in the same direction no matter how G_1 and G_2 are connected to the 'bus bars. Here are the results of an experiment I carried out with a three-phase alternator and two motors. I numbered the alternator terminals 1, 2, and 3, and the mains A, B, C. The letters immediately under the terminals were connected together:

T_1	T_2	T_3	Motor 1 ran	Motor 2 ran
A	B	C	clockwise	counterclockwise
A	C	B	counterclock	clockwise
B	A	C	counterclock	clockwise
B	C	A	clockwise	counterclock
C	A	B	clockwise	counterclock
C	B	A	counterclock	clockwise

—G. P. D.

TUBE BILLS IN PARLIAMENT.

PROCEEDINGS IN COMMITTEE.

The Select Committee of the House of Lords appointed to consider the whole of the Bills promoted in this session of Parliament for the construction of new, or the extension of existing, underground or tube railways in London held their first sitting on Wednesday. The members of the committee are Lord Windsor (president), Viscount Knutsford, the Earl of Lauderdale, the Marquis of Bath, and Lord Zouche of Haryngworth. Committee-room No. 15 of the House of Commons, where the proceedings were opened, was found in the course of the day to be inadequate to the requirements of counsel and of parties interested in the 14 Bills included in the group, and future sittings of the committee will, in consequence, be held in a large room off Westminster Hall.

Before any of the Bills were taken, **Colonel Yorke** gave evidence on behalf of the Board of Trade as to the views they held generally with regard to these electric railways. He expressed the opinion that junctions in tube railways were things to be avoided if possible, because there were certain risks on such lines, particularly in those worked by electricity, which did not exist on railways worked by ordinary locomotives. He referred particularly to the risk of fire owing to the failure of electrical appliances. He thought, however, that there was little difficulty in guarding against the risk of fire if the necessary precautions were taken during the construction of the line and of the rolling-stock. The precautions he suggested were: (1) the exclusion of all woodwork as far as possible from the neighbourhood of the motor cables and electric machinery, and the protection of wooden portions of the train with non-combustible material; (2) the disuse of flexible cables and the use of a rigid conductor protected with some insulating material; and (3) the adoption of some non-combustible material in the construction of all trains. It might even be desirable to abandon the use of wooden sleepers on underground railways. Certainly, if wooden sleepers were used, they should not be creosoted. He would also suggest that there should be in the tunnels—at all events, on one side of the carriages—sufficient space to enable passengers to alight in case of emergency. It might be a further great advantage if the height of the tube were slightly increased, so as to give facilities for dealing with a train in case of derailment. He suggested that the Board of Trade should have power to see that there were certain clearances between the sides of the tunnel and the train. As a purely personal matter, he had formed the opinion that 13ft. 6in. was a convenient diameter for a tunnel. The tube of the Central London Railway was only 11ft. 6in. in diameter, but there were no clearances to speak of between the carriages and the tube itself. Ventilation required somewhat more attention in the future than in the past. The anticipations expressed in the early days of tube railways as to ventilation being afforded by the movement of trains in the tube had not been altogether realised. He thought, also, that some means of lighting should be provided for the tubes between stations in case of accident. One of the dangers to be avoided was panic, and nothing seemed more likely to lead to panic in case of accident than absolute darkness. With regard to platforms, the tendency was in favour of very long trains, and unless the platform was straight there was a certain space between it and the carriages. On one of the existing tube railways, where great crowds assembled at certain hours of the day and where trains were not allowed to remain long, experience had shown that passengers were liable to slip between the platform and the trains. He thought that the Board should have power to arrange with the companies all the necessary details for safety and convenience before the commencement of the works, and he submitted to the committee a draft clause giving them such power as follows: "The company shall submit for the approval of the Board of Trade plans, sections, and other details of their proposals with respect to (*a*) permanent way, tunnels, platforms, stairs, lifts, and other communications; (*b*) rolling stock; (*c*) lighting; and (*d*) ventilation; and the railway, rolling stock, and other works shall be constructed only in accordance with the plans, sections, and other details as approved by the Board of Trade."

A discussion between counsel and members of the committee then took place, as the result of which it was decided to hear first the case for the promoters of each of the competing Bills, and then to take the case of the opponents. Under this arrangement the first group to be enquired into was that comprising the competing Bills of the Charing Cross, Hammersmith, and District Railways (Nos. 1 and 2), Piccadilly and City Railways (Nos. 1 and 2), London United Electric Railways, Brompton and Piccadilly-circus Railway (New Lines, etc.), and the Central London Railway (New Lines).

Mr. Baggallay, K.C., opened the case for the Charing Cross, Hammersmith, and District Electric Railway Bills Nos. 1 and 2. He stated that the main line would run from Agar-street, Strand, under Charing Cross, the Mall, the Green Park, Hyde Park-corner, Knightsbridge, Kensington-gore, High-street Kensington, Kensington-road, and Hammersmith-road, to Hammersmith, and thence under the river to the generating station at Barnes. There was to be also a short loop line from the Strand to Piccadilly-circus and under Piccadilly to Hyde Park-corner, where it would rejoin the main line. It was proposed to adopt the multiple-unit system in order to minimise vibration as far as possible. The size of the tunnel was intended to be 13ft. 6in. The total capital proposed for the two Bills was £3,300,000 share capital and £1,100,000 loan capital. The estimates of the Charing Cross and Hammersmith line worked out at £459,334 per mile; the Central London, with a 12ft. tube, at £453,000 per mile; the Piccadilly and City, with a 13ft. 6in. tube, at £747,000 per mile; and the London United, with a tube about the same size, at £451,500 per mile.

Mr. C. Scott Meik, C.E., of Westminster, joint engineer with Mr. R. E. Middleton for the railway, gave evidence in support of the above statement of counsel. He also stated that the distance between Hammersmith-broadway and Charing Cross was to be covered by the company's trains in 17 minutes.

Under cross-examination, witness said his estimate for lands and works in connection with the scheme was £2,432,960. No arrangement had been made with the London United Electric Tramway Company. He had no reason to suppose that there would be difficulty in effecting an arrangement with the Central London Company for carrying through passengers which would work smoothly.

On the question of vibration, the **Chairman** ruled that it was not necessary that every witness should be examined with respect to that matter. Before the adjournment the Chairman stated the committee's desire at the next meeting to have further evidence upon the financial side of the proposals for the Charing Cross and Hammersmith line.

The committee adjourned.

FORTHCOMING EVENTS.

SATURDAY, APRIL 19.

National Association of Electrical Contractors (Northern Section).—At 3 p.m., meeting at Exchange Station Hotel, Liverpool.

MONDAY, APRIL 21.

Society of Arts.—At 8 p.m., Dr. R. T. Glazebrook on "Glass for Optical Instruments."

TUESDAY, APRIL 22.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper to be discussed: "Locomotive Fire-Box Stays," by Mr. F. W. Webb.

Royal Institution.—At 3 p.m., Prof. Dewar on "The Oxygen Group of Elements" (Lecture III.).

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., extraordinary meeting. Paper: "The Wehnelt Interrupter," by Mr. P. Laubash.

WEDNESDAY, APRIL 23.

Institution of Civil Engineers.—At 8 p.m., Sir Wm. Roberts-Austen on "Metallurgy in Its Relations to Engineering."—At 2.30 p.m., students' visit to the works of the Great Northern and City Railway.

Society of Arts.—At 8 p.m., ordinary meeting. Paper: "Opto-Technics," by Prof. S. P. Thompson.

THURSDAY, APRIL 24.

Institution of Electrical Engineers. — At 8 p.m., ordinary meeting. Paper for discussion: "Problems of Electric Railways," by Messrs. J. Swinburne and W. R. Cooper; followed by discussion on "Form of Model General Conditions in Electrical Construction."

FRIDAY, APRIL 25.

Royal Institution.—At 9 p.m., Mr. J. M. Davidson on "X-Rays and Localisation."

Physical Society.—At 5 p.m. Papers: "An Exhibition of a Mechanical Break for Induction Coils," by Dr. Dawson Turner; "A Temperature Indicator for Use with Platinum-Thermometers, in which Readings are Automatically Reduced to the Gas Scale," by Mr. R. S. Whipple; and "Note on the Compound Pendulum," by Mr. S. A. F. White.

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NEW COMPANIES REGISTERED.

Electric Railway Signalling Syndicate, Limited.—Capital, £10,000. Objects: to carry on the business of electricians, engineers, suppliers of electricity, etc.

Chester Tramways Company, Limited. — Capital, £32,000. This company was originally constituted by Act of Parliament, 41 and 42 Vic., cap. 174, July 22, 1878.

F. A. Glover and Co., Limited.—Capital, £10,000. Objects: to carry on business as electrical and mechanical engineers, to construct and maintain rail and tram roads, etc.

S. Jevons, Limited.—Capital, £5,000. Objects: to take over the electrical engineering business carried on by S. Jevons, and to carry on the business of electricians, electrical and general engineers and contractors, suppliers of electric light, etc.

South-Eastern Metropolitan Tramways Company, Limited.—This Company was constituted by Act of Parliament (51 and 52 Vic., cap. 186) dated Aug. 7, 1888, and registered as a limited company April 11, 1902, with a nominal capital of £82,000.

British Engineers' Alliance, Limited. — Capital, £150,000. Objects: to acquire and develop the business of dealers in machinery of every description, mining requisites, etc., as now and hitherto carried on at Johannesburg, South Africa, by H. Farrar.

Shanghai Electric Power and Traction Syndicate, Limited.—Capital, £6,000. Objects: to carry on business as generators and suppliers of electricity for any purpose whatsoever, in Shanghai or elsewhere in Asia; to lay down cables, wires, motors, dynamos, plant, and machinery.

Charing Cross Syndicate, Limited.—Capital, £10,000. Objects: to adopt an agreement with the London and Provincial Electric Construction Company, Limited, and A. R. Davey, and to construct, equip, maintain, and work by steam, electricity, cable, or other mechanical power, rail and tram ways, etc.

APPOINTMENTS VACANT.

Draughtsman, used to large switchboard work. Full particulars in our advertisement columns.

Shift Engineer, used to direct-current parallel running and with some technical knowledge. Full particulars in our advertisement columns.

Chief Assistant Engineer, Devonport electricity works department, £130 per annum, April 30. Full particulars in our advertisement columns.

Inspector of Fire Alarms, Bradford Corporation fire brigade department, £95 per annum, April 26. Full particulars in our advertisement columns.

Cable Jointer, Devonport electricity works department, used to Callender's fibre cables and solid system, 38s. per week. Full particulars in our advertisement columns.

Power Station Superintendent, Glasgow Corporation tramways, first-class mechanical engineer to take charge of Pinkston power station, £250 per annum, April 21. Full particulars in our advertisement columns.

LEGAL INTELLIGENCE.

DISTRICT RAILWAY GENERATING STATION.

On the 13th inst. Mr. Under-Sheriff Burchell and a jury in the London Sheriff's Court heard a claim brought by Mr. Charles Wall, building contractor, of Chelsea, against the Metropolitan District Railway Company in respect of the removal of his works in Chelsea-street, on the banks of the Thames, to make space for the erection of the District Company's generating station. The total compensation due was computed by one expert at £7C,387.

Mr. Douglas Young (surveyor), called for the company, assessed the value of Mr. Wall's premises at £16,500. He said he did not believe that Mr. Wall would sustain any loss by the removal of the administrative offices to a good central position, because, his business being spread over so wide an area, the effect would not be detrimental.

Mr. Cripps, in addressing the jury for the railway company, said it was impossible to see how public improvements were to be carried out if their promoters were to be placed under large monetary penalties. He contended that £23,280 would be a fair and full measure of compensation.

Sir Edward Clarke, for the claimant, said that the very reason the company desired to acquire the premises and pay the very substantial value which its adviser said it must pay was that it was entering into advantages which none could dispute. He submitted that the claimant was going to less advantageous premises from the south side of the river to the north.

In the result the jury assessed the damages at £35,000.

A TUBE CLAIM.

Before the Lord Chief Justice and Justices Darling and Channel in the King's Bench Division on Monday, Mr. Freeman, K.C., applied an behalf of the Great Northern and City Railway Company, for permission to bring up for consideration a verdict whereby a Dr. Dixon was awarded £230 compensation by a jury in the London Sheriff's Court for damage caused by the construction of the Great Northern and City tube.

Mr. Freeman stated that, while protesting against the whole proceedings, Dr. Dixon's counsel elected to go on, and the Under-Sheriff said he was of opinion that in dealing with the warrant he was bound to take into account the claim sent in by the doctor. Upon this he proceeded to allow evidence to be given as to various heads of damage, in doing which counsel contended he was acting *ultra vires*. The claimant alleged that he was apprehensive that when the railway was completed a great deal of damage would be done by vibration by reason of the running of heavy trains, and that was one of the bases upon which he founded his claim.

In the result the application was granted.

COMPANIES' MEETINGS AND REPORTS

ANGLO-ARGENTINE TRAMWAYS.

Mr. H. Doughty Browne, presiding over the ordinary general meeting of this Company at Cannon-street Hotel on Tuesday, expressed regret at being unable to congratulate the proprietors upon the results of the past year. The Company had had several set-backs. In the first place, the unification scheme, from which a great deal had been expected, was withdrawn, and as the result of this the premium on gold had increased to a certain extent. Next, the depression in business, which had been going on more or less for two years, had been rather intensified. The interference with the traffic caused by the conversion of the line from horse to electric traction was inevitable. The receipts had been adversely affected to a small extent by the competition of other electric tramways. He regretted that there did not seem to be much likelihood of any improvement in the current year. There was some solace in the fact that although they were doing badly now, by the agreement they had made with the Argentine Traction Company they had practically consolidated and strengthened their position. The conversion was proceeding satisfactorily. The power-house was rapidly approaching completion, and 51 out of the 72 miles of line had been practically finished. In conclusion, he moved the adoption of the report, which was given in our last issue.

Mr. R. Corbett second the motion, which was agreed to.

BABCOCK AND WILCOX.

The ordinary general meeting of this Company was held at the Cannon-street Hotel on Tuesday, Mr. John Dewrance in the chair. The report of the directors appeared in our last issue.

The **Chairman** hoped that the past year's figures would be regarded as satisfactory. The amount of profit was very similar to that of the previous year. Last year was one of considerable anxiety to all the staff, and he thought that they had done extremely well, but they looked forward to the present being a better year for the Company. Their order sheet was very satisfactory, and the directors saw nothing but the promise of progress. During the past 12 months a great deal was done to improve the premises and plant at Renfrew. The electrical driving apparatus had been set to work, and was a very fine installation, and in every detail great care had been given to improving the method of manufacture.

Mr. John Palmer seconded the motion, which was unanimously adopted.

A resolution was afterwards agreed to for the payment of the following dividends for the half-year ended Dec. 31 last: At the rate of 3 per cent. on the preference shares, less income tax, and at the rate of 9 per cent. on the ordinary shares, free of income tax, the transfer of £45,000 to the reserve fund, and the placing of £25,000 to the dividend equalisation fund, leaving a balance of £17,446 to be carried forward.

CALCUTTA TRAMWAYS.

At the ordinary general meeting of the shareholders in this Company on Tuesday, **Mr. E. G. Morgan**, who presided, said that the apparent shrinkage of receipts and expenditure as shown in the accounts was entirely due to the altered rate of exchange at which the rupee figures had been converted into sterling. The receipts in reality gave the large increase of £7,500 as compared with those of last year, while the expenditure was greater to the extent of about £2,000. This gave a net increase in receipts of about £5,500, while the percentage of expenditure to receipts had been 75¾, compared with 80½ in the previous year. The receipts in the year had increased by £7,500, the proportion of expenses to receipts had diminished by 5 per cent., while, in spite of an additional mileage of 165,000 miles, the receipts per car mile had increased by nearly ½d. These results had been obtained without any aid from the new motive power, and in the first quarter of the present year the earnings had continued to increase, while the prospects from the adoption of the new power were eminently satisfactory. The prospects of the Company appeared to be entirely favourable, and they hoped that no long time would now elapse before these prospects were converted into accomplished facts, and that they should be in a fair way to cope with the requirements of the Calcutta public in a manner which had hitherto been impossible. With regard to their relations with the Corporation, that body were ready to give them their cordial assistance and support. The telephone company had also carried out the necessary alterations to their system with the greatest promptitude, and if there had been a little delay with the telegraphs it had been due to the great pressure of work in their department. He then moved a resolution for the adoption of the report and accounts.

Mr. Charles Sanderson seconded the motion, which was carried.

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OSWESTRY ELECTRIC LIGHTING AND POWER.

The annual meeting of this Company was held in Oswestry on Monday, Mr. A. W. Corrie in the chair.

The directors in their report stated that the sale of current continued to increase steadily. The profit for the year amounted to £262. 3s. 2d., and they recommended a dividend at the rate of 4 per cent. on the paid-up capital.

The **Chairman,** in moving the adoption of the report, said the income for the past year was £1,287. 0s. 9d., including £1,222. 10s. 6d. derived from sale of current, £54. 13s. 2d. from meter rentals, and £4. 1s. from sale of lamps. The expenditure was £1,024. 12s. 6d., including £608. 14s. 8d. for generation and distribution of electricity, £121. 11s. 1d. for management expenses, £66. 3s. 8d. interest on temporary loan, £134. 4s. 9d. instalments on depreciation fund, and £18. 0s. 6d. written off preliminary expenses. The balance was £262. 8s. 3d. There was not much difference in the items compared with the previous year, except that they had saved very considerably on the coal bill. They had now four engines and three boilers, and they were working up to what he regarded as not a safe margin. Their present plant was equal to the production of 175 kw., and to make themselves quite secure they needed another boiler, or engine and boiler, equal to 80 kw., and that they must have before the heavy drain of next winter began. When they had that they would need no further machinery for three years at the present rate of growth. He would like to see more capital issued, as it would be more agreeable to distribute the income in dividend than to pay interest on loans.

Mr. J. Minshall seconded the motion, which was agreed to, and a dividend of 4 per cent., free of income tax, was declared.

SOUTH LONDON ELECTRIC SUPPLY.

In accordance with the decision come to at the annual general meeting of this Company last week, a poll was taken on Tuesday with reference to the proposed election of Mr. Atherton as a director. From enquiries made we understand that the result of the poll was in Mr. Atherton's favour, and that he obtains a seat on the Board by a majority of 14,072 shares.

INDO-EUROPEAN TELEGRAPH.

The report of the directors for 1901 states that the Indian tariff has been reduced from 4s. to 2s. 6d. per word, and the general tariff to Australia from 3s. 6d. to 3s. per word, which latter rate is now applicable to the colonies of South and West Australia, New South Wales, and Tasmania. Reductions have also been made in the telegraphic charges to the Straits Settlements and the Dutch Indies. These reductions, however, have only come into force in 1902. The receipts for the year show a small increase, but a somewhat large amount had to be debited to the profit and loss account due to an unascertained out-payment which had been accumulating against the Company. The directors on ascertaining the facts made the payment forthwith, and have charged the full amount against the earnings of the year. The Company's revenue from all sources for 1901 amounted to £153,041, showing an increase of £1,398. The expenses were: on commercial and general account, £40,674; on maintenance account, £23,185—total, £63,859—as against £78,359 for 1900, a decrease of £14,500. Deducting the above expenses of £63,859 from the total revenue of £153,041, a balance remains of £89,182, from which income tax paid, £4,946, has to be debited. To this the amount brought from the year 1900, £12,155, has been added, making a total of £96,390. From this amount £5,000 has been placed to reserve, and that sum, together with £10,625, amount of interim dividend, as well as the accumulated out-payments of £33,992, have to be deducted, leaving a balance of £46,773. The directors now propose a dividend for the six months ended Dec. 31 of 17s. 6d. per share, making, with the dividend already paid, 6 per cent., and a bonus of 20s. per share, making in all 10 per cent. for the year, carrying forward £14,898.

CALCUTTA ELECTRIC SUPPLY.

Directors: Colonel A. J. Filgate, R.E. (chairman); E. Boulnois, Esq., M.P.; J. G. H. Glass, Esq., C.I.E.; P. V. Luke, Esq., C.I.E.; Sir Guilford L. Molesworth, K.C.I.E. Secretary: Francis R. Reeves, Esq., M.I.E.E.

Report of the directors (with abstracts of accounts) to be presented at the annual general meeting of the shareholders at Winchester House, Old Broad-street, E.C., on May 1 at 2 p.m.:

The number of units of electrical energy sold during the year were 962,958, compared with 412,950 for the preceding year. The gross revenue from all sources amounted to £23,248. 19s. 9d., compared with £11,147. 15s. 8d.; the working costs were £14,602. 18s. 2d., compared with £8,252. 17s. 4d.; and the result of the year's operations was a net profit of £8,646. 1s. 7d., compared with £2,894. 18s. 4d. Exchange is calculated at 1s. 4d. per rupee. At the general meeting last year the shareholders adopted the suggestion of the Board to deduct £2,500 from the profit and loss account as a provision for repairs and renewals, and the directors have this year deducted £5,000 from the year's account for the same purpose. The amount expended during the year in repairs and renewals and in the purchase of spare parts was £1,900. 10s. 8d., the whole of which has been debited to the renewal fund account, leaving a balance carried forward of £5,599. 9s. 4d. To the net profit of £8,646. 1s. 7d. has to be added £219. 1s. brought forward from last year, and £151. 14s. 1d. interest on deposits at bankers, making a total of £9,016. 16s. 8d., and after deducting interim dividend paid on Nov. 4 last, there remains a balance of £5,822. 6s. 3d. available for distribution. The directors propose to pay a final dividend for the half-year at the rate of 7 per cent. per annum on the paid-up share capital, making, with the interim dividend, 6 per cent. for the year, and to carry the balance, £392. 9s. 2d., forward. During the past year the Board have issued 10,000 additional shares at the price of £6 per share, the premium on the issue, £10,000, being placed to the reserve fund, which now amounts to £15,000. The Board have invested £9,900 of this amount partly in consols and partly in railway preference shares. The capital expenditure during the year amounted to £62,372. 18s. 8d.; the largest proportion, £37,322, was in mains, £12,067 in machinery and tools, and £4,038 on buildings. The total amount of expenditure at Dec. 31 last was £180,639. 3s. 4d. The directors have taken advantage of the presence of Mr. A. H. Preece, M.I.E.E. (who was visiting India), to inspect and report on the Company's installation, and his report is satisfactory. It is proposed during the current year to carry out large extensions to the mains, which will involve considerable additional outlay. The new station in the Alipore district has been erected, and the equipment is nearly completed. The station was opened on March 1. Application has been made to the Government of Bengal for a license to supply the Howrah district, which is on the other side of the river, and as the consent of the Municipality has been obtained, no doubt the Government license will be granted in due course. Owing to the increasingly heavy load in the north of the city it is in contemplation to erect a third generating station at Cossipore. During the year 1901 299 additional houses have been connected to the mains, the total number of consumers being now 880, and the equivalent of 8-c.p. lamps at Dec. 31 58,284, as compared with 28,748 at the end of the previous 12 months. The running of the station has been good. There have been some breakdowns on the mains which have given the directors much concern, but it is confidently expected that with a few alterations in matters of detail the difficulties will shortly be overcome. In accordance with the articles of association, Mr. P. V. Luke, C.I.E. retires from the board of directors by rotation, and, being eligible, offers himself for re-election. The auditors in London, Messrs. J. H. Duncan and Co., chartered accountants, and in Calcutta, Messrs. Lovelock and Lewis, also offer themselves for re-election.

Dr. REVENUE ACCOUNT.	£	s.	d.	£	s.	d.
Generation and distribution—Coal or other fuel	2,094	3	11			
Oil, waste, water, and stores	379	5	1			
Proportion of salaries	1,085	4	6			
Wages and gratuities	1,533	16	4			
Expenses of working fans	423	16	6			
				5,516	6	4
Repairs and Maintenance.						
Amount expended	1,900	10	8			
Balance appropriated for renewals	3,099	9	4			
				5,000	0	0
Rents, Rates, and Taxes.						
Rents payable	121	17	10			
Rates and taxes	278	14	7			
				400	12	5
Management Expenses.						
Directors' remuneration	900	0	0			
Office rent, salaries, etc.	400	0	0			
Stationery and printing	207	17	4			
General establishment charges	691	17	6			
Auditor of Company	66	5	0			
Managing agents' commission, etc.	1,206	9	11			
				3,472	9	9
Special Charges.						
Insurances	109	11	8			
Difference in exchange	3	18	0			
Donation to Queen Victoria Memorial Fund	100	0	0			
				213	9	8
Total expenditure				14,602	18	2
Balance carried to net revenue				8,646	1	7
				£23,248	19	9

Cr.	£	s.	d.
Sale of current (962,958 units) less rebates, etc.	20,472	11	8
Rental of meters	1,079	9	8
Rental of electrical fans	1,549	11	6
Rental of motors	33	12	0
Miscellaneous receipts	100	4	11
Transfer fees	13	10	0
	£23,248	19	9

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	172,693	10	0
Sundry creditors	6,588	8	10
Unclaimed dividends	0	11	10
Reserve fund	15,000	0	0
Balance at credit of renewal fund account	5,599	9	4
Balance at credit of net revenue account	5,822	6	3
	£205,704	6	3

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	180,639	3	4
Investments on account of reserve fund	9,900	0	0
Stores on hand	97	7	4
Sundry debtors for current, etc.	5,873	19	1
Cash at bankers and in hand	9,193	16	6
	£205,704	6	3

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Edinburgh.—The Corporation invite tenders for annual supplies from May 15 for the electric supply department.

Alicante (Spain).—The Harbour Board require tenders for the supply of two movable cranes. Tenders by May 14.

Walsall.—The Corporation invite tenders for a battery of accumulators. Tenders by April 30. Details in our advertisement columns.

Stepney.—The Electrical Committee invite tenders for the supply of meters and demand indicators. Tenders by May 1. Details in our advertisement columns.

Lytham.—The Urban District Council invite tenders for a 300-kw. plant complete for electric lighting. Tenders by April 26. Particulars may be obtained from the Clerk.

Fulham.—The Board of Guardians invite tenders for the supply, delivery, and erection of a switchboard. Tenders by April 29. Details in our advertisement columns.

Cleckheaton.—The Council invite tenders for the supply, delivery, and erection of continuous-current electric motors. Tenders by May 3. Detailt in our advertisement columns.

Edinburgh.—The Corporation invite tenders for the supply of electricity meters for 12 months from May 15 next. Tenders by April 28. Particulars in our advertisement columns.

Hartlepool.—The Corporation invite tenders for one 200-kw. to 250-kw. high-speed steam-engine, continuous-current dynamo, extension to switchboard panel, etc. Tenders by April 30.

Rhyl.—The Urban District Council invite tenders for the wiring of the town hall, etc., for electric lighting. Specification, etc., may be obtained from Mr. E. H. Wright, Electricity Works. Tenders by 28th inst.

West Ham.—The Council invite tenders for two steel chimneys, four fans and engines for induced draught, all brickwork in connection with the flues, and economisers. Tenders by May 13. Details in our advertisement columns.

Rathmines.—The District Council invites tenders for supply and erection of engine-house plant, extension of switchboard and electricity supply mains. Tenders by April 24. Full particulars in our advertisement columns.

Bury.—The Corporation invite tenders for supply, delivery, and laying in the borough of Bury (Lancs.) of tramway feeder and pilot cables, conduits, and accessories. Tenders by May 8. Details in our advertisement columns.

Hull.—The Electric Lighting Committee invite tenders for pipework, pumps, motors, etc., and work required to be executed at Sculcoates-lane generating station. Tenders by April 24. Details in our advertisement columns.

Swindon.—The Corporation invite tenders for the supply, delivery, and laying in the borough of Swindon (Wilts) of feeder and distributing cables, conduits, and accessories. Tenders by April 23. Details in our advertisement columns.

Mansfield.—The Corporation invite tenders for the construction and erection of pipework, valves, and tanks, steam, exhaust, water, and other pipes, valves, tanks, foot-plates, and accessories. Tenders by May 1. Details in our advertisement columns.

Stockport.—The Gas and Electricity Committee invite tenders for supply and erection of a 200-kw. engine and dynamo for traction purposes. Specification, etc., can be obtained on application to the Engineer on or before 19th inst. Tenders by 23rd inst.

Oldham.—The Electricity Committee invite tenders for the supply, delivery, and erection, complete, of lighting and traction switchboards, with connections and instruments comprised in Specification No. 5. Tenders by May 6. Full details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of concentric and single main cables, insulated with paper or fibre, impregnated with oil, bitumen, or other substance impervious to moisture, or with vulcanised bitumen. Tenders by April 21. Details in our advertisement columns.

Sydney.—The Municipal Council invite tenders for supply and erection of plant and machinery required for the complete equipment of their proposed electricity supply stations and sub-stations. Particulars may be obtained from Messrs. Preece and Cardew, Westminster. Tenders by May 7 at noon.

Fulham.—The Establishment Committee invite tenders for the supply, delivery, and erection of one 600-kw. two-phase steam alternator, with Willans, Belliss, or Allen engine; or one 600-kw. two-phase Parsons turbo-alternator. Tenders by May 5. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of special (permanent way) track work, cross-over roads, and points and crossings. Specifications, etc., may be obtained on application to Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders by May 3.

Dundee.—The Gas Commissioners invite tenders for triple-expansion engine and dynamo, 750 kw. capacity at 200-230 revolutions, to be supplied and erected at the electrical power station, Dudhope-crescent-road, Dundee. Specifications may be obtained from Mr. Walter H. Tittensor, city electrical engineer, Dudhope-crescent-road, Dundee. Tenders by April 24.

George Town (Penang).—The Municipal Commissioners invite tenders for the supply and delivery, f.o.b., of boilers, etc., ejector condenser, pumps, tanks, etc., pipes, steam dynamos and balancer boosters, switchboards, batteries, cables, junction boxes, &c., and arc and glow lamps, posts, and accessories. Tenders by April 28. Details in our advertisement columns.

Aberdeen.—The Electric Lighting Committee invite tenders for the supply and erection of a 20-ton electrically-driven overhead crane, with the necessary supporting columns and girders, for their Dee Village electricity works. Specification, etc., may be obtained from Mr. J. Alex. Bell, city electrical engineer. Tenders by May 7. Details in our advertisement columns.

London, W.—The Central Electric Supply Company, Limited. invite tenders for the supply, delivery, and erection of high and low tension switchboards at the company's generating station at Grove-road, St. John's Wood, N.W. Specification, etc., can be obtained from the General Manager of the Company, 19, Carnaby-street, Golden-square, W. Tenders by April 23.

Barnsley.—The Corporation invite tenders for the labour and materials required in wiring, and for providing and fixing the necessary electrical fittings to the Kendray Hospital, the extent of which will probably be equivalent to 300 16-c.p. lights. Specification, etc., can be obtained from Mr. J. Henry Taylor, M.I.C.E., borough surveyor, The Manor House, Barnsley. Tenders by April 22.

Trowbridge.—The Trowbridge Urban District Council having obtained a provisional order for the supply of electricity in their district, are prepared to receive applications for a lease of their powers under the said order. A plan of the district can be seen at the offices of the Council. Applications to be sent to Mr. T. S. Hill, clerk, Council Offices, Town Hall, Trowbridge, by April 30.

Rotherham.—The Corporation invite tenders for the supply, delivery, and erection of rolling stock; overhead construction, with trolley wires, posts, switch pillars, etc.; and permanent-way construction, excavation, concrete foundations, steel rails, and special work, paving, etc. Specifications, etc., can be obtained from Mr. H. Hampton Copnall, town clerk. Tenders by April 23.

Burton-upon-Trent.—The Corporation invite tenders for the construction of about 5¾ miles of route length of tramways, constructed as single line with passing places. Specifications, etc., may be inspected and obtained at the office of the consulting engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, or at the Borough Engineer's Office, Town Hall, Burton-on-Trent. Tenders by April 22.

Bath.—The Corporation invite tenders for supply and erection of steam dynamos, motor-alternator, motor-driven balancer, switchgear for continuous current, transformers, water-softening plant, H.T. plug switch fuse gear, L.T. plug switch fuse gear, arc lamps, cables, meters, glow lamps. Specification, etc., may be obtained from Mr. Francis Teague, city electrical engineer. Tenders by April 21. Full particulars in our advertisement columns.

London, S.W.—The London County Council invite tenders for the supply, delivery, and laying on the routes of the London County Council tramways (southern system) of (a) 48 miles of extra high-tension three-core lead-covered, paper-insulated cables; and (b) 87 miles of low-tension single, lead-covered, paper-insulated cables, and 14 miles of dry-core telephone cables. Particulars may be obtained at the County Hall, Spring-gardens, S.W. Tenders by April 22.

London, S.W.—The London County Council invite tenders for the supply, delivery, and laying on the routes of the London County Council tramways (southern system) of (a) 48 miles of extra high-tension three-core lead-covered, paper-insulated cables; and (b) 87 miles of low-tension single, lead-covered, paper-insulated cables, and 14 miles of dry-core telephone cables. Specifications, etc., may be obtained from the County Hall, Spring-gardens, S.W. Tenders by April 22.

Nelson (Lancs.).—The Tramways Committee invite tenders for the supply and fixing of rails, overhead equipment, etc., for the light railways to Colne and Barrrowford boundaries, comprising rails, fish-plates, crossings, etc., overhead equipment, bonds, feeding pillars, etc., 1,000 yards ·25 cable, and laying, and tramcars. Specifications, etc., may be obtained from Mr. B. Ball, borough engineer, Nelson, and Mr. W. A. Fraser, electrical engineer, Electricity Works, Nelson. Tenders by 28th inst.

Sudbury.—The Corporation invite tenders for the supply and erection of water-tube boiler, with fittings, feed-water heater, feed pumps, etc.; pipework, etc., in engine and boiler house; two steam dynamos (vertical enclosed high-speed engines) and motor boosters; storage batteries, main switchboard and connections; underground mains, conduits, and roadwork for private and public lighting; and station lighting. Copies of specification, etc., may be obtained at the offices of Mr. W. B. Ransom, town clerk, Town Hall, Sudbury, Suffolk, on and after April 14. Tenders by May 1. Full particulars in our advertisement columns.

RESULTS OF TENDERS.

Fulham.—The Borough Council have accepted the tender of De Grelle, Houdret, and Co. for the supply of carbons, at £5. 12s. per 1,000 pairs.

Liverpool.—The Corporation have renewed their contract for the supply of incandescent lamps for the ensuing year with the Electrical Company, Limited, Charing Cross-road.

Hackney.—The Hart Accumulator Company, Stratford, have secured from the Borough Council the contract for renewing the storage battery of 120 cells at the Hackney Public Baths with their standard lighting type sections.

Storage Batteries.—Messrs. Ashmore, Benson, Pease, and Co. of Stockton-on-Tees, have secured the following orders for storage batteries: Talgarth Asylum, Breconshire (O'Gorman and Cozens-Hardy, consulting engineers); Saltburn Electrical Supply Station; and Sir William Ingram, Bart., Westgate-on-Sea.

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Cardiff.—The Corporation have received the following tenders for a switchboard for the central sub-station (in the Hayes):

Dornan and Smith, Manchester	£2,225	0	0
General Electric Company, London	1,877	0	0
British Thomson-Houston Company, London (accepted)	1,482	10	0
Edison-Swan Company	2,009	0	0
Ferranti	2,800	0	0

Bristol.—The following firms have tendered for a 210-kw. multipolar direct-current generator to be installed at the Temple Back electricity works: Siemens Bros. and Co., Woolwich; British Westinghouse Company, London; Crompton and Co., Chelmsford; British Schuckert Company, London; Lancashire Dynamo and Motor Company, Manchester; Bergtheil and Young, London; T. Parker and Co., Wolverhampton; Indiarubber Company, Silvertown; Electric Construction Company, Wolverhampton; E. Scott and Mountain, Newcastle-on-Tyne; Johnson and Phillips, Old Charlton; Johnson-Lundell Traction Company, London; C. A. Parsons and Co., Newcastle; Brush Electrical Engineering Company, London; Mather and Platt, Salford; Greenwood and Batley, Leeds; Fuller-Wenstrom Company, London; Bruce Peebles and Co., Edinburgh; International Engineering Company, Liège and London; Mavor and Coulson, Glasgow; Dick, Kerr, and Co., London (accepted); Lahmeyer Electrical Company, London.

Swansea.—The Corporation have received the following tenders for Contract No. 10—the supply, delivery, and erection of two 600-kw. continuous-current steam dynamos, together with condensing plant for each engine, and all steam and exhaust pipes, steam valves and connections, etc.:

Allgemeine Company dynamo, Belliss and Morcom engine, £9,890 · Yates and Thom or Belliss condenser, £2,457; Yates and Thom, Lloyd and Lloyd, Stewart and Menzies, or Russell steam-pipes, valves, etc., £1,304.
Ditto, Yates and Thom engine, £12,094; Allen and Sons' condenser, £2,157; steam-pipes, valves, etc., as before.
Ditto, Ashton, Frost, and Co. engine, £13,875; Ashton, Frost, and Co. condenser; Stewart and Menzies or Spencer steam-pipes, valves, etc., £1,498.
Ashton, Frost, and Co. engine, Allgemeine Co. dynamo, £13,490; Ashton-Frost condenser, £770; Stewart and Menzies or Spencer's steam pipes, valves, etc., £1,470.
Ditto, E. C. C. dynamo, £13,750; Ashton-Frost condenser, £1,930.
Ditto, Brush dynamo, £13,465.
Ditto, Siemens dynamo, £13,950.
Bow, McLachlan, and Co. dynamo and engine, £16,095; Bow-McLachlan or Stewart and Menzies steam pipes, valves, etc., £1,500.
Ditto, £16,575; Bow-McLachlan or Stewart and Menzies steam pipes, valves, etc., £1,500.
Cole, Marchent, and Morley engine, Schuckert dynamo, £11,090; Cole, Marchent, and Morley condenser, £1,411; Mannesman and Co. steam pipes, valves, etc., £1,600.
Ditto, Allegmeine dynamo, £11,112; Cole, Marchent, and Morley condenser. £2,480; Stewart and Menzies steam pipes, valves, etc., £1,497.
Ditto, Dick-Kerr dynamo, £11,390.
Ditto, E. C. C. dynamo, £11,482.
British Schuckert Company dynamo, McLaren engine, £14,340; McLaren condenser; Atkinson steam-pipes, valves, etc., £1,110.
Ditto, Coombe, Barbour, and Co. engine, £12,646; Coombe-Barbour condenser.
Ditto, Browett, Lindley, and Co. engine, £8,808; condenser, £3,587; Aiton and Co. (London) steam-pipes, valves, etc., £1,300.
Ditto, Willans engine, £11,658.
British Westinghouse Company, Limited, dynamo, McLaren engine, £15,146; Yates and Thom steam-pipes, valves, etc., £1,085.
Ditto, Coombe, Barbour, and Co. engine, £13,526; Babcock and Wilcox steam-pipes, valves, etc., £870.
Ditto, Belliss and Morcom engine, £11,767.
Ditto, Ferranti engine, £12,173.
Bruce Peebles and Co. dynamo, Willans engine, £11,818; condenser, £2,687; steam pipes, valves, etc., £1,105.
Ditto, McLaren engine, £14,600.
Ditto, Ferranti engine, £9,991.
Coombe, Barbour, and Co. engine, E. C. C. dynamo, 125 revs., £8,708; Coombe-Barbour condenser.
Ditto, E. C. C. dynamo, 90 revs., £9,750; Coombe-Barbour condenser.
Crompton and Co. dynamo, Browett, Lindley, and Co. engine, £9,406; condenser, £2,894; Stewart and Menzies steam pipes, valves, etc., £1,228; Lloyd and Lloyd ditto £870.
Ditto, Belliss and Morcom engine, £10,163: condenser, £2,670.
Ditto dynamo, Ferranti engine, £10,394; condenser, £1,596.
Dick, Kerr, and Co. dynamo, Ferranti engine, £9,545; Klein condenser, £2,800; Russell steam pipes, valves, etc., £1,090.
Ditto, McLaren engine, £14,260; McLaren condenser.
Ditto, Belliss and Morcom engine, £9,696; Worthington condenser, £1,875.
Ditto, Coombe-Barbour engine, £12,708; Coombe-Barbour condenser.
Electric Construction Company dynamo, Willans engine, £12,046; Ferranti condenser, £1,493; Ferranti steam pipes, valves, etc., £890.
Ditto, Ferranti engine, £10,093: Stewart condenser, £2,486; Stewart steam pipes, valves, &c., £1,387.
Ditto, D. Stewart and Co. engine, compound side by side, £12,885: Stewart condenser, £2,697.
Ditto, D. Stewart and Co. engine, cross compound, £13,427.
Ferranti, Limited, engine, E. C. C. dynamo, £10,080; Korting condenser, £1,433; Mannesman steam pipes, valves, etc., £820.
Ditto, Bruce Peebles and Co. dynamo, £10,050; Babcock and Wilcox steam pipes, valves, etc., £868.
Ditto, Westinghouse Company dynamo, £10,800.
Ditto, British Schuckert Co. dynamo, £950.
Greenwood and Batley dynamo, Yates and Thom engine, £13,396; condenser, £1,330; Lloyd and Lloyd, Stewart-Menzies, or Russell steam pipes, valves, etc, £1,280.
Johnson-Lundell dynamo, Stewart and Co. engine, £11,680; Yates and Thom condenser, £1,382; Lloyd and Lloyd, Stewart-Menzies, or Russell steam pipes, valves, etc., £1,340.
Ditto, Yates and Thom engine, £12,148; Korting condenser, £1,490.
Ditto, Ferranti engine, £10,112; Klein condenser, £2,980; Babcock and Wilcox steam pipes, valves, etc., £909.
Ditto, Belliss engine, £10,045.
Lahmeyer and Co. dynamo, Yates and Thom engine, £10,070; Yates and Thom condenser, £1,345; Stewart and Menzies, Lloyd and Lloyd, or Russell steam-pipes, valves, etc., £1,340.
Ditto, Willans engine, £12,050; Allen and Sons' condenser, £3,180.
Ditto, McLaren engine, £15,645; Stewart and Menzies steam-pipes, valves, etc., £1,505.
Lancashire Dynamo Company dynamo, Browett-Lindley engine, £940; Storey condenser, £2,537; steam pipes, valves, etc., £1,131.
Ditto, Willans engine, £12,448.
Ditto, Belliss engine, £9,986.
Markham and Co. engine, dynamo, £13,400; condensers, £900; Mannesmann and Co. steam pipes, valves, etc., £1,200.
Mather and Platt dynamo, Willans engine, £11,770; condensers, £2,650; Lloyd and Lloyd steam pipes, valves, etc., £1,240.
Ditto, Victor Coates engine, £14,750; condensers, £2,650.
Ditto, McLaren engine, £15,800; Stewart and Menzies steam pipes, valves, etc., £1,500.
Ditto, Ashton-Frost engine, £14,760.
Ditto, Coombe, Barbour, and Co. engine, £13,900.
McLaren engine, Siemens dynamo, £15,010; McLaren condenser; Lloyd and Lloyd steam-pipes, valves, etc., £1,427.
Ditto, Dick-Kerr dynamo, £14,670; McLaren condenser.
Ditto, Westinghouse dynamo, £15,276; McLaren condenser.
Ditto, Schuckert dynamo, £14,238; McLaren condenser.
Parsons and Co. turbine, £10,980; condenser, £3,694; steam-pipes, valves, etc., £1,312.
Siemens Bros. dynamo, McLaren engine, £14,850; McLaren condenser; McLaren steam-pipes, valves, etc., £1,495.
Ditto, Ashton-Frost engine, £14,220; Klein condenser, £3,600; Russell steam-pipes, valves, etc., £1,140.
Ditto, Willans engine, £11,920; condenser, £2,180.
Ditto, Browett-Lindley engine, £8,890.
Stewart and Co. engine, Johnson-Lundell compound side-by-side dynamos, £11,588; condenser, £2,394; steam-pipes, valves, etc., £1,339.
Ditto, Johnson-Lundell cross-compound dynamo, £12,755; condenser, £2,585.
Ditto, E. C. C. dynamo, add £700.
Ditto, Brush dynamo, add £500.
F. Suter and Co. dynamo, Ashton, Frost, and Co. engine, £13,865; Ashton-Frost condenser.
Witting Bros. dynamo, Ferranti engine, £9,600; condenser, £1,450; Babcock and Wilcox steam-pipes, valves, etc., £830.
Ditto, Markham and Co. engine, £10,460.
Ditto, Browett, Lindley, and Co. engine, £9,120.
Yates and Thom engine, Dick, Kerr, and Co. dynamo, £12,525 condenser, £1,330; Lloyd and Lloyd steam-pipes, valves, etc., £1,280.
Ditto, ditto, £10,302; condenser, £1,315; Stewart-Menzies or Russel steam-pipes, etc.

The tender which was accepted finally was that of the British Westinghouse Company, with McLaren engines. This tender includes a triple-expansion McLaren engine and surface condenser combined. We notice from the details to hand that these engines with a speed of 125 revs. have a steam consumption of only 15·2lb. at three-quarter full load condensing. In the same list the consumptions of McLaren engines are quoted in various other combinations at 15·4 and 15·5, the next lowest being a dynamo and cross-compound engine, both by Bow-McLachlan, where the figures are 115 revs. and 16·2lb. respectively. In another combination (Ferranti engine and Bruce Peebles dynamo) 16¾lb. are indicated, but no figure as to speed of engine is supplied. Section C (Yates and Thom) was also accepted, the sum of £15,146 for Sections A and B was finally amended, and a tender by the Westinghouse Company, amended to £14,000, was accepted for Sections A and B, and £1,085 conditionally for Section C.

BUSINESS NOTES.

TRACTION.

Ayr.—A *plébiscite* of the town is to be taken on the Sunday car question.

East Ham.—The Council are inviting tenders for the erection of additional buildings at the electric tramcar station.

York.—The City Council have decided to proceed with that portion of the Tramways Bill of which the ratepayers have approved.

Mexborough.—The Mexborough and Swinton Tramways Bill has passed the Standing Orders Committee of the House of Commons.

Burton.—Application is to be made for sanction to borrow £14,000 for an installation of three 100-kw. generators for the tramway power station.

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Dewsbury.—The Town Council have decided to support the proposed light railway from Wakefield to Dewsbury *via* Ossett and Soothill.

Scarborough.—A special meeting of the Town Council has passed a resolution approving the provisions which affect the Corporation in the Scarborough Tramways Bill.

Johnstone.—Mr. Murphy, having completed his arrangements in the borough for the proposed new tramways, will shortly place his plans before the local authorities.

Warwick.—A deputation from Warwick has visited Wolverhampton to inspect the new electric tramway in Cleveland-road. Much interest was manifested in the Lorain system, the details of which were carefully noted.

Wolverhampton.—The Town Council on Monday confirmed their resolution in committee to acquire property in New Hampton-road for the widening of that thoroughfare in connection with the tramway scheme.

Norwich.—The Norwich Electric Tramways Company have, in accordance with the agreement entered into by them with the Corporation, completed the construction of the additional lines of tramway at Orford-place.

Sheffield.—The Tramways Committee have decided to advance to the Angel-street Land Committee, out of tramway profits, a sum not exceeding £16,000 for the erection of saleshops. Interest at the rate of 3 per cent is to be paid.

Smethwick.—In connection with the tramway scheme, the Tramways Committee have agreed to spend £2,000 on the widening of Cranford-street Bridge. It is hoped to have the electric cars running in the borough in 12 months' time.

Glasgow.—The last horse car has made its disappearance from the streets of the city. On Monday the electric cars commenced running to Tollcross, which was the last horse section of the tramway system to be converted to electric traction.

Oldbury.—Upon satisfactory terms being arranged the District Council have agreed to give their consent to the Bill of the Birmingham and Midland Tramways Company for powers to construct tramways between Oldbury and Blackheath and Langley.

Aberdare.—The Board of Trade have declined to sanction the scheme of the Urban District Council to construct an electric tramway system, five miles in length, through the district, at a cost of nearly £60,000. Frontagers on both sides of a narrow street objected.

Southwick.—Assurances were made at the last meeting of the Urban District Council that the tramway company had not dropped their proposal to construct electric tramways in the district in any way. Every endeavour would be made to carry the scheme through.

Walsall.—The Council having authorised the raising on mortgage of a further sum of £50,000 for tramway purposes, progress is being made with the scheme. Tenders for constructing the authorised extensions have been accepted, but the contracts are not yet entered into.

Ilford.—It is now definitely decided that the electric tramways shall extend to Barkingside. There was some fear that this section would not be proceeded with at once, but the contract for the work has been signed, and the whole scheme will be carried out at the one time.

Devonport.—Power has been relegated to the Tramways Committee to accept contracts for the construction of the proposed tramway extensions from Camel's Head to St. Budeaux, from Milehouse to the borough extension, and the loop line to Albert-road. Tenders for the work were opened on Wednesday.

South Shields.—The Parliamentary Committee after fully discussing the Sunderland and South Shields Light Railway Bill, have, with the view of arriving at a compromise, decided to ask the British Electric Traction Company's representative to meet the committee in conference at an early date.

Manchester.—At the last meeting of the City Council it was mentioned that, independent of their obligations to supply current for the working of certain tramway routes by November next, the Electricity Committee were also in a position to supply current almost immediately for the Upper Brook-street route.

South Lancashire Tramways.—Some of the lines contemplated by the above scheme will connect with the Warrington Corporation tramways at Longford, but the right of running over the Corporation line rests entirely with the Corporation. Tenders for the construction of the South Lancashire tramways have been let.

Nottingham.—A large portion of the overhead work in connection with the Woodborough-road section of the Corporation electric tramways has been completed, and it is hoped that the Board of Trade inspection will take place in the week before Whitsuntide, so that the route may be put into working order for the holidays.

Stockport.—The Town Council have sealed an agreement to be made between the Corporation of Stockport and the Corporation of Hyde, the Bredbury and Romiley Urban District Council, and the Oldham, Ashton, and Hyde Electric Tramway, Limited, in reference to running powers over tramways in Hyde and Bredbury

Halifax.—This week the Select Committee of the House of Commons of which Sir Robert Gunter is chairman are considering the Corporation Bill, under which, among other things, authority is sought to construct additional tramways, to extend the electricity undertaking, and to establish within the borough a municipal telephone system.

Brighton.—The suggestion of introducing tramways on the King's-road is reported to be without foundation. The Town Council have rejected a proposal that all future appointments upon the Corporation tramways shall be given to efficient local residents, except that if no local resident can be found qualified for a post, a non-resident may be appointed.

Erdington.—The Erdington Tramways Bill, which has recently passed all its stages in the House of Commons, came this week before Mr. Symons Jeune, examiner of petitions for private Bills, for proof of compliance with further Standing Orders of the Upper House. The examiner granted a certificate, and the Bill was sent forward for its committee stage.

Subsidences due to Tunnelling.—Several subsidences have taken place in the City-road owing, it is suggested, to the tunnelling for the tube railway from Islington to the City. The Lying-in Hospital has had to be shored up because of its condition, and several other premises near are stated by surveyors to have the appearance of having had an earthquake shock.

Londonderry.—It is stated on reliable authority that a scheme has been seriously taken up for the construction of an electric railway from Londonderry to Moville. It is the intention of the promoters to apply to the Irish Privy Council next August for an Order in Council authorising the construction of the line. Electric current would be generated by water near Cabry, Quigley's Point.

Light Railways.—The Board of Trade have confirmed the following light railway orders: amending the Lizard Light Railway Order, 1898; authorising the construction of a light railway in the county of East Suffolk between Southwold and Kessingland, and the conversion of the gauge of the existing Southwold Railway, and the working thereof as a light railway under the Light Railways Act, 1896.

Pontypridd.—Much disappointment is felt in the town at the rejection by the Board of Trade of an important part of the tramway scheme. It seems that an official communication has been received from the Board stating that the proposed lines through Mill-street and Rhondda-road to form a junction with the existing tramway to Porth have been struck out, and that the other part of the scheme is approved.

Sunderland.—The Corporation recently applied for a provisional order for the construction of new tramways to Fulwell and Pallion. One of the clauses was to the effect that the Corporation can charge on workmen's cars ½d., but are not to accept less than 1d. The Board of Trade want to amend this to ½d. per car mile, but the Tramways Committee cannot see their way clear to agree to this, and a deputation is to visit London on the subject.

Middlesex Tramways.—A number of local authorities have handed in petitions at the Private Bill Office of the House of Commons to be heard by counsel against the Middlesex Council Tramways Bill when it reaches the committee stage. The petitioners are the Urban District Councils of Hendon, Acton, Chiswick, Twickenham, Tottenham, and Heston and Isleworth; the Ealing Borough Council, and the London United Tramways Company.

Stoke-on-Trent.—A special meeting of the Town Council has passed a resolution objecting to the plans submitted by Mr. Sellon on behalf of the British Electric Traction Company, Limited, for light railway No. 1 under the Light Railways Order, 1902, from Stoke to Newcastle, *viâ* Hartshill, on the ground that the road upon which it is proposed to construct the light railway is not of sufficient width to allow of a double track being laid with safety.

Corwen.—The proposal to construct a light railway from Corwen to Cerrigydruidion and Bettws-y-coed is now taking definite shape. At a meeting of representatives from Llangwm Cerrig, Llanfihangel, Pentrefoelas, Ysbytty, and Penmachno the scheme was heartily approved, but before proceeding further in the matter the meeting decided to ask for plans, and also for particulars respecting the syndicate which has taken the matter in hand.

Darlington.—In reply to a letter from the Town Council objecting to the confirmation of the Darlington light railways order, the Board of Trade have written to the effect that they see no sufficient reason to vary in the manner suggested the provisions of the order as made by the Commissioners. Messrs. Kennedy and Jenkin have been asked to prepare plans for the extension of the power station, in view of the current which will be needed for the proposed tramways.

Trafalgar-square.—The Navy League have issued an alarmist statement to the effect that one of the proposed electric tube railways in the neighbourhood of Trafalgar-square might mean the "possible collapse" of Nelson's monument. At the Office of Works, however, one of the *Daily Chronicle* representatives was assured that the railways passing near the monument were being closely watched, and that no plans would be allowed that would in any way endanger the structure.

Ashton.—At the last meeting of the Town Council the Tramways Committee reported that the sub-committee appointed to attend a conference of local authorities at the Salford Town Hall, to consider a proposal for the establishment of a Manchester district tramway board, attended the conference which was held on the 7th inst., and at which representatives of Salford, Eccles, Prestwich, Stretford, Audenshaw, and Denton were present also. After discussion, it was unanimously agreed that a through connection between Manchester and Salford is desirable.

London Motorcar Exhibition.—The Automobile Club's Exhibition at the Agricultural Hall, Islington, will open to-morrow (Saturday) under the direction of Mr. Charles Cordingley. Evidence of the progress of the motorcar industry will be seen in the crowded state of the galleries, as well as the ground floor, and among the features of popular interest will be the new car for the King, and a new motor designed for M. Santos Dumont's next airship. The exhibition, which will be visited by the Prince of Wales, will remain open till Saturday, the 26th inst.

Rochester.—A conference is being arranged between representatives of the City Council and the Chatham Corporation with reference to the establishment of a joint tramway scheme. As having an important bearing upon the question it should be mentioned that the

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British Thomson-Houston Company have nearly completed their system of electric tramways in Chatham and Brompton, which serves practically all the principal thoroughfares, with the exception of High-street, Chatham, which is far too narrow in places to allow of even a single line being laid with safety.

Cardiff.—Further satisfactory trial trips on those sections of the tramways which have been converted to electric traction have been made in the last few days. The Board of Trade inspection of some of the new lines will take place in about a week's time. At the last meeting of the Tramways Committee Mr. Ellis, the electrical engineer, reported satisfactory progress with the work of construction. He hoped the electric cars would be running by May 1. The question of Sunday trams is being much discussed in the town, but no final decision on the question has been come to yet.

London County Council Subways.—Before the Court of Referees of the House of Commons on Monday objection was taken to the Great Northern and Strand Railway Company being heard against the London County Council's Subways (Tramways) Bill. It was explained that the London County Council propose to construct a subway for trams from Theobald's-road and Southampton-row to the Embankment. The Great Northern Railway Company have secured certain easements for the purpose of running a tube railway, and it was thought the two would clash. The objection, however, was not allowed.

Chiswick.—At a special meeting of the District Council last week it was resolved, subject to an agreement with the London United Tramways Company, to abandon the Council's application to the Board of Trade for a provisional order empowering them to construct tramways in Chiswick. During the week negotiations had been going on between Mr. E. F. Collins (representing the Council) on the one hand, and Mr. J. Clifton Robinson on the other. The result was that Mr. Clifton Robinson agreed to formally put in writing a promise that in the event of his promoting further tramways he will consult with the Council first.

Gloucester Light Railway.—This scheme was considered at the last meeting of the Gloucestershire County Council. The Chairman of the Highways Committee said that great inconvenience would arise if the Gloucester Corporation were allowed to work tramways in the county area, and the County Council had agreed with Mr. Nevins's proposals to construct part of the railway under discussion. The Highways Committee had offered terms to the Gloucester Corporation which they refused, and therefore the matter as between the County Council and the City Corporation had fallen through. The action of the Highways Committee was approved.

Huddersfield.—The financial statement of the borough treasurer regarding the tramway revenue and expenditure for the 12 months ended March 31 last shows that the income from steam trams had been £21,639. 14s. 9d., or 13·50d. per mile, and the expenditure £24,999. 3s. 11d., or 15·58d. per mile—a gross deficit of £3,359. 9s. 2d., or 2·08d. a mile. The receipts from the electric car service amounted to £27,371. 14s. 8d., or 10·64d. a mile, and the expenditure £33,157. 0s. 10d., or 13·89d. a mile—a deficit of £5,775. 6s. 2d., or 2·25d. a mile. The salary of Mr. H. N. Thomas, tramways manager, has been increased by £100 per annum.

Liverpool.—The Standing Orders Committee of the House of Commons on Tuesday considered the report of the examiners of the House that the Standing Orders had not been complied with in respect to an additional provision which the promoters of the Liverpool Corporation Bill proposed to insert. The object of the new provision is to repeal certain portions of the Liverpool Corporations Tramways Act, 1897, so as to permit the City Council to apply tramway profits to rate relief. After consultation the chairman announced that the committee had decided to allow the Standing Orders to be dispensed with. The additional clause now becomes part of the Corporation Bill.

The Woollen District.—Preparations for an early start with the construction of the Yorkshire (Woollen District) electric tramways are being rapidly pushed forward. The company intend commencing with the Dewsbury, Thornhill, and Ravensthorpe sections first, and the material for these is arriving in quantities and being stored in convenient places. Messrs. Dick, Kerr, and Co. are the contractors for the permanent way. Negotiations are still proceeding between the Dewsbury Corporation and the company relative to the supply of energy. The Heckmondwike District Council will supply the company with electrical energy for the running of the trams in that district.

Chester.—Active preparations are being made for the conversion of the tramways to electric traction. The city surveyor has submitted plans, conditions, and specification for the permanent way of the new tramways, and the drawings for alteration and additions to the present car-shed. These are now under consideration, together with a report from the city electrical engineer (Mr. F. Thursfield) on the electrical equipment. In this report he mentions that telephone communication will be provided from each of the feeder pillars which are placed at intervals of approximately half a mile all along the route to the car-shed and the electric generating station. It is estimated that in connection with the scheme a sum of £8,000 will have to be spent on new machinery for the power-house

Salford.—The municipal electric tramway system was further extended last Friday by the opening of the Weaste and Trafford Bridge tramway routes. The lines had previously met with the approval of the Board of Trade inspectors, and a frequent service of cars was run during the day. The overhead equipment in the Lower Broughton district is now nearing completion. The relaying of tramway lines between Ladywell sanatorium and Eccles Cross has been begun; when they are completed there will be a through service between Blackfriars and Eccles. The Parliamentary Committee have sanctioned the demolition of certain houses in Tatton-street by the promoters of the electric express railway, on the understanding that other houses should be erected on the same sites if possible.

Warrington.—It was reported at the last meeting of the Town Council that a local enquiry had been held by the Light Railway Commissioners into the application of the Corporation to construct light railways in Stockton Heath and Latchford Without, and that the Commissioners had decided to make the order. It is expected that the Corporation tramway from Latchford to Sankey Bridges will be opened for traffic on Monday. The official inspection of the line was to take place this week. Tenders have been received during the week for the construction of tramways from Scotland-road to the cemetery, and also from Scotland-road along Winwick-road to the borough boundary at Longford. The tenders have been opened by the committee and referred to Messrs. Preece and Cardew, the engineers, for a report thereon.

Birmingham.—The agreement between the Corporation and the tramways company for the substitution of electrical for steam traction on the Birmingham and Midland line has been signed. No time will be lost by the company in giving effect to this agreement, and as electric traction has also been sanctioned by the Smethwick and Oldbury authorities, the company will, when the equipment is completed, be able to run electric cars over their entire stretch from Lionel-street, Birmingham, to Dudley. The Great Western and London and North-Western Railway Companies, the National Telephone Company, and the Birmingham Canal Company have notified the Private Bill Office authorities that they intend to oppose the Birmingham and Midland Tramways Bill before the committee of the House of Lords to which it has been referred.

Leeds-to-Manchester.—There is still an area of about 10 miles without tram facilities in the long stretch from Leeds to Manchester, a large portion of that district being within the borough of Todmorden. On the Yorkshire side of the borough just named the Halifax Corporation have recently opened tramlines to Hebden Bridge, which is 4½ miles from the centre of Todmorden. On the Lancashire side trams already run from Rochdale to Littleborough, and further powers have been obtained to extend the lines to Summit, where the Todmorden boundary begins. A Bill is being promoted by the Todmorden Corporation for the laying of tramlines throughout their district, and the Halifax Corporation have consented to bring their trams to the Yorkshire side of the Todmorden borough, so that there is every prospect of a through communication from Leeds to Manchester by tram at no distant date, a distance of about 50 miles.

Canterbury and Herne Bay Light Railway.—On Wednesday the Light Railway Commissioners (the Earl of Jersey, Colonel Boughey, and Mr. Steward) renewed their enquiry into the application of Messrs. Bowen, Kershaw, and Kittings, of Birmingham, for sanction to the construction of a light railway between Canterbury and Herne Bay. It was stated that terms had been arranged with the Kent County Council, the Canterbury Town Council, and Herne Bay Urban Council. The sole opposition was that offered by Mr. Richards, K.C., M.P., on behalf of the South-Eastern and Chatham Railway Company, who contended that this line would come into competition with the railways. He pointed to the fact that the construction of a similar light railway in Thanet had in places reduced the income of the company 79 per cent. The president announced that the Commissioners considered there was a need and a desire by the public for the light railway, and the application would be granted.

Electrical Equipment of the Underground Railways.—The order for economisers in connection with the electrical equipment of the generating station of the Metropolitan District Traction Company must necessarily be a large one, and we understand that it has just been placed with Messrs. E. Green and Son, Limited, of Manchester, amounting to nearly 10,000 tubes. This, we are informed, is the largest order for economisers ever placed by an individual firm, and it may be gathered that the competition for securing it was of the keenest description. Messrs. Green and Son further inform us that at the forthcoming light railways and tramways exhibition to be held in the Agricultural Hall they will show an economiser of 96 tubes, with the usual blow-off and safety valves and patent access branch pipes at the bottom, these latter tending to facilitate the easy cleaning out of the bottom boxes. The top boxes will be fitted with internal lids, and the economiser will be constructed for a working boiler pressure of 160lb. The scraper motion will be driven by a motor.

Crystal Palace Light Railway.—The promoters of this scheme withdrew their application before the Light Railway Commissioners last Thursday week, but they have since written to the metropolitan borough of Camberwell to the effect that they intend actively to prosecute the proposal for placing Camberwell in tramway communication with the Crystal Palace. The application will accordingly be renewed in May next, when an additional proposal will be brought forward to extend the line along Lordship-lane and Sydenham-hill to the Crystal Palace. In the meantime a member of the Camberwell Corporation has put down on the paper a motion to the effect that in consequence of the Crystal Palace Light Railways Company's scheme having been withdrawn, and with the view of affording the residents of East Dulwich better facilities of communication with the Crystal Palace and district, a letter on behalf of this Council be sent to the promoters of the City and Crystal Palace Railway Company asking them to use every effort to bring their scheme to a successful issue.

Middleton.—The new electric tramways were formally inaugurated at this place on Monday. The system in the borough is owned by the Middleton Electric Traction Company, who have obtained an order under the Light Railways Act for the construction of tramways in the adjoining district as well. Their lines extend to Castleton and Rochdale on the north, through Chadderton to the Oldham boundary on the east, and to Rhodes, on the borders of Prestwich, on the west. This last line will eventually afford a connection with Manchester by means of the extension of the Manchester Corporation's Cheetham Hill

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section to the Middleton boundary. Arrangements have also been entered into by which the Manchester cars, which already run from High-street to the boundary of the city, will shortly continue their journey along Manchester New-road into the centre of Middleton, and thence to Middleton Junction. The Middleton Corporation, from their new electricity works, which were also inaugurated on Monday, will supply the electric traction company with current to work their eight miles of tramways, and will also provide the power for the Manchester cars within the boundaries of the borough.

Aberdeen.—The contractors have made a start with the erection of the poles for the electrical equipment of the Albyn-place and Queen's-road sections of the tramway system. The Tramways Committee are to consider as to the propriety and practicability when the whole tramway system is electrically equipped of fixing fares at the rate of ½d. per half-mile on all the routes. A service of electric cars is now being run from the new dead-end siding in Union-street to the Corporation bathing station, this being the first time the cars have run since the service was withdrawn at the end of last season for the conversion of this section to electric traction. In connection with the electric car service to the bathing station, it may be mentioned that a member of the Town Council is in receipt of a letter from Mr. J. M'Elroy, of the firm of M'Elroy, Grunow, and Co., of New York, the patentees of the "twin-rail" system of electric traction, who, with the consent of the Town Council, laid their patent system on the part of the beach route from Constitution-street to the bathing station. In this letter they state that they expect to be in Aberdeen by the end of this month, and are hopeful that, with the improvements they have designed at very considerable expense, they will prove that the system is thoroughly safe and satisfactory.

District Railway Bill.—This Bill came before the Court of Referees of the House of Commons on Monday, the question at issue being whether the Ecclesiastical Commissioners, the London County Council, the Middlesex County Council, and the promoters of the North-East London Railway Bill had a *locus standi* to appear against the scheme when being considered on its merits by a committee of the House. For the Ecclesiastical Commissioners it was contended that that body was entitled to a *locus standi* so far as the question of extension of time was concerned, they being the owners of considerable property in Westminster, including buildings situate above and abutting on the railway near Westminster Bridge Station. On behalf of the promoters it was contended that the buildings would be subjected to vibration of a much less serious kind in the future than had been the case for 30 or 40 years past. There would be less vibration with the electric motor than is the case with a steam-engine. The chairman said that was a question of merits. The committee would grant a *locus standi* only so far as Clause 40 was concerned. With regard to the application of the London County Council, Mr. Clode, on behalf of the Metropolitan Railway Company, raised no objection to a *locus standi* so far as mains, sewers, electrical lines, etc., were concerned. The court granted a limited *locus standi* relating to Clauses 5 and 12 of the Bill. The court declined to allow a *locus standi* in the case of the promoters of the North-East London Railway Bills Nos. 1 and 2. Mr. Moon, K.C., then claimed a *locus standi* on behalf of the Middlesex County Council against the Metropolitan District Railway Bill as the owners of the Westminster Guildhall. It was feared, he said, that there might be so much vibration as to greatly interfere with the use of the buildings. The chairman said the court was inclined to give the same *locus standi* as to the Ecclesiastical Commissioners—namely, against extension of time.

LIGHTING AND GENERAL.

Buxton.—Arrangements have been made for Mr. Calvert to complete the laying of the new cable.

Dumbarton.—The Town Council have finally approved their electricity supply provisional order.

Peterhead.—The Council are corresponding with Messrs. Crompton and Co. with regard to electric lighting.

Dorking.—The Council have signed a draft agreement with Edmundsons' Electricity Corporation, Limited.

Tharsis Copper Company.—At the annual meeting of this Company a dividend of 20 per cent. was adopted.

Dudley.—The Corporation are advertising the supply of electric motors, the same to be kept in repair by the Council.

Heywood.—A letter from Mr. W. P. Adams, M.I.E.E., with respect to the free wiring scheme is before the Town Council.

American Pacific Cable.—San Francisco has been chosen as the landing place of the Commercial Cable Company's Pacific cable.

Diamond Drill.—An electrical diamond drill, or perforator of rocks, has been introduced by the firm of Dunand, of Carouge, Geneva.

East Barnet.—The Urban District Council have adopted a lighting scheme, which includes a dust destructor. The estimated cost is £13,729.

Removal.—Messrs. Nalder Bros. and Co. have removed their offices and showrooms to 12, Carteret-street, Queen Anne's-gate, Westminster.

Gravesend.—We understand that Mr. Crickmay is reporting upon the material and workmanship of the buildings for electricity and dust destroying.

Shrewsbury.—The Town Council have resolved to expend about £100 in illuminating public buildings by electricity on the occasion of the Coronation.

Notre Dame, Paris.—Candles, hitherto used in lighting the Cathedral of Notre Dame, Paris, are to make way for electricity at a cost of about £20,000.

Newcastle.—At a meeting of the City Lighting Committee of the Corporation on Tuesday it was decided to erect 13 additional electric lamps of 1,000 c.p. each.

Southend.—Mr. Jefferies, of Newcastle, has been appointed assistant electrical engineer at £130 per annum, rising by yearly increments of £10 to £200.

Pudsey.—A committee is collecting information on the electricity and refuse destructor question in order to present a report to the Council as early as convenient.

Perth.—We understand that the proposed extension of the mains to Bridgend, Glasgow-road, and Balhousie districts is to be carried out at a cost of £2,476. 8s. 5d.

Falkirk.—The Electric Lighting Committee have received plans and specification for the proposed electric light station, also a report by Mr. Ronald estimating the cost at £5,800.

Scarborough Telephones.—The Corporation having considered the report of Mr. Bennett with respect to the establishing of a municipal telephone system, a canvass is to be made.

St. Annes.—The Urban District Council have appointed the following Electric Lighting Committee: chairman, vice-chairman, and Councillors Harker, Irving, Rothwell, Spring, Thompson, and Walmsley.

Hull Telephones.—The Corporation Telephones Committee have agreed to continue negotiations with the National Telephone Company, which were opened some time ago with the view of acquiring their system.

Darwen.—The Electricity Committee are paying £500 to the Health Committee for all the steam generated at the destructor. Electricity is to be supplied free on the Coronation Day for outdoor illumination purposes.

City Lighting.—We understand that a conference took place last night with regard to the charges made by the City of London Electric Lighting Company for current at the Guildhall and other large institutions in the City.

Kingswinford.—The District Council are conferring with Mr. Maclean, engineer to the Midland Electric Corporation for Power Distribution, Limited, with regard to the number of lights to be erected in the side streets.

Sports.—In the first round of the Swinton and District Workshops Cup Competition, the Chloride Electrical Storage Syndicate Football Club beat the General Electric Football Club by the substantial margin of 16 points to nothing.

Bootle.—The Town Council have decided to borrow £7,300 to defray the cost of works of street electric lighting, executed pursuant to the orders of the committee, and approved by the Council on Oct. 19, 1897, and various subsequent dates.

Wakefield.—About 90 applications have been considered for the position of electrical engineer, in the place of Mr. R. Blackmore, who has received a more important appointment at Ashton-under-Lyne. The applications have now been reduced to 14.

Ludlow.—The Board of Trade have extended the period of the provisional order for electric lighting until Nov. 1 next. The Council have received an offer from Mr. Allen Jenkins, stating that if they wished to dispose of the order he would recommend a company prepared to take it over.

New Agency.—Messrs. C. A. Parsons and Co., Heaton Works, Newcastle-on-Tyne, have recently opened offices at 99, Great Clyde-street, Glasgow, and have appointed Mr. A. A. W. Wynne, M.A., to represent them in Scotland for their steam turbines for driving dynamos, alternators, pumps, compressors, etc.

Personal.—We are pleased to note that Mr. A. J. Arnot, who, until recently occupied the position of city electrical engineer of Melbourne, Australia, has now been appointed by Messrs. Babcock and Wilcox their engineer and manager for the whole of Australasia. His head office will be at 63, Pitt-street, Sydney.

Hammersmith Borough Electricity Athletic Club.—Exchanging the field of athletics for the concert platform last week, the members of the Hammersmith Borough Electricity Athletic Club gave a successful concert, at which the mayor (Councillor T. Chamberlen) and other members of the Borough Council attended.

Harrogate.—With regard to the recent breakdown, Mr. Wilkinson, the engineer, stated at the last meeting of the Council that the engine had been working two years at the top load, and the breakdown was practically due to a flaw in a bolt, which nearly wrecked the engine. The flaw could only be discovered when the bolt broke.

Maidstone.—The success of the first three months' working of the electric light at Maidstone has exceeded all expectations. It was estimated that six months would yield a revenue of £800, but in three months £700 has been reached, despite the fact that a good proportion of the customers have only been connected a month or so.

Croydon.—The Croydon County Council have appointed Mr. John G. Scott, burgh electrical engineer of Leith, to the office of Corporation electrical engineer at a salary of £400, rising to £600. There were 50 applications. Mr. Scott has had previous electrical engineering experience at Glasgow, Coatbridge, Bradford, and Whitehaven.

Bangor.—The last report of the electrical engineer (Mr. W. Price White) states that up to March 21 there were 6,826 8-c.p. lamps connected with the electric light works. The approximate number of units of electrical energy sold during the month of February was 10,331, representing an increase of 59 per cent. on the corresponding month last year.

Salford.—The Council on Wednesday decided, in order to facilitate the use of electric light and power in the borough, to make the following reduced charges: for lighting, 4d. per unit; and for power 1½d. for consumers using over 5,000 units per quarter, and for con

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sumers not using 5,000 units per quarter 2d. for the first 1,000 units and 1½d. for the remainder.

St. Marylebone.—The electric inspector's estimate of £74. 1s. for an electric light installation at the town hall has been approved by the Borough Council, also a notice from the Metropolitan Electric Supply Company, Limited, of the company's intention to lay a 5in. cast-iron pipe along the east side of Bird-street, from the north side of Oxford-street to 4, Bird-street.

Telegraph Rates.—The London correspondent of the *Neue Wiener Tagblatt* states that he has reliable information that a system of urgent telegrams to and from abroad will be introduced by the English Post Office. There will also, he reports, be a further extension of cheap tariffs for Press telegrams to countries hitherto not included in the telegraphic area for such dispatches.

Boston.—At the last meeting of the Town Council the Mayor reported that several firms had communicated with him with reference to the advertisement he had inserted in the newspapers as to electric lighting and motive power. The names are to be submitted to Mr. Adrian Collins, with a request that he will recommend the Corporation which firms they are to approach.

Keighley.—It appears that during the past year the consumption of electricity was 50 000 units less than estimated, notwithstanding that the price received per unit was ½d. less than anticipated, due to the granting of a lower price for motive purposes than for illumination, but a considerably increased consumption is now expected, several large consumers having applied for current.

Darlington.—At the last meeting of the Electric Lighting and Tramways Committee of the Corporation it was reported that there was a favourable balance of £90 in the electricity accounts, this being the first, and it was hoped the forerunner of an increasing one. It was decided to pay back the £700 borrowed for electricity purposes, and never used, into the district fund account.

Kensington.—Notices received from the undermentioned electric lighting companies relative to proposed extensions of their mains in the borough—viz., Kensington and Knightsbridge Electric Lighting Company (Kelso-place and Tarn-mews), Brompton and Kensington Electricity Supply Company (Finborough-road and Tregunter-road)—have been agreed to subject to the usual conditions.

Worcester.—The surplus arising from the electricity accounts for 1901 has been placed to a reserve fund by the Electricity Committee for purposes authorised by the Council's provisional order, and out of the surplus funds £400 are to be spent in laying lamps and mains and £200 on repairs to engines. It has also been resolved to purchase a new transformer for the Cross sub-station at a cost of £68.

Union Elektricitats-Gesellschaft, Berlin.—The profit of this Company for the year 1901 is stated at £185,052. General expenses, taxes, interest, and £45,925 for amortisation of capital having been deducted, left the sum of £70,500, which was used to pay a dividend of 6 per cent. on the capital of £1,200,000, a bonus to the directors of £1,681, and £1,321 to carry over. The dividend in 1901 was 10 per cent.

Hull.—The Electric Lighting Committee have, on the recommendation of the electrical engineer, Mr. Barnard, authorised the extension of the Fountain-road main from Waterloo-street to Wincolmlee at an approximate cost of £280. The lowest tender for painting the outside of the Sculcoates-lane power station was £34, whereas the city engineer submitted an estimate of £18. The work will now be done by the city engineer's staff.

Kilmarnock.—At the Town Council meeting on Wednesday last week it was reported that Mr. Bryson, electrical engineer, had put in a claim against the Corporation for the payment of £976. 17s. 3d. Mr. Bryson was consulting engineer to the Corporation in connection with their proposed electric installation, but the scheme was abandoned, and the question taken up *de novo*. The matter was remitted to a committee.

Huddersfield.—It is reported that an Austrian firm of electrical engineers are seeking to establish works in this country, and a syndicate of local moneyed men is being formed at Huddersfield for the purpose of taking steps to float a company. A further meeting will be held shortly to meet a representative of the firm. A site near Messrs. Learoyd's mill, in Leeds-road, is spoken of as likely to be chosen for the works.

Electrifying the Mersey Tunnel.—A 250ft. chimney, which is a part of the electrical power station to provide the new motive power for the Mersey Tunnel Railway, has just been completed. It is 24ft. square at the base and 13ft. across the flue, and its erection was commenced on Jan. 11. The work of remodelling the Mersey Railway for electric traction is being carried out by the British Westinghouse Electric Manufacturing Company.

Northamptonshire Municipal Telephones.—Last week a meeting took place of delegates from the Corporation of Northampton and the Urban District Councils of Kettering, Rushden, and Wellingborough, at Wellingborough. After discussion it was resolved, "That in the opinion of this meeting it is desirable to establish a joint telephone board for the area, which will be co-terminous with the National Telephone Company's Northampton and district area."

Chesterfield.—The Electrical Energy Committee of the Chesterfield Corporation are holding an electrical exhibition in the Stephenson Hall with a view to illustrating the various uses to which electricity can be applied in the service of man. The Mayor (Mr. W. Spooner) opened the exhibition on Wednesday in the presence of a large company of prominent townspeople. Mr. E. P. Robinson, the chairman of the Electrical Energy Committee, presided over the proceedings.

Watford.—Mr. H. Morten Turner has submitted a report with regard to electric lighting, in which he arrives at the following conclusion: "Setting aside for the moment the question of repayment of instalments of principal and interest, the figures for the year ending Dec. 31, 1901, show a satisfactory improvement upon preceding years; and it is not unreasonable to anticipate that this improvement will be maintained and augmented in the years ending March 31, 1902, and March 31, 1903."

Basingstoke.—The Council intend to apply to the Board of Trade for an extension of time for their electric lighting order, which expires in June next, in view of the fact that the Council are heavily engaged in arranging new schemes of water supply and sewage. They also point out that if a new sewage system is adopted, the present pumping station may be available for the purpose of an electric lighting station, and that an extension of time would enable the Council to procure further information.

Harwich.—It will be remembered that in March, 1899, the Council sold their rights of the electric lighting provisional order to the English Industrial Company, Manchester, who have since transferred their rights to a local company, calling themselves the Harwich Electric Tramways Company. The Town Council have now written to both these companies, asking them to put the provisional order into operation, as the Board of Trade will hold the Council responsible for the carrying out of the order.

Morley.—Mr. H. Drewett, electrical engineer, in his last report states that the output of electricity during the five weeks ending March 22 was 11,814 units, as against 8,997 for the corresponding period last year, being an increase of 31·3 per cent. Mr. Edwards has been appointed assistant engineer-in-charge vice Mr. Williams resigned, and the engineer will be allowed to receive two improvers at the electricity works on payment of a premium of £10. Enamelled iron shades are to be fitted to the street lamps in place of the opal shades.

Hammersmith.—From the estimated expenditure for the year ending March 31, 1903, of the Borough Council, we note that the Electricity and Lighting Committee estimate, for 1902-1903, £3,690 as the cost of lighting various thoroughfares with 164 1,400-c.p. electric arc lamps (at £22. 10s. per lamp per annum), and £208 for maintenance of 50 Loftus pattern incandescent lamps in various thoroughfares. The actual cost (1901-1902) and estimate (1901-1902) were £3,690 for the first and £218. 3s. and £138 respectively for the second item.

King's Lynn.—The Council have informed the Parish Council of Gaywood of their willingness to supply current for street and private lighting within the parish at Gaywood, on the same terms as those charged within the borough, provided a sufficient revenue be obtained. The engineer is making enquiries in the parish with a view to ascertaining the probable demand. The engineer's last report states that during the past month application had been received for 474 lamps of 8-c.p. or equivalent (including one 9-h.p. motor), making a total of 12,000 lamps from private consumers.

Doncaster.—The borough electrical engineer's last report gives the number of applications received since March 31 to the present date as eight, being equal to 254 8-c.p. lamps; the number on the books was 200; 12,972 8-c.p. lamps have been applied for up to present date, making 11,776 8-c.p. lamps at present connected; 12 consumers await connection, equal to 1,196 8-c.p. lamps. A booster is to be obtained at a price of £83, and the two 150-kw. generators at the works are to be altered so as to make them useful for tramway purposes as well as lighting, at a cost of £129 each.

London Gazette.—The partnership existing between J. K. Rogers, J. F. Rogers, and T. J. Stables (trading as Rogers Bros. and Stables, mechanical and electrical engineers, Heaton-street, Cleckheaton, and Heckmondwike, has been dissolved by mutual consent.—The estates of E. J. Paterson and C. F. Cooper, trading as Paterson and Cooper, electrical engineers and contractors, European Works, Pownall-road, Dalston, London, have been released from trusteeship.—The British Electric Meter Company is to be wound up voluntarily, and Mr. F. S. Springett, Wardrobe-chambers, 146A, Queen Victoria-street, E.C., has been appointed liquidator.

Bills in Parliament.—The Eston Urban District Council, South Bank, Stockton (Rural District), and Thornaby-on-Tees Corporation Electric Lighting Orders have been ordered for second reading in the House of Commons. A Bill to confirm the provisional order granted to Stanley (Durham) for the supply of electricity for lighting purposes has been read a first time. The London County Council (Tramways and Improvements) Bill, which was down for second reading last week, has been postponed till 21st inst. The Standing Orders Committee of the House of Commons have decided to dispense with the Standing Orders in respect of the petition of the South Wales Company to be allowed to insert a new clause empowering them to acquire by agreement from any local authority any particular area of supply.

Stock Exchange.—The Stock Exchange Committee have appointed April 29 a special settling day for Charing Cross and Strand Electricity Supply Corporation's further issue of 20,000 ordinary shares of £5 each fully paid, Nos. 50,001 to 70,000, and 20,000 4½ per cent. cumulative preference shars of £5 each fully paid, Nos. 50,001 to 70,000; and Electric Lighting and Traction Company of Australia £75,000 5 per cent. debenture stock, and a further issue of 10,000 6 per cent. cumulative preference shares of £5 each fully paid, Nos. 20,001 to 30,000. And have ordered the undermentioned securities to be quoted in the official list: Charing Cross and Strand Electricity Supply Corporation's further issue of 20,000 ordinary shares of £5 each fully paid, Nos. 50,001 to 70,000, and 20,000 4½ per cent. cumulative preference shares of £5 each fully paid, Nos. 50,001 to 70,000; City and South London Railway Company's £150,000 5 per cent. perpetual preference stock, 1901; Electric Lighting and Traction Company of Australia £75,000 5 per cent. debenture stock, and a further issue of 10,000 6 per cent. cumulative preference shares of £5 each fully paid, Nos. 20,001 to 30,000. Applications have been made to the Exchange Committee to appoint a special settling day in and to grant a quotation to Cape Electric Tramways further issue of shares of £1 each fully paid.

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Whitehaven.—The following scale of charges has been adopted by the Council: to consumers using 75 per cent. of their maximum demand for an average of 40 hours per week throughout the quarter, 2d. per unit; to consumers using 75 per cent. of their maximum demand for an average of between 40 and 100 hours per week throughout the quarter, 1½d. per unit; to consumers using 75 per cent. of their maximum demand for an average of over 100 hours per week throughout the quarter, 1d. per unit. The committee have also agreed to charge a medical battery at 3s. for each charge.

Swindon.—A pamphlet showing the advantages of electricity and the terms and conditions of supply for light and power, has been prepared by Messrs. Lacey, Clirehugh, and Sillar, and copies are to be distributed to the occupiers of premises in the streets in which the electric mains will be laid. Tenders for the work, which are now being advertised for, will be considered at the next meeting of the committee. The committee hope to be able to supply current by the end of the year, providing the mains were ready to connect with the generating plant. The question of free wiring is under consideration.

Taunton.—All the new machinery has been delivered and fixed at the Town Council's electricity works. The Electric Lighting Committee are advertising for tenders of 500 tons of Main Colliery or Powell Duffryn coal. They are purchasing 300 extra lamps, to stock, for illumination purposes. The lamp connections to the mains during the past quarter were equivalent to 771 8-c.p. lamps—namely, for light 465, for public light 6, and for power 300. The total connections at the end of 1901 were equivalent to 24,020 8-c.p. lamps—namely, private lighting and power 22,488, and public lighting 1,572—traction supply not included.

"The Smart Set."—The April number is readable from cover to cover. Mr. Marvin Dana, evidently with De Lusignan and Cyprus in his mind, opens the ball with the "Ambition of the Baron," a clever yarn, somewhat spoiled by heaviness in diction. "He spoke English better than does the native," is an unconscious piece of evidence on the part of the author. Another sample is "I know every detail as well as do you yourself"; "Scrupolosity" is good. Mr. Edgar Saltus has some nice epigrammatical satire, and a very forcible study, almost a poem in prose, by Mary L. Pendered, entitled "A Glimpse of the Garden," is decidedly above the average.

Ayr.—The Lighting Committee have agreed to lay a new cable for the hospital supply, on condition that the hospital contribute the sum of £100 to the cost thereof. An additional loan of £10,000 is required. A sub-committee appointed by the Cleansing Committee anent the disposal of the town's refuse submitted a report, which stated that the committee had visited Paisley, Gourock, St. Helens, Preston, Darwen, and Nelson and inspected refuse destructors of various types. The committee approved of the Meldrum type of destructor as seen by them at Nelson, and recommended that a site be secured at the north-west side of the Corporation electricity works. The estimated capital outlay is £8,680.

Camberwell.—On Oct. 30 last the Borough Council agreed to request the London County Council to obtain compulsory powers for the acquisition of a site adjoining the Bonar-road Wharf upon the canal, for the erection of the necessary works for the supply of electrical energy. On Wednesday it was reported that notice had been given to withdraw the clauses contained in the London County Council (General Powers) Bill, in reference to the acquisition of the site for a generating station. The Board of Trade have consented to an application by the County of London and Brush Provincial Electric Lighting Company, Limited, for an increase from 750,000 volts to 1,000,000 volts in the supply of power to their distributing station at 126, Hill-street, Peckham.

Bury St. Edmunds.—The electrical engineer in his last report states that during seven months (to March 31, 1901) there were 65 consumers; in the subsequent 12 months 104, or an increase of 39. A comparison during similar periods showed that there had been an increase of 1,810 consumers' lamps; consumers' motors, 42½ h.p. increase; street lamps, 272 increase. The total income showed an increase of £616. 14s., whilst the total working costs had only increased by £61. 13s. 3d. The electricity department propose to supply motive power for pumping at the waterworks on such terms as can be mutually agreed between the two departments. A cable for private lighting is to be laid from Westgate-street to the south end of Southgate-street at a cost of £300.

Pemberton.—The Electric Lighting and Parks Committee have offered to supply electricity for lighting purposes to the railway company for a term of three years at 3d. per unit, and a discount of 10 per cent. is to be allowed on all accounts for electrical energy supplied if paid within one month of delivery of account. The engineer's (Mr. J. K. Salter) last report states that satisfactory progress is being made with the installing of arc lamps. The cable is laid, and all materials have have arrived. The balancer is well in hand, and will be delivered within the month. Applications for current for lighting still continue, and there are now connected to the mains an equivalent of 1,390 8-c.p. lamps, with applications for 130 more, while there are also several good enquiries for current for motors.

Railway Engineering Shops.—The new works of the Union Pacific Company at Omalia, U.S.A., are to be electrically equipped throughout on the most modern principles. Direct-coupled steam-driven generators of about 750 h.p. capacity are now being installed. It has been decided to split the driving power up into as small units as possible, the idea being to provide each machine tool with an independent motor for its driving and control. For this purpose over 20 motors, ranging in size from 5 h.p. to 25 h.p., are to be put in. A similar installation is also being put down in the workshops of the Oregon Short-Line Railroad Company at Pocatello, Idaho, where generating plant of about 500 h.p. and 12 motors of from 5 h.p. to 25 h.p. are now being installed. Both installations are being carried out by the Westinghouse Company.

Devonport.—We congratulate Mr. James W. Spark upon his appointment to the position of borough electrical engineer at Devonport. Mr. Spark is the second son of Mr. Alexander Spark, electrical engineer, Aberdeen, and received his early training in his father's workshops. He was subsequently in the employment of the Aberdeen Corporation, and afterwards held an appointment under the Corporation of Leith. The Devonport generating station is a new one, having been in operation for not more than 12 months. In connection with the recent visit of their Majesties the King and Queen a vast amount of temporary illumination was prepared for the occasion under Mr. Spark's supervision. The Town Council have shown their appreciation of his able services generally by promoting him to be head of their electrical undertakings, with a salary commencing at £250 a year.

Dartmouth.—The Urban Electric Light Supply Company have opened business at Dartmouth, in charge of Mr. G. E. Smith, at Lower-street. They are about to erect works on the quarry site at Sandquay, which will be fitted with two Babcock and Wilcox water-tube boilers, and two Belliss-Morcom compound engines, driving two Parker two-pole dynamos. Accumulators will also be provided as a stand-by. The company are prepared to wire houses complete, with all fittings and lamps, free of initial cost to the consumer, charging a small rental for the use of the wires. No guarantee is demanded for a period of supply, and consumers can make a trial for one year without any obligation to continue. The scale of charges will be 7d. and 4d. per unit on the maximum demand system, and the rental 4½d. per lamp per quarter. The supply will probably be ready by August. Messrs. Higgs and Hill have secured the contract for the works, and the work has been started.

Bristol.—The demand for current for power purposes having increased so rapidly, the City Council agreed on Tuesday to put down additional plant immediately, and they recommend that a steam turbo-dynamo of 500 kw. capacity be provided at an estimated cost of £6,300. The salary of Mr. Oliver Wheeler. charge engineer, who has been on probation for six months, at weekly wages, is to be made up to £130 per annum, as from March 13, and further increased to £156, at such time as the committee think fit. The committee have had under consideration the desirability of extending the lighting of the streets by electricity, and they have prepared a scheme for erecting 366 additional arc lamps, partly in the centre of the city and partly as extensions of the existing installations in the main roads leading to the suburbs. The proposed lamps are to be of 1,000 c.p. each, and the price at which the Electrical Committee are prepared to provide, light, and maintain them is £14. 10s. per lamp per annum.

Glasgow.—An agreement has been arrived at between the Tramways and Electricity Committees, under which the latter committee will take of the Tramway Committee's surplus supply a maximum of 50,000 Board of Trade units per annum, while the maximum is 1.800 kw., the supply to be taken for the increased demand during winter afternoons, extending over a period of from a half hour to 2½ hours. The supply is to be taken from Coplawhill sub-station into the St. Andrew's Cross electricity works. The tramway department are to charge 1½d. per unit, plus 5 per cent. per annum upon the capital expenditure necessary for the transference of the power, which may amount to £1,800. The total annual payment is estimated at £1,023, while the Electricity Committee estimate their net saving at £20,000. The agreement is for three years from 31st prox., and thereafter to be terminable on 14 months' notice being given by either committee. It is estimated that the tramways department will not be able to utilise for at least 10 years the power which they are selling to the electricity department.

Hackney.—The Electric Lighting Committee reported to the Borough Council last night upon the advisability of revising the charges for electrical energy, especially with reference to the most profitable classes of consumers, such as public-houses, hotels, railway stations, and recommended that the present system and rates of charges for electrical energy—viz., 4d. per unit for lighting and 2d. per unit for power—be continued, with the provision that a discount of 10 per cent. be allowed on all lighting accounts of £10 per quarter and upwards to theatres, music halls, fully licensed public houses, hotels, railway stations, hospitals and infirmaries, workhouses, churches, and chapels, and subject to the condition that the account be paid within a period of 21 days from the date of same. The committee have considered the Electric Lighting (London) Bill, promoted by the Board of Trade, and see no objection to the proposed Bill. Applications by the National Electric Wiring Company, Limited, for permission to fix various electric lamps to overhang the public footways were granted subject to the usual conditions and during the pleasure of the Council; also an application by Mr. F. W. Walker for permission to retain two lamps overhanging the public footway at 14, The Broadway, London Fields.

Barnsley.—The electricity main in Doncaster-road is to be continued to the Kendray Hospital. During the year £9,747. 17s. 9d. has been spent out of capital on machinery for electricity purposes, leaving yet unexhausted borrowing powers to the extent of £4,536. 19s. 7d., £2,500 of which is reserved for works now in hand. The number of consumers has increased from 209 to 280, and 14 are now waiting to be connected. The number of arc lamps has been increased from 15 to 27, and 41 motors of 191 h.p. are now in use, and eight of 100 h.p. on order. The output also increased very largely—from an equivalent of 14,825 8-c.p to 22,183 8-c.p lamps. The total cost of the works increased by £731. 9s., but savings in other departments amount to £148, which leaves £583. 9s. to be reckoned with as additional cost upon the works over and above the cost of last year. The revenue, however, increased in more than a corresponding degree. The total receipts from the sale of current amounted to £4,460. 14s. 9d., and fittings £149. 6s. 1d., and the year's profit amounted to £2,543. 4s. 3d., or an increase of £292. 8s. 9d. over last year. Bringing forward the balance from last year, £8. 1s. 10d., and setting aside

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£2,397. 0s. 5d. for interest and redemption, there remains a balance of net profit amounting to £154. 5s. 8d., which was to be carried forward. In consequence it has been agreed to reduce the flat rate unit charge from 4½d. to 4d.

Stamford.—Rapid progress has been made in the borough during the past few weeks with the installation of the electric light, which is being carried out by the Urban Electric Supply Company, Limited. This is the first of the Urban Electric Supply Company's stations, and it is stated that the company have succeeded in breaking the record for lamps connected at any of Edmundsons' stations. The previous record was at Newport, Isle of Wight, where the figures were: lamps connected, 2,236; lamps applied for not connected, 629—making a total of 2,865. The figures at Stamford are: lamps connected, 2,258; lamps wired not connected, 513; lamps applied for not wired, 487—making a total of 3,188. In addition to the above there are 200 more lamps in hand, although these have not yet been actually signed for. The Wharf-road works were built by Messrs. Hinson and Co., contractors, of Stamford, and have been fitted with Belliss-Parker sets, Messrs. Charrington's switch, Babcock and Wilcock boilers with superheaters and chain grate stokers, a set of 240 D.P. battery, and a set of accumulators consisting of 240 stalls. The accumulators will maintain 2,700 lamps continually for seven days, and every precaution has been taken whereby any possibility of danger has been reduced to a minimum. Messrs. Callender are laying five miles of cables on the three-wire system. The company wire houses complete with plain fittings and lamps free of all initial cost to the consumer. Mr. W. E. Milnes is the resident engineer, and Mr. R. Hill has charge of the supply department.

Islington.—From the last report of the Electric Lighting Committee, to be submitted to the Borough Council this evening, we note that experiments are being carried out in Offord-road with electric incandescent lamps, five gas lanterns being fitted with lamps and fittings of the Improved Glow Lamp Company, and five others with the Reason Company's fittings. In Aberdeen-park six gas columns are being fitted with Nernst lamps, which the committee believe will be not only more efficient than the ordinary incandescent lamp, but much more effective. Exhaustive trials are being conducted at the works with two entirely new forms of arc lamp, which bid fair to shown an efficiency considerably above any arc lamp now in use. Numerous experiments with enclosed arc lamps and different forms of globes and lamps have been and are from time to time conducted with the object of securing the most efficient and up-to-date appliances and such improvements or modifications of existing lamps as may at small cost be effected. Low-tension distributing mains are to be laid in Sotheby-road at a cost of £124; in Caledonian-road, and Highbury-quadrant and Highbury New-park, at £745; and in Hornsey-road, at £150. It is proposed to raise the salaries of two clerks, and to appoint a new one, commencing at £126. The following resolution will also be submitted: "That in the event of the London County Council sanctioning the borrowing of £10,438 and £4,873 for electric lighting purposes for a period of 42 years, the Islington Borough Council hereby undertake that during the currency of the loans no further loans will be raised to replace any of the plant and machinery, the cost of which is to be defrayed out of such loans, and that any renewals required during the period thereof shall be provided out of a sinking fund to be created for the purpose, or from maintenance account."

Bath.—At the electric light station last week, the Mayor presented 10 members of the staff with honorariums for services rendered during the breakdown in November. The sum of £150 was voted for the purpose, and of this sum Mr. Teague, the electrical engineer, received 50 guineas. The occasion of handing cheques and written letters of thanks to Messrs. F. Teague, F. Hale, A. H. Snewin, A. R. Shapley, T. Cutler, D. T. Miles, C. A. Nethercott, P. R. Morris, W. Tucker, and J. Griffin was made the nucleus of a little ceremony. The Mayor, in a short speech, thanked the staff on behalf of the Council and citizens for having so freely and with such hearty goodwill rendered valuable services when they were in very great difficulties with regard to the electric light at the end of last year. Mr. F. G. Isaacs, in supporting, said he felt there must be some sort of friendly society between the engineer and his staff; not only Mr. Teague could be found working there hour upon hour and day after day, but every member of the staff most honourably supporting him throughout the whole of that trying time. There was not a man who attempted to shirk his duty until the job had been put on a satisfactory footing. Afterwards, Mr. Teague, in proposing the health of the Mayor, hoped such an occasion would never arise again in Bath. It certainly was a bad time for the citizens—possibly worse for the citizens and the Council than for the staff, for they could see daylight through it, and the people outside, who were waiting for the light, would rather have had daylight. If the electric light department of Bath had fair play, the city would yet become proud of it. Mr. Powell, who proposed a vote of thanks to the Mayor for presiding, did not think the new committee had discovered anything they did not know before. The Enquiry Committee had had a laborious duty, and probably nothing but what had been done would have satisfied the citizens. He felt every confidence in Mr. Teague, and when certain facts were known he thought they would hear very little of selling the works except from those who were anxious to buy. We learn that the accounts for the city electric light works for the last year show a profit, after paying sinking fund and interest, and including the extra expenses in connection with the breakdown, of nearly £700. The application to borrow £25,000 for extensions, referred to in our last issue, has now been made.

Photographic and Optical Exhibition.—Various novelties are being shown at the third Photographic and Optical Exhibition, which is now open at the Portman Rooms, Baker-street, Mr. A. C. Brookes being the secretary. Among these we note specially a 16-c.p. electric bichrome lamp made by Messrs. W. Watson and Sons, High Holborn. This lamp consists of two bell glasses, one inside the other, the space between the two being filled with a solution of bichromate containing certain proportions of aniline dyes. It gives a magnificent light, in which ordinary plates can be safely developed. The lamp is well ventilated, and the liquid helps to keep it cool, thereby still further adding to the comfort of the room. The inner glass is weighted down with shot. Another pattern for suspension with 8-c.p. lamp is also shown The Rotary Photographic Company, Limited, New Union-street, Moorfields, E.C., exhibit specimens of rolls of prints made by their special machinery by means of which a million half-plate prints can be obtained by direct contact. This machinery is driven by electricity, and incandescent lamps are employed during the printing process. Serviceable electric lanterns, fitted with Kamm's patent arc lamps and patent rheeostat, are shown by L. Kamm and Co., 27, Powell-street, E.C., who also exhibit accumulators, induction coils, etc., and, as a novelty, the kammatograph, by means of which a series of 350 photographs are taken on one circular plate. The Elgé adjustable rheostat for continuous current, and the Elgé arc lamp for 60 amperes, and other cinematograph specialities are shown by L. Gaumont and Co., 25, Cecil-court, Charing Cross-road, W.C. Messrs. Harry W. Cox, Limited, exhibit the well known X-ray and wireless telegraphic apparatus manufactured by them. The magnificent specialities of Mr. C. P. Goerz, Holborn-circus, London, E.C., form a most important part of the exhibition, the powerful prismatic Trieder binoculars being specially noteworthy. Zimmermann, Schering, Bayer, and Co., and the Berlin Aniline Fabrik (Agfa) are to the fore with a number of new chemicals and plates, and Mr. D. A. Lowthime, Paradise-street, Finsbury, shows an instrument invented by him recently, which is no less than a hand camera for 12 plates which can be loaded and unloaded in daylight. During the course of the exhibition, which attracts a numerous attendance, lecturettes and demonstrations on colour photography, liquid air, X-rays, etc., are given by Dr. W. Hampson, M.A., and Mr. T. C. Hepworth. The Imperial Orchestra also contributes to the entertainment.

PROVISIONAL PATENTS, 1902.

APRIL 7.

8032. Improvements in or connected with incandescent electric lamps. Albert Louis Reinmann, 15, Water-street, Liverpool.

8060. An improved connector for joining electric cables. John Charles Gill, 19, Southampton-buildings, Chancery-lane, London.

8065. A door switch for electric light or gas. Boyd Lakeman Langman, East Meon, Clarence-road, Sidcup, Kent.

8103. Improvements in or relating to electrodes for storage batteries. Max Schneider, 111, Hatton-garden, London.

8112. Improvements in electrical indicating and controlling mechanism. The Honourable Reginald Thomas Dudley Brougham, 24, Southampton-buildings, Chancery-lane, London.

8121. Improvements in or relating to electric lighting of railway or other vehicles. Max Büttner, 46, Lincoln's-inn-fields, London.

APRIL 8.

8126. Improved service box and cable connection. Charles Hellyer Pearson, 46, Upper Jackson-street, Hulme, Manchester.

8136. Improvements in connection with fittings for the overhead trolley wires of electric tramcars. George Hill, 17, St. Ann's-square, Manchester.

8172. Improvements in and relating to apparatus for the production of electrical oscillations of requisite amplitude and frequency. Horace Manders and Alexander William Sharman, 9, Bentinck-street, Cavendish-square, London.

8178. Improvements in switching apparatus for electric circuits. Joseph Devonport Finney Andrews and Electrical Productions, Limited, 61, Carey-street, Lincoln's-inn, London.

8181. Improvements in and relating to devices for controlling polyphase and alternating current motors. William Spielter and Fritz Dunker, 36, Chancery-lane, London.

8188. Improvements in or connected with the controlling of electromotors. Percy Coote, Norfolk House, Norfolk-street, Strand, London.

8189. Improvements in electric circuit regulating devices. George Philip McDonnell, 55, Chancery-lane, London. (Complete specification.)

8190. Improvements in controlling means for electric motors the invention being applicable to electric elevators. Otis Elevator Company, Limited, 55, Chancery-lane, London. (Otis Elevator Company Incorporated, United States.) (Complete specification.)

8202. Improvements in Rontgen-ray apparatus and in interrupters applicable for use in connection therewith, or for other purposes. James Mackenzie Davidson, 323, High Holborn, London.

8217. Improvements in safety cut-outs for trolley lines and other wires carrying strong electric currents. Owen Thomas Griffith and Thomas Henry Kerr, 6, Lord-street, Liverpool.

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APRIL 9.

8281. Improvements in or relating to spring jacks for use in telegraph, telephone, or the like circuits. The Telegraph Manufacturing Company, Limited, and William Bartlett, 111, Hatton-garden, London.

8288. Improvements in and relating to the electrical smelting of ores and the refining of metals, and to furnaces therefor. Ernesto Stassano, 139, Queen Victoria-street, London. (Complete specification.)

8308. Improvements in electric light cure arc lamps for the treatment of skin and other diseases. Robert Otto, 40, Chancery-lane, London. (Complete specification.)

APRIL 10.

8315. The Mec. electric coupling (for table decorations). Ernest M. Chapman, 21, Palace-street, Buckingham-gate, London.

8323. Improvements connected with up and down swinging brackets, arms, rods, holders, carriers, and such like, particularly applicable for gas, oil, and electric light fittings, and for displaying articles in windows. Edmund Townshend, 11, Burlington-chambers, New-street, Birmingham.

8334. Improvements relating to the regulation of electric arc lamps. Maximillian J. L. Weston, 34, Castle-street, Liverpool. (Albert de Puydt, Belgium.)

8337. An improved shadeholder for use in connection with incandescent electric lamps. Joseph Edward Smith, 62, Market-street, Manchester.

8338. A new or improved switch for use in electric incandescent lighting. Joseph Edward Smith, 62, Market-street, Manchester.

8339. Improvements in or in connection with incandescent electric lighting. Joseph Edward Smith, 62, Market-street, Manchester.

8340. Improvements in or in connection with incandescent electric lighting and electric call bells. Joseph Edward Smith, 62, Market-street, Manchester.

8341. Improvements in or in connection with means for connecting incandescent electric lamps with dry batteries. Joseph Edward Smith, 62, Market-street, Manchester.

8345. An improved electric hand lamp for use in coal mines and the like. Frederick James Turquand and John Frederick Wakelin, 5, Tottenham-street, Tottenham Court-road, London.

8347. An electrical time recorder for checking workmen and the like. Alfred Beasley and Harry Hughes Harrison, 20, Bulmer-street, Shepherd's Bush, London.

8362. Apparatus for transmitting synchronous and equal movements to a distance. Siemens Bros and Co., Limited, and Francis Hird, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

8367. Improvements relating to apparatus for electrically heating sealing-wax or the like. Hugo Halberger, 45, Southampton-buildings, Chancery-lane, London.

8389. Improvements in electric clock winding mechanism. Albert Tuerk, 18, Buckingham-street, Strand, London. (Complete specification.)

8396. Improvements in troughs or conduits, more especially intended for underground electric cables. Thomas Easton Devonshire, 47, Lincoln's-inn-fields, London.

APRIL 11.

8414. An improvement in or relating to holders for incandescent electric lamps. John Oliver, Lloyd's Bank-buildings, Bristol.

8441. An improved combined magneto bell and indicator. August Eckstein and Arthur Brooker, Peel Works, Adelphi, Salford, Manchester.

8456. Improvements in or relating to electric ignition devices for gas or oil motors. Frank Bryan and Abel Henry Bayley, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

8484. Improvements in apparatus for multiplex telegraphy. Henry Schmitt, 72, Cannon-street, London.

8486. Improved means for operating the carriages and controlling mechanism of same of electric telegraphic and similar printing machines. Philip Middleton Justice, 55, Chancery-lane, London. (The Rowland Telegraphic Company, United States.) (Complete specification.)

8487. Improvements in transmitting devices for electric telegraphic and like apparatus. Philip Middleton Justice, 55, Chancery-lane, London. (The Rowland Telegraphic Company, United States.) (Complete specification.)

8486. Improved method of and means for producing synchronous motion. Philip Middleton Justice, 55, Chancery-lane, London. (The Rowland Telegraphic Company, United States.) (Complete specification.)

8503. Improvements in and relating to electrical measuring instruments. Claude William Atkinson, 1, Queen Victoria-street, London.

APRIL 12.

8520. Improvements in converting electric currents. Granville Hugh Baillie, 82, Victoria-street, Westminster, London.

8543. Improvements in electric switch fuses. Herbert Henry Berry, Philip F. W. Simon, and Ernest Skinner, 78, Upper Thames-street, London.

8550. A water-power valve governed by electricity, water, or by hand. William Toothill, 26, Higher-croft, Barton-on-Irwell, Lancashire.

8557. Improvements in electric motor control systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (John B. Linn, United States.) Complete specification.)

8558. Improvements in electric motor control systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (John B. Linn, United States.) Complete specification.)

8566. Improvements relating to wireless telegraphy. John Nevil Maskelyne, jun., 6, Breams-buildings, Chancery-lane, London.

8577. An improvement in carbon commutator brushes. Siemens Bros. and Co., Limited, Charles Rodgers, and William Parker, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

8583. Improvements in pincers particularly adapted for the use of electricians. Reginald Haddan, 18, Buckingham-street, Strand, London. (Bergmann Elektricitäts-Werke Aktien-Gesellschaft, Germany.) (Complete specification.)

8592. Improvements in the construction of secondary batteries. Frederick How Hadfield, Clun House, Surrey-street, Strand, London.

8596. Improvements in rails for electric railways and tramways. Leopold Paul Stark, 226, High Holborn, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published May 1.

1901.

7553. Electric alternate-current motors. Thompson.

7958. Means for working or controlling semaphore or other signalling or indicating apparatus in connection with electric tramway systems, also applicable for other purposes. Wilkinson.

8110. Means for raising, lowering, and supporting arc lamps, and for electrically connecting them with the mains. Harrison.

9080. Controlling of the working of railway signals and points by electricity. Timmis.

9740. Celling switch. Reckenzaun.

11237. Electric arc lamps. Società Generale Italiana Edison di Elettricità. (Date applied for under International Convention, Nov. 26, 1900.)

11676. Rheostat elements or resistance boxes. Perkins. (Date applied for under International Convention, Nov. 9, 1900.)

11677. Protecting devices for the coils of electrical apparatus. Thomas. (Date applied for under International Convention, Nov. 9, 1900.)

11709. Construction of contact maker or current conductor for electric motors. Allcroft.

15689. Electric incandescence lampholders and switches therefor. Quain.

18569. Incandescence electric lamps. Quain.

23380. Electric fans. British Thomson-Houston Company, Limited. (Wood.)

24805. Electrical measuring instruments. British Thomson-Houston Company, Limited. (Read.)

24810. Charging stations for electrically-propelled vehicles. British Thomson-Houston Company, Limited. (Holmes and Cox.)

24812. Means for signalling between drivers on electrically-propelled railway trains. British Thomson-Houston Company, Limited. (Potter.)

25218. Resistance coils. Johnson. (Electric Controller and Supply Company.)

25390. Electric rheostats. British Thomson-Houston Company, Limited. (Mackintosh.)

25941. Tripping electric circuit breakers or cut-outs. British Thomson-Houston Company, Limited. (Hilliard.)

25943. Electric railway systems on a sectional conductor system. British Thomson-Houston Company, Limited. (Potter.)

26135. Means for starting alternating-current dynamo-electric machines. British Thomson-Houston Company, Limited. (Woodbridge.)

26138. Electric railways on a sectional conductor block system. British Thomson-Houston Company, Limited. (Potter.)

26348. Starting alternate electric current machines. British Thomson-Houston Company, Limited. (Woodbridge.)

26691. Electric circuit controllers. British Thomson-Houston Company, Limited. (Hewlett.)

26692. Electric current-controlling devices. British Thomson-Houston Company, Limited. (Knox.)

1902.

1028. Sectional conductor systems of electric railways. Farnham.

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4273. Automatic electric fire-alarms. Offenbroich and Mafell.

4374. Electric arc lamps. Rignon and Eisenmann.

4729. Electric incandescence lampholders. Knowles.

5366. Electric accumulators. Méran.

5802. Electrical safety-fuse appliance. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.

5862. Rheostats. Lundie. (Date applied for under International Convention, Aug. 15, 1901.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	Apr. 12	569	635	- 66	31,950	29,919
Birmingham Tramways	—	—	—	—	—	—
Blackburn Corporation	,, 11	609	921	- 312	9,318	8,009
Blackpool Corporation	Mar. 29	415	147	+ 268	2,351	1,883
Blackpool-Fleetwood Tramways	Apr. 12	254	706	- 452	3,323	2,973
Bolton Corporation	,, 13	1,462	1,471	- 9	19,632	18,106
Bradford Corporation	Mar. 28	1,937	500	+ 1,407	24,275	9,668
Bristol Tramways Company	Apr. 11	4,042	5,050	- 1,008	—	—
Carlisle Tramways Company	Mar. 15	122	123	- 1	1,282	1,192
Central London Railway	Apr. 12	6,720	6,652	+ 68	99,196	91,541
City and South London Railway	,, 13	2,931	1,953	+ 978	44,733	30,190
Cork E. T. and L. Company	,, 10	419	438	- 18	5,254	5,059
Darwen Corporation	Mar. 22	169	154	+ 15	1,951	1,844
Darwen-Hoddlesden	,, 14	26	—	—	—	—
Dover Corporation	Apr. 12	175	252	- 77	2,611	2,472
Dublin & Lucan Electric Railway	,, 13	96	158	- 62	1,339	1,192
Dublin U. T., electric cars	,, 11	3,484	3,824	- 340	—	—
Dublin S. District, Electric	,, 11	760	1,213	- 453	—	—
Dundee Tramways Company	,, 9	654	619	+ 35	—	—
Glasgow Corporation	,, 12	10,995	8,790	+ 2,205	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 12	1,572	1,739	- 167	3,328	3,463
Liverpool Corporation	,, 5	9,841	8,605	+ 1,236	123,914	110,339
Liverpool Overhead Railway	,, 13	1,507	1,871	- 364	20,996	22,684
Newcastle-on-Tyne Corporation	,, 12	1,958	—	—	—	—
Portsmouth Corporation	,, 12	1,252	738	+ 514	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 12	3,521	—	—	—	—
Southampton Corporation	Mar. 27	775	537	+ 238	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £552 decrease.

Barcelona Ensanche y Gracia, £47 decrease. Barcelona, £256 increase.

Brisbane, £402 increase (month of March, £10,934; increase, £1,789).

Buenos Ayres and Belgrano Electric (month of March, receipts £12,184; decrease £647), £75 decrease.

Calcutta, £20 decrease.

Cape Town (month of March), receipts, £17,888; expenditure, £7,343.

La Capital Traction and Electric, Buenos Ayres (month of Dec.), £1,394 increase.

Mexico Electric (month of March), receipts, £19,000; expenditure, £10,500.

Perth Electric, £141 increase.

Port Elizabeth (month of March), receipts, £3,818; expenditure, £1,947.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Tramways.—	£	£
Anglo-Argentine, 1-260,007	5	3⅝-4⅛
—— Permanent 6 per cent. Debenture Stock, 1888	100	124-127
Blackpool and Fleetwood Tramroad	10	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	2⅞-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¾-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	6¾-7¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	9¼-9⅝
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	102-104 p.c xd
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	13¼-14½
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12¼-12⅝
—— 5 per cent. Perpetual Debenture Stock	100	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1⅝-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	5¼-5⅜
—— 5 per cent. Deb. Stock, Red.	100	103-106
—— Prov. Cert., all paid	100	97-100
Cape Electric Tramways, Nos. 1-400,000	1	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	5-5¼ xd
—— 4 per cent. 1st Mortgage Debentures	100	101-104 xd
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	11½-12½
—— 6 per cent. Pref., Nos. within 1-60,000	10	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	96-99
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14½-15½
—— 4½ per cent. Deb. Stock	100	112-114
Kidderminster and District Lighting and Traction, Pref.	5	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100	102-104
New General Traction, Ordinary	5	2½-3½
—— 6 per cent. Cum. Pref.	10	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10	10½-10¾
—— 5 per cent. Cum. Pref.	10	11¼-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	99-102
Potteries Electric Traction, Ordinary, 26,667-40,000	10	9¼-10½
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	106-109
South Lancashire Electric Traction and Power Company—		
—— £220,000 Ordinary	1	1
—— £91,132 6 per cent. Preference	10s.	¼
—— £50,000 ,, ,,	1	1
—— £500,000 4½ per cent. Debenture Stock	50 p.c.	50 p.c.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	½-⅝
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1	⅛-⅜
—— Ordinary, 1-125,000	1	⅜-⅝
British Insulated Wire, Ord., 1-70,000	5	9-10
—— 6 per cent. Cum. Pref., 1-40,000	5	5¾-6¼
—— 5 per cent. Mortgage Debentures	100	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	5¾-6
Brush Electrical Engineering, Ordinary	2	½-1
—— Nos. 90,001-105,731	2	½-1
—— Non. Cum., 6 per cent. Pref.	2	1¼-2
—— 4½ per cent. Debenture Stock	100	101-104
—— 4½ per cent. 2nd Debenture Stock	100	97-100
Callender's Cable, Debentures	100	111-115
—— Ordinary	5	17-18
—— 5 per cent. Pref.	5	5¼-6
Crompton and Co.	3	3-3¼
—— 5 per cent. Debentures	—	100-105 p.c
Edison and Swan United, Ordinary	3	⅛-⅜
—— 5 per cent. Debentures	5	2-3
—— 4 per cent. Deb. Stock, Red.	100	78-83
—— 5 per cent. Second Deb. Stk. Prov. Crts.	—	82-87
Electric Construction, Limited, Nos. 1 to 112,100	2	1-1¼
—— 7 per cent. Cumulative Pref.	2	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	97-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	98-101
W. T. Henley's Telegraph Works, Ordinary	5	17-18
—— 4½ per cent. Preference	5	5¼-6
—— 4½ per cent. Debentures	100	111-115
India Rubber, Gutta Percha, and Telegraph Works	10	21-22
—— 4 per cent. Debentures	100	99-102
Parker, Thos., Limited, Ordinary	10	15¼-16½
Telegraph Construction and Maintenance	12	34-37
—— 5 per cent. Bonds	100	102-105
Telegraph Manufacturing, Ordinary	5	10¼-11¼
—— 5 per cent. Cum. Pref.	5	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5	8½-9½ xd
—— 6 per cent. Cum. Pref., 30,001-60,000	5	6¼-6¾ xd
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	105-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1	⅜-⅝
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	100-104
Bournemouth and Poole, Ordinary	10	11-12
—— 4½ per cent. Cum. Pref.	10	9¼-10¼
—— Debenture Stock, Red.	100	103-106
Brompton and Kensington, Ordinary	5	9-9½
—— 7 per cent. Preference	5	9-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	8¼-9½
—— Nos. 20,001-30,000	5	8-9
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14¼ xd
—— ,, ,, ,, £10 Ord.	6	10¾ xd
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	106-108
Charing Cross and Strand	5	9-10
—— 4½ per cent. Cum. Pref.	5	5¼-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	105-107
Chelsea Electricity Supply	5	5¼-5⅜
—— 40,501-50,936	5	5-5¼
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	8-9
—— 6 per cent. Cumulative Pref.	10	12-13
—— 5 per cent. Debenture Stock	100	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	103-106
County of London and Brush Provincial, Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	6¼-6⅜
—— 6 per cent. Cum. Pref.	5	6-6¼
—— 4½ per cent. First Mort. Deb.	100	106-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	4-4½
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	5¾-6¼ xd
—— 4½ per cent. First Deb. Stock, Red.	100	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	10-11
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	103-106
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9¾-10¼
London Electric, Ordinary	3	1¼-2
—— 6 per cent. Pref.	5	4¼-4¾ xd
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	95-100
Metropolitan, Ordinary	10	14¼-15½
—— 4½ per cent. First Mortgage Debenture Stock	100	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9¼
—— Preference	4	6¼-6¾
Notting Hill Electric Lighting	10	14-15
Oriental, 1879	1	1¼-1⅜
—— £5 Shares	5	7¼-8
—— £4½ Shares, New	4½	6¾-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6
—— 4 per cent. Debenture Stock	100	98-101
River Plate Electric Light and Traction, Deb.	100	65-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	1¾-2¼
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	2¼-2¾
St. James's and Pall Mall, Ordinary, 101-20,080	5	14¼-15½
—— 7 per cent. Pref.	5	8-9
—— 3½ per cent. Deb.	100	98-101
Westminster, Ordinary	5	11¼-12¼
Electric Railways.—		
Central London, Ordinary	100	103-106
—— 4 per cent. Pref.	100	103-106
—— ,, ,, deferred	100	99-102
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	116-118
City and South London, Consolidated Ordinary	100	65-68
—— Ordinary	10	—
—— Nos. 60,001-70,000	10	—
—— 4 per cent. Debenture Stock	100	112-116
—— 5 per cent. Pref. Stock '91	100	128-133
—— ,, ,, '96	100	123-126
Liverpool Overhead, 5 per cent. Pref.	—	13-13¼
—— Ordinary, 1-50,000	—	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	91-94
Telephones.—		
National Telephone, Preferred	100	95-99
—— Deferred Stock	100	58-62
—— 6 per cent. Cum. First Pref.	10	13-15
—— Preferred, 590,001-790,000	3½	3⅛-3⅜
—— 6 per cent. Cum. Second Pref.	10	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	4⅞-5¼
—— 4 per cent. Deb. Stock, Red.	100	93-96
—— 3½ per cent. Deb. Stock, Red.	100	101-105
Oriental Telephone and Electric Company	1	¾-1

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NOTES.

Institution Meeting.—An extra meeting of the members of the Institution of Electrical Engineers will be held in the rooms of the Institution of Civil Engineers at 8 p.m. on Thursday, May 1, when Mr. S. G. Brown's paper on "Automatic Rely Translation for Long Submarine Cables" will be read, and a demonstration of the working of the author's apparatus will be given.

Franklin Institute.—The current number of the *Journal* of the Franklin Institute has just reached us. In it are given two interesting papers which were read before the Electrical Section of the institute this session under the following titles: "Parallel Operations of Alternators," by Mr. Paul M. Lincoln, and "Electro-Chemical Polarisation," by Mr. C. J. Reed. Two papers from the Physical Section also appear in this issue—viz., on "The Harmonic Curves known as Lessagous Figures," by Mr. H. C. Richards, and "The Mechanism and Causation of Hot Waves," by Mr. H. M. Watts.

Military Experiments in Wireless Telegraphy.—Some extensive experiments are at present being made in wireless telegraphy on the Marconi system by the Royal Engineers around Chatham. A permanent station has been set up at St. Mary's Barracks, Chatham, from which it is sought to maintain communication with a body of troops detailed to represent a moving column in the field. So far wireless connections have been successfully established with the Chatham station by the moving column from Darland, Maidstone, and Farningham, which places are all within a radius of 10 miles of the centre of operations.

Perpetual Motion.—We have received this week a circular from Ireland from another engineer who has solved the perpetual motion question, and is now able to get ample power from gravity to work steamships, stationary engines, etc. The inventor in question is inclined to give his discovery to the world, as he does not propose to patent the arrangement he has devised. Curiously enough, however, he requires financial assistance from individuals or a syndicate to prove the truth of his statements. We do not propose to give his name, and we trust that he will not find anyone foolish enough to waste money in the way he suggests.

Speech by Telephone.—A New York correspondent calls attention to a unique performance of the long-distance telephone recently, when speeches were received by telephone from Chicago—over a thousand miles away—during the progress of a dinner in honour of the founder of the Page-Davis College. Each of the guests was supplied with a small telephone receiver, and speeches were delivered from Chicago by Mr. Samuel Davis and Mr. T. Le Quatte, which were distinctly heard by those in the New York hotel and enthusiastically applauded. The applause, it is even said, was audible to the speakers at the Chicago end of the line. The previous longest-distance speech by telephone was delivered by Mr. Depew to the New York Chamber of Commerce last year from Washington to New York.

A Horizontal Telephone Switchboard. — The telephone exchange at Hamburg, one of the largest in Germany, is equipped with a horizontal switchboard, which is said to have many advantages over the ordinary upright type. The principal advantage claimed for it is an economy in the number of jacks required and the length of board, and consequently in the space occupied. As the sections are horizontal instead of vertical, operators can work from both sides of the board, and, theoretically at least, each section can carry twice the number of answering jacks that a vertical board can. It follows, therefore, that for a given number of lines a horizontal board is only half as long as a vertical board, although it must occupy more ground space breadthways. These horizontal boards are made by a German firm, who have supplied a large number for the Imperial German Telephone Department. It will be remembered that the Glasgow municipal board is of this horizontal type.

Royal Meteorological Society.—At the meeting of this society held on Wednesday evening, the 16th inst., at the Institution of Civil Engineers, Mr. W. H. Dines, the president, in the chair, Captain D. Wilson Barker delivered a lecture on "Clouds." After some remarks on the composition and the height of the atmosphere, the lecturer said that clouds are formed by one of two causes—viz. (1) the mixing of two masses of moist air of unequal temperatures; or (2) through changes occurring in the atmosphere, where expansion and consequent loss of heat take place, causing condensation of moisture. A simple primary classification is best arrived at by a two-fold division of cloud types—viz. (1) "stratus" or sheet clouds, and (2) "cumulus" or heap clouds. The former may be roughly considered the cloud of a settled and the latter of an unsettled state of the atmosphere. He showed by means of lantern slides a number of cloud pictures illustrating certain varieties of both main types. In conclusion, Captain Wilson Barker referred to various optical phenomena associated with clouds, such as coronæ halos, sun pillars, rainbows, and also the colour of the sky.

Incandescent Lights.—In an article on this subject in a recent number of *Der Gastechniker*, Mr. G. Rothgiesser mentions that electrical vibrations exercise a favourable influence upon the mixing of gas and air in the incandescent burner. The same is the case with sound vibrations, which bring about a considerable increase in the illumination of a burner in which the gas supply is in excess. It is conceivable, therefore, that it might be advantageous to construct burners with some arrangement for producing artificial vibrations. In the same manner that electrical vibrations affect the thoroughness with which the gas and air mix, the light waves, the author thinks, also may act. This action, perhaps, may afford an explanation of that capriciousness in illuminating power of the incandescent gaslight which has hitherto not been accounted for. Great differences in the illumination given off by an incandescent gaslight are likely to be obtained according to whether there are or are not sound vibrations permeating the room, and it follows that the reflected light and the temperature of the apartment in which photometric tests are made must be taken into consideration in future.

Electrolytic Reduction of Lead.—The electrolytic process now in operation at Niagara Falls for the reduction of lead was described by the inventor, Mr. P. G Salom, before the recently-organised American Electro-Chemical Society at the beginning of the month. The principle of the process would seem to lie in the use of lead sulphide as cathode in an acid solution, the hydrogen cation forming with the sulphur gaseous hydrogen sulphide, and thus reducing the lead sulphide to lead in spongy form. This form and construction of the cells used were described by the author, and the difficulties discussed which had been encountered. The principal difficulty was that the reduction was not complete, and the degree to which the ores are reduced varies without apparent reasons. It was stated that at present 92 to 95 per cent. of the sulphide is reduced. Another difficulty is that the workmen's eyes are affected in the operation of the process. Two pounds of lead are

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produced per horse-power hour, 48 cells in series being electrolysed at 130 volts. Specimens were shown of spongy lead, compressed sponge, litharge, and other materials made by Mr. Salom's company. Owing to the spongy form, the material is very readily transformed into litharge.

Crystal Palace Engineering School.—The Wilson premium for the best paper read before the Crystal Palace Engineering Society during the present session has been awarded by the council to Mr. G. de Havilland for his paper on "Motorcars." The premium was presented to the successful student by the Hon. Sir John Cockburn, K.C.M.G., late Agent-General for South Australia, who presided, on the occasion of the eighty-eighth distribution of certificates at the school on the 18th inst. The Chairman remarked that the results of the recent examinations showed a high average of merit on the part of the students. In no school that he had had the pleasure of examining had he seen better facilities for combining practice with theory than were to be found in the engineering school of the Crystal Palace. The students had no difficulty in obtaining employment when they entered on the business of life, and many of the former students were doing important work abroad, and reflecting credit on the institution in which they had acquired knowledge and efficiency in their profession. He wished them every success in their future life. The principal, Mr. Wilson, afterwards addressed the meeting, and read a long list of the names of students who were distinguishing themselves both in this and in other countries.

The Midlands' World's Fair.—The Wolverhampton Art and Industrial Exhibition, to be opened by his Royal Highness the Duke of Connaught on Thursday next week, will provide a unique feature in the history of the Black Country. Mr. C. Imre Kiralfy, the director of the enterprise, is well known to the general public as the promoter of similar places of amusement and instruction at Olympia and Earl's Court in London, and he has provided a new set of attractions in the Midlands, such as will doubtless make the exhibition a success. Electricity will, of course, be large employed for illuminating purposes. For instance, the new spiral toboggan—an ingenious network of machinery which in a space of two minutes brings the passenger in circles upwards till a height of 100ft. above ground is attained—will be illuminated by 40,000 c.p. of electric lamps. Again, the electrical illumination will be a strong feature of the Canadian water chute, which is equipped with some 73 500-c.p. Twentieth Century lamps, and will presumably present a very brilliant spectacle at night time. On the "Fairy River"—another special attraction of the exhibition—some 50,000 c.p. will be used for illumination purposes, and by the aid of reflectors the lights will be multiplied many times. "The Hall of Mirrors" is also to be lit by electricity up to 39,000 c.p., the new Twentieth Century golden lamps being used. Electricity as a lighting agent will thus be in great demand at Wolverhampton this year. The exhibition will remain open during the summer months.

Railways in India.—The speech of the evening at the anniversary dinner of the Institution of Mechanical Engineers, at the Hotel Cecil on Thursday last week, was delivered by Lord George Hamilton, the Secretary of State for India, who confined his remarks almost exclusively to the railway interest in that country. This, he said, was one special branch of engineering that was capable, in India at least, of unlimited development. Railways in that portion of the Empire were now beginning to be remunerative, and he believed that in the future they would be a certain source of revenue. His great desire was that all orders for material in connection with the Indian railways should be placed within the limits of the British Empire, and he regretted that in the last two or three years some orders for locomotives in particular had gone abroad. It was also to be regretted that British manufacturers should not be so able as their rivals to comply with the terms as to time, and he advocated the adoption of some measure of standardisation as had been done in the United States. To that end, he announced he had called a conference in Calcutta. In closing his remarks Lord George Hamilton expressed his profound belief that the British engineer could hold his own with all rivals under adequate conditions, and if the State and the profession combined their best efforts, he maintained that this could be done. The dinner, which was attended by over 200 members and guests, passed off very successfully. Mr. Wm. H. Law, the president of the institution, occupied the chair.

A Tide Indicator.—The system employed for recording and indicating the fluctuations of the tide by the United States Government is described by Mr. D. A. Willey in the current number of the *Scientific American*. There is first what is termed the harbour indicator, which has a large semi-circle indicator board painted white, and faces up stream. The inner edge of the board is divided into spaces by heavy black lines, representing feet and half-feet. The longer of these division lines are numbered by figures in black. Turning about the centre of the board is a pointer, actuated by the rise and fall of the tide, which indicates at any moment the number of feet of water above or below the plane of reference (mean low water), to which soundings on the chart are reduced. The navigator coming into the harbour or waiting to go out to sea is thus able to tell at a glance the height of the tide, the indicator board being quite legible at the distance of a mile with the aid of an ordinary marine glass. There is also another form of tide indicator and recorder known as the inland indicator. This apparatus is installed at inland points, and is connected with the seaboard or harbour indicator by electric wires. The arrangement is such that the rise and fall of the water-level is utilised to complete electrical circuits, which, through the intervention of electricmagnets, communicate the motion to the indicator arm, by which the required information concerning the height and character of the tide is made known to the public. Another device is also in use which predicts the fluctuations of the tide, but a description of this is reserved by the writer for another article.

Electricity in Paris.—The last few years have witnessed a great increase in the demand for electrical energy in Paris, as recent statistics show. Thus, the number of consumers on the six electrical companies whose circuits supply the city has increased from 15,956 in 1898, to 23,649 at the end of 1900. Correspondingly, the supply of energy through the mains, expressed in kilowatt-hours, has gone up from 13,553,000 to 23,276,000, while the total price realised has increased from £553,000 in 1898 to £840,000 in 1900. The average price per kilowatt-hour in the former year was 8d., as compared with 5½d. in the latter year, so that this increase is all the more remarkable. The concessions granted to the supply companies in question by the Municipal Council were for 18 years, and some of them expire in a few years. Notwithstanding the short duration of the concessions, large outlays have been made by the undertakings in maintaining their plant in an efficient state. We have already described in these columns the new plant which the Edison Continental Company have laid down at St. Denis, in the suburbs of Paris, which has a capacity of 2,000 kw. This is to be increased to 4,000 kw. before next October. One of the most important of the city

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systems is that of the Société de la Place Clichy, which receives three-phase current from a generating plant at Asnierès, the latter being operated by the Société Le Triphasé. The sub-station in the city of Paris receives the three-phase current at 5,500 volts and 25 cycles, and it is there lowered by step-down transformers to 390 volts. Part of the current is transformed to continuous current by a set of eight-pole rotary converters, and the rest by a set of motor-generators, in which non-synchronous, three-phase motors are direct-coupled to eight-pole 400-kw. generators giving 440 volts. All these machines have been working successfully for some time.

British Electric Superannuation Fund.—We have received from Mr. W. G. Bond, the secretary of the above fund, a report of the first annual meeting of the subscribers, together with a pamphlet describing its objects and the annual balance-sheet. From these we gather that the fund was established on July 1, 1900, by the British Electric Traction Company, and that it was primarily intended for the employés of that company and of the many subsidiary undertakings connected with it. The working arrangement may be briefly summed up as follows: On a member of the staff joining the fund he has to make a regular contribution out of his monthly salary, which varies from 2½ per cent. for a young man under 25 years of age up to 8 per cent. for an employé aged 45. Besides this contribution the companies associated with the fund also pay a percentage on the salaries of their employés which is equal to 3 per cent. on the same. The benefits conferred by these contributions are two. The first is that on superannuation at the age of 60, or on retirement through ill-health, the contributor receives from the fund an annuity equal to as many fiftieths of his average salary for the last seven years as he has been a member. The maximum annuity is two-thirds of full pay. The second advantage is that if a contributor should leave the service of the company associated with the fund, or should be dismissed, he can at once withdraw the whole of the amounts which he has paid in, but without profits. It seems to us that the fund has many good points about it, but we see that it is compulsory on all members of the staff, with few exceptions, and there may be cases in which it may not be equitable. Such a case would be a man suffering from a fatal disease, and leaving the company in consequence. He would obviously have made a better provision for his family if he had insured with an ordinary insurance company on the limited payment system.

Electric Traction.—On Tuesday, the 15th inst., Mr. Philip Dawson read, by request, a paper on the above subject before the Gloucestershire Engineering Society at the Municipal School, Gloucester. Mr. Hamilton Kilgour, borough electrical engineer of Cheltenham, and the president of the society, was in the chair. The paper dealt with a broad aspect of the subject, showing that England, although at one time behind the time, had in recent years made very good progress. There were, said the author, 1,252 miles of electric tramways and railways in operation and 846 in construction, and 1,348 miles of new lines had been authorised. The total capital invested at the end of last year was approximately £51,000,000, while the amount invested in power distribution schemes was not far from £20,000,000. Comparing Greater New York with Greater London, the former was far ahead as regards traction facilities. New York with a smaller population had nearly three times as much power installed for traction and power purposes. Mr. Dawson then briefly described the chief systems on which electric tramways were operated—viz., the overhead, conduit, and surface-contact systems—pointing out the advantages and disadvantages of each, and the different conditions under which they should be used. He also described the various systems of continuous and polyphase power stations, and examined the conditions that governed the choice of system. In conclusion, the author made some remarks on long-distance lines, and stated that he was of opinion that until it could be satisfactorily shown that electricity would reduce the working expenses and increase the receipts, it was certain that none of the large railway companies would adopt it for long-distance travelling, and that at the present moment traction engineers were not prepared to equip long-distance lines. The matter was quite different as regards urban and suburban lines which required immediate attention; here the traffic was ready made, and could only be satisfactorily dealt with by means of electrical haulage. The lecture was illustrated by numerous lantern slides and samples which had been kindly lent by manufacturers. A discussion afterwards took place, in which a large number of the members participated. In conclusion, Mr. Dawson was accorded a vote of thanks for his interesting paper.

Amalgamation of Tube Interests. — Another important fusion of "tube" interests has been brought to light by the proceedings of the Select Committee of the House of Lords enquiring into the various proposals for providing underground communication in London. This new amalgamation is between the promoters of the Piccadilly and City Railway (who are also the promoters of the North-East London Railway) and the promoters of the London United Electric group, which provides for both tubes and new tramways in the west of London. Should the proposals embodied in these schemes be authorised, the tube lines will give a continuous communication from New Southgate, Edmonton, and Tottenham in the extreme north to the Mansion House in the City; thence—by the North-Eastern London Railway—along Fleet-street and the Strand, by Charing Cross and Piccadilly, to Hyde Park-corner (the Piccadilly and City Railway). From this point, in accordance with the plans of the London United Electric Railway Company, the tubes will continue to Hammersmith and Shepherd's Bush, and so form a connection with the electric tramway system in West London. There is also in contemplation by the same promoters the construction of a cross-tube from the Marble Arch to Clapham Common by way of Sloane-square and Battersea Park. This proposed joining up of the tubes with the electric tramways, it will be noticed, is in strict accord with the first recommendation of the Joint Committee of last year, to the effect that the future requirements of the population would best be dealt with by means of underground railways in London and its immediate suburbs, from the termini of which passengers could proceed further afield by electric tramways. The committee especially favoured one through line from Hammersmith, along Piccadilly to Piccadilly-circus and the City, and this, it will be seen, is met by the amalgamation of the above interests. In view of the rival schemes for providing exactly the same facilities between Piccadilly and Hammersmith as those proposed above, there is considerable doubt as to what the decision of the Lords Committee now sitting will be. It may, however, be some considerable time before the decision is given, owing to the arrangement come to that all the rival proposals shall be enquired into before the committee deliberates.

Cost of Light.—Of the making of comparisons of the cost of illumination from various sources of light there is no end, and every experimenter assumes new conditions which are more or less applicable in a general way. Hence

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the conclusions to be drawn from tables of costs are not reliable unless other matters are borne in mind at the same time. We forget how many times cheaper than electric light the most enterprising gas experts work out their favourite system of gas illumination to be, but it is in the ratio of 1 to 10. One would expect to find from this that all electric light stations are fighting against diminishing load, and were in an exceedingly bad way. The reverse, however, is absolutely the case, and we are repeatedly hearing of cases where new consumers cannot be connected until more plant is ready for operation. It may be interesting to glance through the following figures, which have been obtained in Germany by Prof. Lummer, and brought before an electrical society in that country. We have converted the comparative figures to English candle-power, and the costs are given for one hour. With incandescent gas, and gas costing 3s. 8d. per 1,000 cubic feet, the cost per candle-power hour is 0·00355d. With incandescent oil with petroleum at 1d. a pound, the cost is 0·0041d. With the Bremer arc lamp, with electricity at 6d. per Board of Trade unit, the cost varies from 0·0026d. to 0·0041d. With the ordinary arc lamp without a globe, the candle-power hour costs 0·0068d., and with a globe the cost is 0·0136d. With the ordinary incandescent lamp with a carbon filament, the candle-power hour costs from 0·019d. to 0·026d.; while the ordinary gas burner, with gas at the above-mentioned price, gives one candle-power hour for 0·0284d. It will be seen from these figures that Prof. Lummer finds the Bremer arc lamps the cheapest source of light, although he assumes his electrical energy to cost him 6d. per Board of Trade unit. In this country this price is high for arc lighting, for which an average price would be more like 2½d. We do not expect the editors of our gas contemporaries to accept the above figures, but we think they represent more nearly actual facts than the majority of these comparative statistics. The real test after all is which light the public prefers to use, having due consideration to its cost. The indirect advantages of the electric light then receive proper consideration, which they do not in any figures such as those given above.

Coming Air-Ships.—Although the subject of air-ships is only remotely connected with that of electrical science, a short description of the different types of vessels which will be represented at the forthcoming World's Fair, St. Louis, will not, we think, be out of place in these columns. There are two distinct classes of air-ships. Mr. Santos-Dumont has devoted his attention to what are termed dirigible balloons, while Sir Hiram Maxim represents the aeroplane, and Prof. S. P. Langley the aerodrome. Both of these latter types are gliding machines. They depend upon their power to propel them through the air, and by means of tilted planes are lifted from the ground; whilst Mr. Santos-Dumont and his school depend upon gases for lifting the ship, and use power only for propelling and guiding. Among the new air-ships which will be exhibited at St. Louis this summer is one invented by Mr. Gustave Whitehead, an American. In design the craft is a kind of mechanical bird. The balloon rises from the earth by means of power supplied by a 20-h.p. engine. The machine has four wheels, upon which it rests, and when it is started these wheels are given rapid motion, and the wings are tilted so as to lift it from the ground. When the air-ship is started, energy is applied to powerful propellers which maintain the speed, and the craft continues to sail upwards like a huge bird. The machine is built of wood and bamboo, and the covering is silk. The engine drives the propellers at a speed of about 700 revolutions per minute. The propellers are 6ft. in diameter, and when running at full speed have a forward thrust of 365lb. The entire weight of Mr. Whitehead's air-ship is 280lb. Another craft which will be exhibited at the World's Fair is the invention of Mr. W. C. Horgan, of Chicago. In his design the inventor has taken the four-winged dragon fly as his model. The air-ship is equipped with 12 wings or more, equally divided on a small body. The motive power is furnished by gasoline or hot-air engines. The frame is of aluminium, the wings of silk. Mr. Horgan holds that machines that depend upon gas for their lifting power cannot be successful, for the reason that they are too bulky to allow of successful steering. Altogether, it is anticipated that at least 100 aerial machines will enter the proposed air-ship races at the St. Louis Exposition. The resident representative in the United Kingdom for the enterprise is Mr. George F. Parker, who has his offices in Sanctuary House, Westminster, S.W.

The American Electro-Chemical Society.—At the beginning of the present month a society under the above title was officially inaugurated at Philadelphia, U.S.A. We understand from our contemporary, the *Electrical World*, that the proceedings were eminently successful. About 87 members were registered as in attendance, and this number was sometimes swelled to 100 or more. Preceding the formal organisation of the society on April 3, a visit was made to the chemical works of Messrs. Harrison Bros. and Co., in order to see the operation of the Darling process for the electrolytic production of sodium and nitric acid from nitrate of soda. The short description of this process in our contemporary will bear reproducing here. It seems that the electrolytic cells consist of an iron pot, within which, extending close to the bottom, is a pair of concentric cylinders of perforated iron, the annular space between the two being packed with powdered magnesia. The outer vessel forms the anode, and the carbon electrode is submerged in the fused electrolyte contained with the inner concentric cylinder. In order to prevent these cylinders from being attacked, they are in shunt connection with the anode. The drop of voltage in each cell is 15 volts. A pipe leading from a space between the cylinders and the outer vessel carries off the gases liberated, which elsewhere are condensed and form nitric acid. The sodium floats on top of the space enclosed by the inner cylinder, and at intervals is ladled out and deposited in tin cans; paraffin is first placed in the bottom of these cans, and as the sodium is added this material floats on top and protects the surface from the atmosphere. No difficulty has been found in handling the sodium, though, of course, every precaution is taken to obviate the presence of moisture. In the same works there is apparatus for the electrolytic production of cyanide, but the details of the process were not divulged to the visitors. The same company is completing a new type of primary battery which is soon to be placed upon the market. The negative element consists of a lead plate, which has been pasted with red lead and "formed" to peroxide. An alkali electrolyte is used. The positive element is a hollow zinc rod open at one end; the wire connection passes through a lateral hole near the bottom of the rod, and the interior is filled with mercury, the creeping of which over the top keeps the rod amalgamated. It is claimed that this battery is superior commercially to other constant-current types now in use.

The Vowel "AE."—The issue of the *Physical Review* for March has some particularly interesting articles on experimental work, not the least informing of which is one by Mr. Louis Bevier, jun., in which he discusses the acoustic character of the above-named vowel, as in "hat." The observations were made from wave-form records. The apparatus employed consisted of a vibrating mirror carefully

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mounted to secure motion about one axis only. The present studies were made from the records of nine different voices, securing enough variety, it is believed, to eliminate from the results conclusions based on peculiarities of utterance that are merely individual. The waves were measured under a microscope, with appropriate attachments. As a result of his observations, the author defines the American "aᵉ" as consisting of the following acoustic elements: First, a chord-tone more or less strong, according to the amount of reinforcement which the mouth cavity gives it, varying within great range. In general it is quite strong below 200 vibrations to the second, and weak between 250 and 600, above which last point it becomes very strong, coinciding with the lowest observed mouth-resonance of the vowel. In the second place, he finds that a characteristic "a" resonance in the region of 1,550 vibrations to the second is always present, but not absolutely stationary, because the vowel may tend more or less toward "a" or toward "e," with endless nuances. This characteristic resonance is not a particular point, but covers a considerable region. His third conclusion is that there is a strong resonance at one or two lower regions centering in 650 and 1,050 to the second respectively. Both may be present, but one at least must be. Great individual variation is shown in the relation of these resonances to each other and to the fundamental. The characteristic "aᵉ" resonance at ("cᵃ") 1,550 largely determines the vowel character, but it must receive "body," so to speak, by one or more reinforced lower tones. This gives to the ear a certain fulness or openness which it requires, setting it in sharp contrast to the thinness of "i" (as in pique). From the information given by the author it is apparent why all "aᵉ's" whether pronounced by man, woman, or child, are heard by the ear as a unit sound. There is a large element which is substantially a constant. The variable chord-tone does not disguise the identity, for the ear has learned by long practice to dissociate this form from the function of vowel-differentiation. On the other hand, it is equally clear that no one "aᵉ" is ever quite like any other, and that, without isolating the essential characteristics of the vowel, there is room for infinite variety of individual utterance. Not the least important deduction which this careful investigation would appear to warrant is that it will be practically impossible to decipher a record of speech from the photograph of the sound vibrations.

Cable Communications. — Lord Balfour's Inter-Departmental Committee on Cable Communications has just issued their second and final report, which deals with the subject in a more general way than did the first report, published in February last. The committee's recommendations will be read with interest. In the first place, they consider that in view of the probability of cable-cutting, a variety of alternate routes should be provided wherever it is essential to secure telegraphic communication in time of war. Appreciable, but not paramount, value should be attached to all-British routes, and every important colony and naval base should be connected with this country by one cable touching only on British territory or on territory of some friendly neutral. After this there should be as many alternative cables as possible following commercial routes. The normal policy of this country and its dependencies, the committee further recommend, should be to encourage "free trade in cables," exceptions to this rule only being made on the ground of national, not of private interests. As to State ownership of cables, the committee are strongly opposed to the general purchase of cables by the State. The existing rates are not excessive, with the exception of those to the Gold Coast and Nigeria, and the committee recommend that an attempt should be made to reduce these in connection with the renewal of the Eastern Telegraph Company's landing rights at Porthcurno in 1903. They would also welcome the introduction of "deferred" rates in any case where the time required for postal communication is considerable and the cables are not fully occupied with ordinary messages, but are sufficiently occupied to admit of a real distinction between "ordinary" and deferred messages. One other point should be mentioned, and that is with regard to relieving the Board of Trade of its present responsibilities as to cables. The committee propose that the Cables (Landing Rights) Committee should be strengthened and its functions enlarged so as to include the consideration of all questions relating to cables, that it should be known as "The Cables Committee," and that it should report direct to the Treasury instead of to the Board of Trade. In some preliminary observations the Inter-Departmental Committee state that their experience has convinced them that there is no widespread feeling of dissatisfaction with the present state of British cable enterprise, and that such dissatisfaction as exists is of a somewhat vague and unpractical character. Some of the proposals laid before the committee were based on insufficient acquaintance with the facts and difficulties of the case; and the views expressed upon such subjects as the desirability of all-British cables, or the possibility of reductions in rates, were in many cases not such as would stand cross-examination. Among the witnesses examined before the committee was Sir Edward Sassoon, who gave it as his opinion that all the efficient cables owned by British companies could be acquired for between £3,000,000 and £4,000,000, his estimate being based on the market value of the cables. On cross-examination, however, he raised the estimate to £5,000,000. With regard to this the committee observe that the nominal value of the British companies' stock is £26,899,982; the market value is not precisely ascertainable, but probably £25,000,000 would fairly represent it. They add that the operation suggested is one of serious magnitude, even when a deduction is made for the reserve funds in the hands of the companies. No serious attempt was made before the committee to establish that submarine cables would be more efficiently managed by the State than by private companies, and they themselves are decidedly of a contrary opinion. Some valuable statistical tables are appended to the report, one of which shows that the total sum paid to cable companies in the form of subsidies, etc., to Dec. 31, 1900, by the Imperial, Indian, and Colonial Governments was £2,912,924, of which £2,398,069 was taken by the associated group, comprising the Eastern, Eastern Extension, Eastern and South African, and African Direct Companies. The new cables, the construction of which is recommended by the committee, are as follows: (*a*) a cable connecting either Rodriguez and Ceylon, Cocos-Keeling and Ceylon, or Cocos-Keeling and Singapore; (*b*) a land line connecting the Straits Settlements and Burma; (*c*) an "all-British" cable to St. Lucia, to be commenced as soon as the state of cable enterprise in the West Indies permits. Writing to the *Times* on the above report, Mr. J. Henniker Heaton takes exception to the committee's statement that "all proposals for a very large reduction in existing rates, such as Mr. Heaton's suggestion of a 1d. rate to America and Australia, are quite impracticable." Mr. Heaton retorts that he did not advocate an immediate introduction of a 1d. rate to Australia, but a 1s. rate for the present, and a 6d. rate to India. Basing his case on the improved carrying capacity of the cables and "the glorious work of my friend Marconi," he is still of opinion that the 1d. rate is within sight to America.

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LONDON COUNTY COUNCIL TRAMWAYS.

The work of constructing the first section of conduit tramways for the London County Council is now in full operation at Tooting. Through the courtesy of the contractors, Messrs. J. G. White and Co., we have been able to obtain some photographs of the various stages of the work which will be of great interest to all tramway and electrical engineers. Thus, in Fig. 1 is seen the way in which the roadway is excavated, with special recesses in the old concrete to receive the yokes which form the supports for the conduit rails. These are then lined out and the conduit rails fixed to them, as is seen in the background of this illustration. In Fig. 2 the next stage of the work is shown, in which the wooden strips run from the one yoke to the next in order to support the concrete while it is setting are in place in a few of the sections. In Fig. 3 this concrete has been all placed in position, and the boxes for access to the insulators can be seen at intervals along the track. In Fig. 4 the track rails have been laid, and little remains to be done except to replace the surface of the roadway. It will be gathered from these facts that only one track is being reconstructed at a time, so as not to entirely disorganise the present horse tramways. In looking over the work we were particularly struck with the organisation of the labour, and the prompt way in which the various sections of the work were arranged to be done by Messrs. J. G. White and Co., so as to have the roadway up for as short a time as possible.

During the past week a new decision has been come to with respect to the equipment of these lines, as the orders have been placed by the London County Council for the first

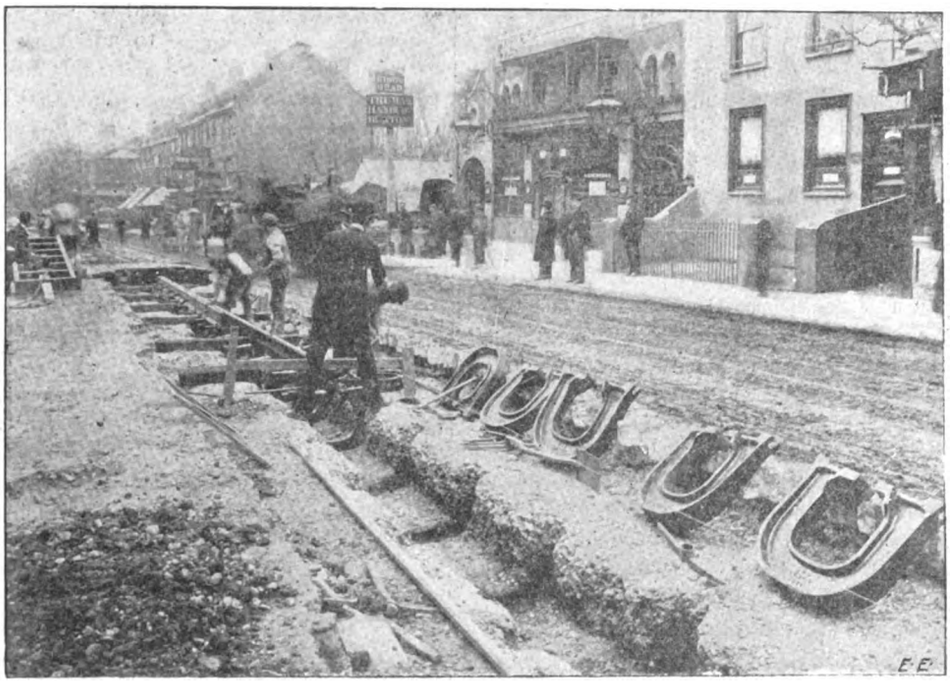

FIG. 1.—Placing and Lining out the Conduit Yokes on the London County Council Tooting Lines.

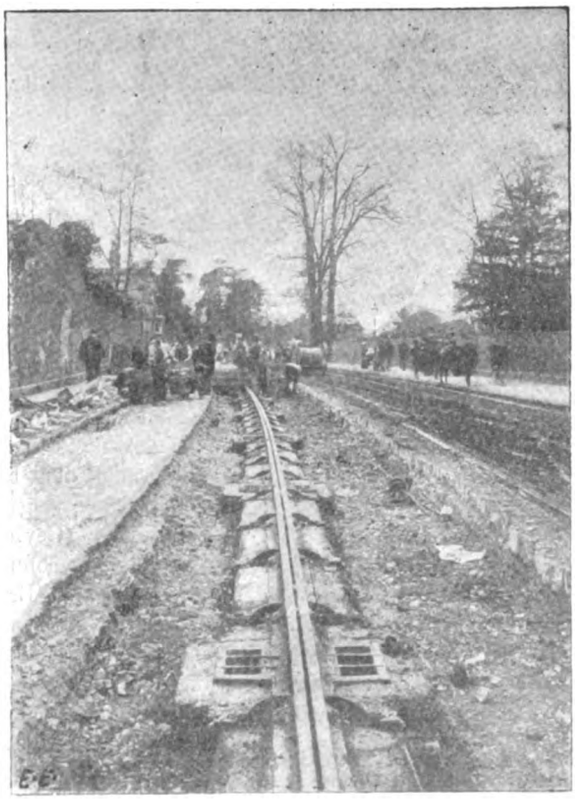

FIG. 3.—View of the Conduit after Concreting.

FIG. 4.—Conduit and Running Rails Complete.

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100 cars. As will be seen, this order has gone to Messrs. Dick, Kerr, and Co., whose tender has been selected out of 23 others submitted by nine different firms. In face of the keen competition it is of interest to note that the German tenders were amongst the highest submitted. On account of the system being a conduit one, there are certain modifications in the car from the trolley type. Obviously the chief difference arises in the introduction of a plough contact, the one adopted being known as the J. G. White's, which is identical with the form of plough designed by Mr. Connett for the Paris conduit system. The type of car (Fig. 5) will bear considerable resemblance to what is known as the "Preston" pattern, which has been supplied by Dick, Kerr, and Co. to many of the tramway systems in this country. It will be remembered that this design embraces new features in tramcar construction, giving greater space in the interior and slightly increasing the seating capacity on the outside,

FIG. 2.—Next Stage in Construction, showing the Wood Joiners in place ready for the Concrete.

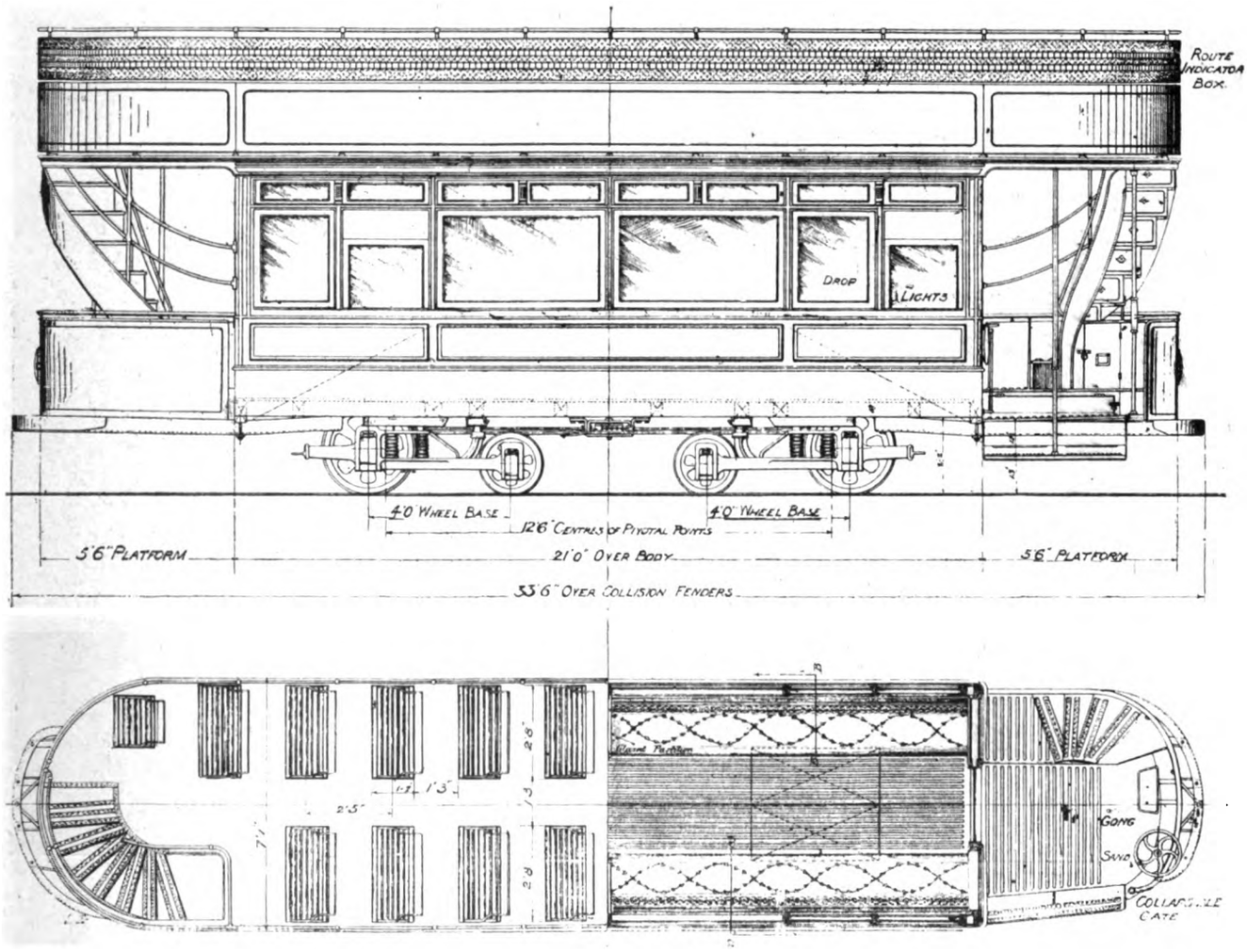

FIG. 5.—The London County Council's New Electric Tramcars, with Brill Trucks, Electric Railway and Tramway Carriage Works Cars, and English Electric Manufacturing Company Motors and Controllers.

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The reversed staircase, which was first employed in this type, has much to recommend it, and has become distinctly popular with tramway authorities. The seating capacity of the new London County Council cars will be 66 passengers, 28 inside and 38 outside; the total length over all will be 33ft. 6in. The frame of the car will be so arranged as to

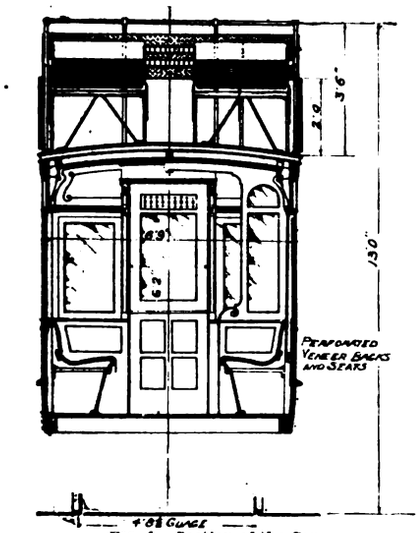

FIG. 6.—Section of the Car.

accommodate on each side two large fixed windows in the centre, and four end windows arranged to lower in the manner shown in the drawing. Above these there will be a line of narrow, ornamental pivoted sashes to allow for ventilation—this we may mention is a special feature of the Preston car. At each end of the car will be route indicator boxes, provided with revolving linen screens. A new feature in the interior of the car will be a glazed partition arranged in the manner shown in the drawing. The interior woodwork of the cars will be made up of quartered oak, the end doors will slide in the usual way, and will be fitted with the necessary handles, catches, etc. The roof seats will, as already stated, carry 38 passengers, and will be of the garden type, with angle-iron legs. The cars will be mounted on maximum traction bogies by Brill, each bogie carrying one motor. The electrical equipments will be in most respects similar to those usually supplied by Dick, Kerr, and Co., the notable features connected with the motor being the freedom from sparking of the commutator under all conditions of load and its high efficiency. The temperature rise will be also well under the specified requirements. The cars will be fitted with series-parallel controllers, and there will be the usual equipment of emergency switches, lightning arresters, hand brake, etc.

It will be remembered that the order for the electrical generating plant for the County Council system was also placed with Dick, Kerr, and Co., Limited.

THE TOSI ENGINES.

This noted firm, which has its works at Legano, in Italy, has made a large number of engines for driving dynamos in central stations on the Continent. In Fig. 1 we give a view of three horizontal tandem engines of from 1,500 b.h.p. to 2,000 b.h.p. manufactured by the firm for the Milan-Verese Electric Railway. These engines are erected in the central station of the line at Tornavento. The illustration shows well the high finish of the engines and the magnificent engine-room in which they are placed. The firm have recently commenced to make large vertical engines of the three-crank type, and the details of these engines are novel in several respects. Two of these new engines, each of 2,000 h.p. for triple expansion, have been ordered for the power station at Kiew in Russia, which station is being erected by the Russische Elektrizitäts-Gesellschaft. In Fig. 2 we show one of these engines as erected for a trial run before being dispatched from the maker's works.

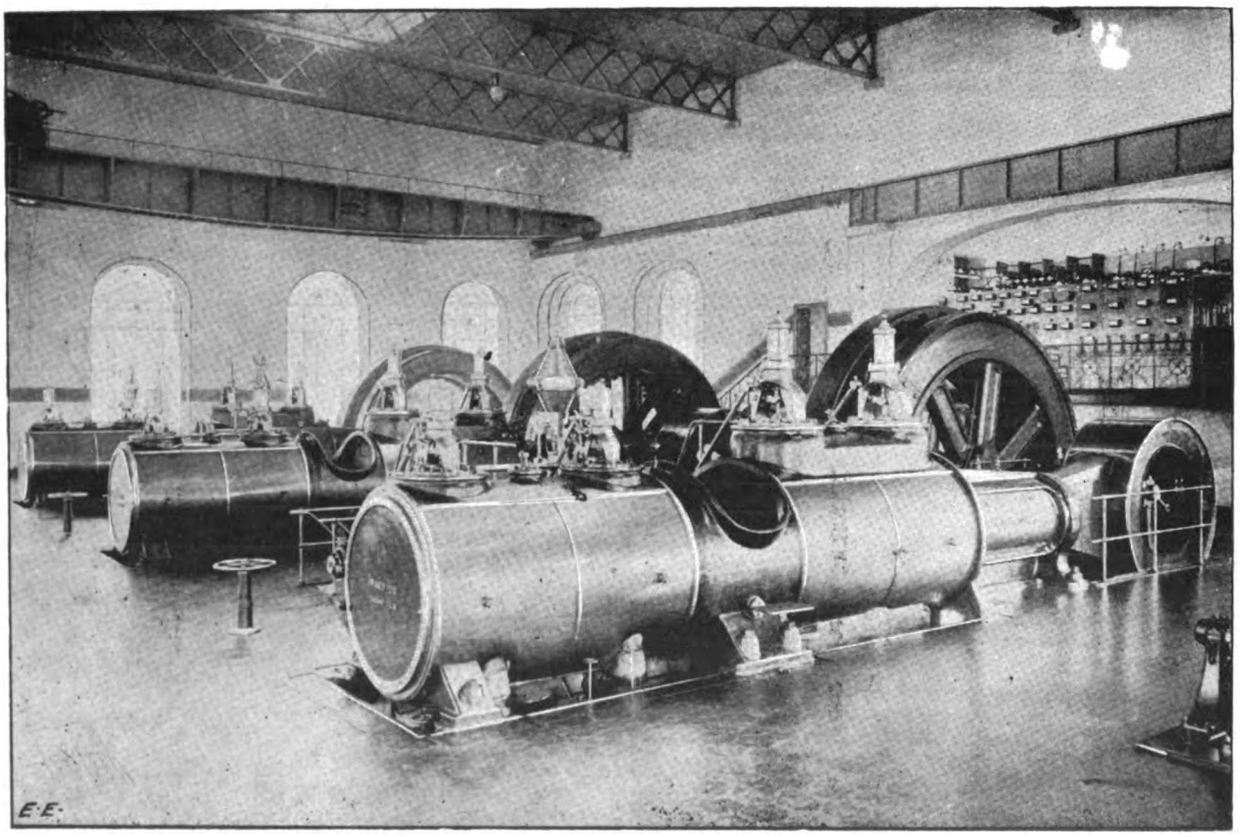

FIG. 1.—The Tornavento Central Station, with Three Horizontal Tandem Tosi Engines of 2,000 h.p.

The first thing to be remarked about the engine as a whole is that all the cylinders are equipped with poppet valve gear, whereas the majority of the large vertical engines constructed on the Continent have a mixed system of steam distribution, with poppet valves only on the high-pressure and Corliss valve gears on the intermediate and low-pressure cylinders. It is claimed for the new Tosi engine that the alteration made will permit of

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much closer regulation of the engine when working at light loads, and also that the arrangements are more suitable for the use of highly superheated steam. The dimensions of these 200-h.p. engines are as follows: diameter of the high-pressure cylinder, 2ft. 3½in.; diameter of the intermediate cylinder, 3ft. 7½in.; diameter of the low-pressure cylinder, 5ft. 9in.; stroke in each case, 3ft. 5¼in. revolutions per minute, 94. All the cylinders are provided with steam jackets, but on the high-pressure cylinder this is only done to get a hard liner, as the jacket is only used for heating-up the cylinder before starting, and is out of circuit when once the engine is at work. The jackets on the intermediate and on the low-pressure cylinders are heated by passing round them the steam from the preceding cylinders.

Each of the three cylinders is provided with four poppet valves. An admission and an exhaust valve are placed in each end of the cylinder, so as to reduce the steam clearances to a minimum. The valves of the high-pressure and intermediate cylinders are made with four distinct seats in order to reduce the motion required in lifting them. For the same reason the valves of the low-pressure cylinders are made with six seats, and are, we believe, quite a new departure in this respect. All the valves are driven from the revolving shaft, which is placed horizontally in the front of the engine, as shown in Fig. 2. This shaft is driven from the main crankshaft by means of two pairs of helical gear with the vertical shaft seen to the right of Fig. 2. The admission valves on the high-pressure cylinder are worked from a single eccentric keyed to the revolving shaft, which acts on a single wrist plate common to both valves. The trip device is controlled by a Porter governor, which is driven from a horizontal valve shaft by helical gear.

All the other poppet valves are moved in pairs of two admission valves or two exhaust valves on each cylinder from one wrist plate common to both, moved by one eccentric keyed on the revolving gear shaft. The wrist plate is connected by means of rods to one end of the "rolling" or "progressive" valve lever, whose other end is attached to the stem of the poppet valve. This valve gear combines thus the advantages of the quick wrist-plate motion with those of the rolling lever. The valve is slowly and without shock lifted from its seat and then opened quickly. The cut-off in the intermediate and low-pressure cylinder can be regulated by hand within certain limits. The admission valve in the lower head of the high-pressure cylinder is more than counterbalanced by a weight combined with dashpot in order to secure the closure of a valve in case of breaking of the spiral spring, thus guarding against running away of the engine. The governor is fitted with a sliding weight on the lever to vary the number of revolutions of the engine, and also with a safety device, which will stop the engine in case of a breakdown of the governor, and which will also enable the engineer in case of an emergency to quickly stop the engine by simply moving a lever, instead of shutting off the steam at the engine stop valve. The framing of this engine is built up of three vertical cast-iron pillars, which act as the cross-head guides, and these three are well braced together by cast-iron struts and wrought-iron tiebars. The common bed-plate is also cast in three portions and bolted together. The crankshaft proper is made in two pieces, each piece having one forged "U" crank. Of the two dynamo shafts connecting to the flanged ends of the crankshaft, one carries a continuous-current generator and a flywheel, while the other carries a generator for alternating current. The duplex single-acting air-pump in connection with jet condenser is driven from the I.M. cross-head by means of connecting rods and beam. Suction valves are omitted, whereby the resistance to the water entering the pump is reduced

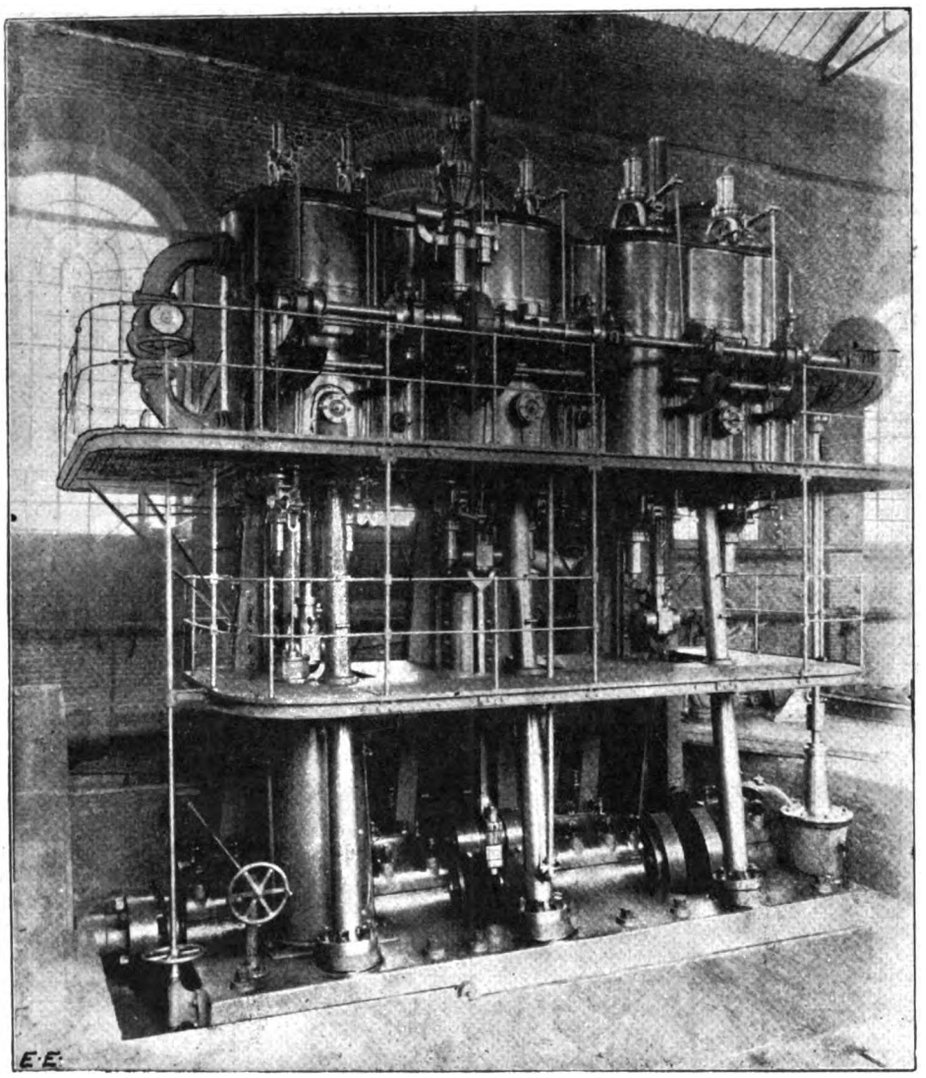

FIG. 2.—The New Vertical Triplex Tosi Engine.

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and a good vacuum is obtained. The passages for the flow of the water and air are of ample size in order to secure noiseless running at high speed. All delivery valves are made easily accessible. All cylinders have direct lubrication to the inside through the top heads, and the high-pressure cylinder has besides three additional oil supplies, one through the upper admission valve, one through the lower steam-pipe, and one through the stuffing box. These six oil supplies are fed from a three-throw pump driven from the gear shaft by means of eccentrics. The lubrication of all the journals and guides is made continuous from a reservoir placed at some height over the engine. The spent oil is collected in a tank located in the basement of engine-room, filtered, and pumped up again into the reservoir. In this manner an abundant lubrication with little loss of oil is effected. The barring gear consists of an electric motor acting through worm and wormwheel on a pinion, which can be thrown in or out of contact with the toothed rim of the flywheel.

We understand that this first engine, before its dispatch for Russia, was tested in the presence of a number of leading engineers in Italy and gave every satisfaction. We are indebted to Mr. W. C. C. Hawtayne for the loan of the photographs from which our illustrations were made, which he obtained on his recent tour of inspection round the large electrical works of the Continent.

LONG-DISTANCE TELEGRAPHY AND MARCONI'S LATEST EXPERIMENTS.

BY LIEUTENANT FERNAND PONCELET.

(*Continued from page 549.*)

III. There is a third theory that M. Guarini and I have thought of to explain the whole of the facts known to this day. This theory is that of the rectilineal propagation of the electromagnetic waves in planes normal to the surface of the radiating antennæ. In our hypothesis the resulting obstacle of the earth's curve must be overcome by a convenient inclination given to the radiating and collecting antennæ. Marconi strictly conforms himself to it each time, that to obtain a long transmission of power he inclines his antennæ to the vertical. We notice principally in Fig. 13 the antennæ of the Biot station, and in Fig. 14 that of the Cahr station (experiments of April, 1901,

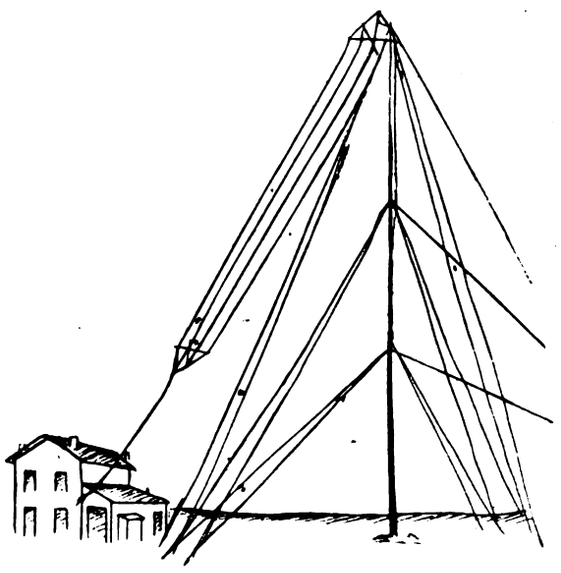

FIG. 13.

between France and Corsica). Fig. 3 shows us the various inclinations given to the Lizard Point antennæ. According to M.M. Boulanger and Ferrié ("La Télégraphie sans fil et les ondes électriques," third edition, 1902, Berger; Levrault et Cie., Paris) the line A A' (Fig. 15) joining the summit of both antennæ, B A and B' A', of Biot and Cahr would pass at 550 yards approximately under sea-level. This fact shows that the electromagnetic waves can traverse sea-water, but as soon as the straight line, B B' (Fig. 15), joining the foot of both antennæ reach the bottom of the sea, transmission is stopped. It has been put forward that a saturated solution with sea salt is practically opaque to the Hertzian waves. We replied that they were dealing with very short waves, and that sea-water is far from being saturated; it contains about 3·5 per cent. only of various salts, principally sodium chloride. We

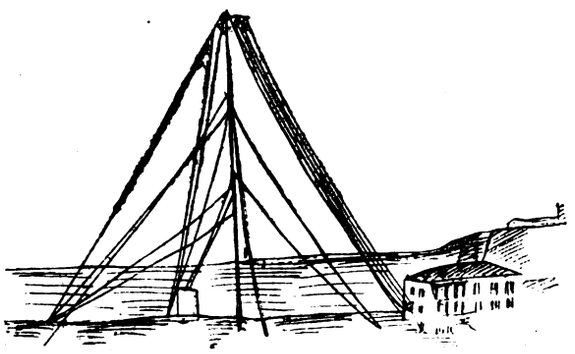

FIG. 14.

also think that experience agrees with us so far, that the transmission is better effected in cold seas, such as the English seas and the Atlantic at the latitude of Newfoundland, than in hot seas, such as the Mediterranean, the Red Sea, and the equatorial seas or lakes, because in these latter the evaporation is more active.

FIG. 15.

The success of Marconi's experiments between an ironclad and a cruiser has also been objected to. How could transmission be effected, it was said, between two ships which were continually changing the position of their antennæ? The reply to this is easy. There are always parallel elements in the antennæ. We think, however,

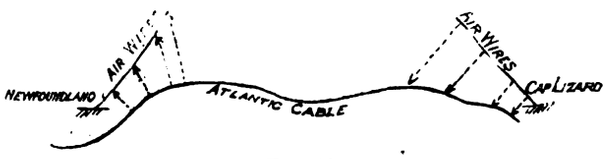

FIG. 16.

that the best result obtained at fixed stations is precisely due to a proper and fixed orientation which can be given to their antennæ, whilst whatever pains that are gone to to properly fix the movable antennæ it is certain that we have, with these latter, less chances of having parallel elements.

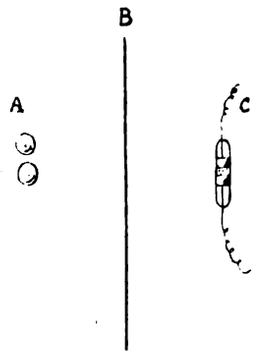

FIG. 17.

A confirmation of our theory is found in the fact, wel known to telegraph operators, that storms have sometimes a slight influence on submarine cables, notwithstanding that these cables are armoured and lay at considerable depths. A wireless telegraphy receiver is affected when in water, and not when it is placed in earth, as proved by the recent experiment made by M. Eugene Lagrange, professor at the Ecole Militaire de Belgique (*Compte-rendus de l'Académie des Sciences*, Paris, meeting of Jan. 28, 1901).

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Has wireless transmission been possible between the Lizard and Newfoundland? We say without the least doubt, "No." Let us not forget that the depth, M N (Fig. 2), caused by the earth's curve is 140 miles, and that the largest depth found in the Atlantic is only 5·18 miles. The straight line, A B (Fig. 1), joining the Lizard to the Newfoundland station passes at about 134 miles under the bottom of the ocean! The waves transmitted at the Lizard were not able to reach Newfoundland either through earth, or through the water of the ocean, or through the atmosphere. In this latter case it is not admissible to assume that the diffraction phenomena

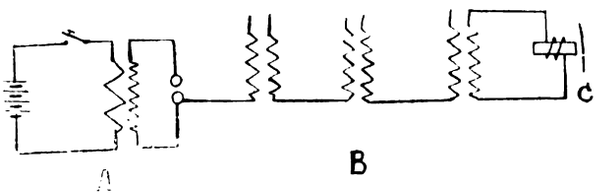

Fig. 18.

have such an influence that an obstacle of 140 miles can be overcome.

A correspondent to *Cosmos* (Jan. 18, 1902) puts forward the hypothesis that the waves could reach Newfoundland by borrowing the Transatlantic cable, which lands at St. John's, Newfoundland. In other words, the powerful transmitter of the Lizard induces currents in the Transatlantic cable, which in turn is supposed to have induced currents in the antennæ at Newfoundland (Fig. 16). M. Guarini rather inclines to believe the correctness of this hypothesis. He recalls our experiment mentioned to the Académie des Sciences, in which (Fig. 17) the transmitter, A, induces current in the screen, B (Transatlantic cable), which, in turn radiating, impressed the coherer, *c*. He also mentions his 1900 experiments, in which it is proved that at the telephone, C (Fig. 18), receives the greater part of the power emitted in A, and that through three transformers, B, have open circuit. Finally, he mentions the last arrangement adopted by Marconi (see Fig. 4), in which the antennæ, *a*, has already been connected to the transformer, T, before acting on the collecting antennæ.

Whatever the case may be, this hypothesis is the only one which might explain the receiving of signals at Newfoundland. The future will tell us what we must think of it.

IV.

Before going into the study of other systems permitting of long-distance wireless transmission, it is necessary to make one remark concerning the apparatus used by Marconi at the Lizard. In Fig. 4 we see the antennæ

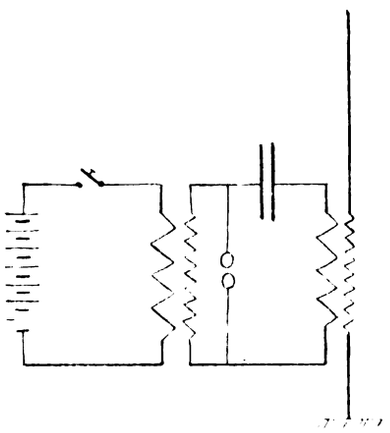

Fig. 19.

joined to the secondary of an induction coil, in the primary of which the discharge takes place. One of the principal reasons for this arrangement is to give a length of wave almost independent of the electric constants of the antennæ. This arrangement also allows the antennæ to transmit several simultaneous messages. It would, perhaps, be interesting to make a comparison between the arrangements of Marconi and those of Guarini. In his British patent, No. 7,777, of April 26, 1900, Marconi claims the arrangement in Fig. 19, in which we see the oscillator as a shunt on the secondary of a second transformer joined to the antennæ and to the earth. In his Belgian patent, No. 146,942, of Dec. 27, 1899, M. Guarini claims the

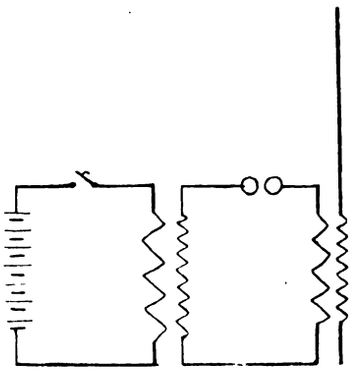

Fig. 20.

arrangement shown by Fig. 20, in which the oscillator is in series in the secondary of the induction coil, and the secondary of a second transformer is joined to the antennæ and to its second free extremity. This arrangement, which corresponds to the third claim of the

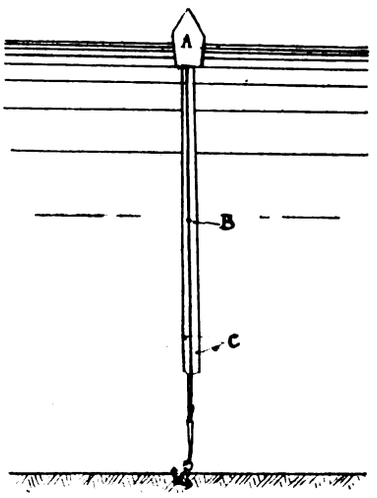

Fig. 21.

British Guarini patent, No. 1,555, of Jan. 24, 1900, is described as follows: "An arrangement which allows one to make the period of the oscillator almost independent of the capacity, the self-induction and the resistance of the wire by which it is wished to carry to a

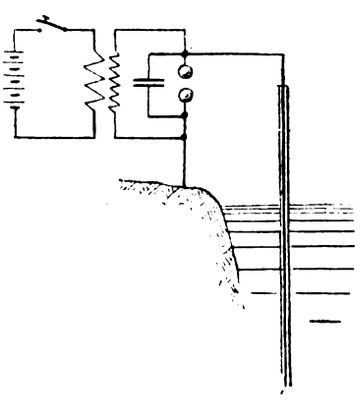

Fig. 22.

distance a high-frequency current or spread radiations in space. This arrangement consists of inducing in the wire the Hertzian current, instead of directly joining this wire to the discharging circuit." This question settled, let us now see if there exists simpler systems than those employed at the Lizard. If, for instance, it was necessary to employ 25 h.p., and an expensive installation, cumbrous and exposed to the changes of weather, like that of Fig. 3, the

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problem of long-distance wireless telegraphy would be far from possible in practice. In Part III. we have already shown the advantage of the Guarini indirect transmission over Marconi's direct transmission from an economic standpoint in the energy used. But is there another practical way of using Guarini's automatic repeaters? Let us examine the means proposed by the inventor.

In order to save the loss resulting from the waves passing from one medium to the other, M. Guarini proposes to completely plunge in water the antennæ of the terminus and intermediary relays. For these latter (Fig. 21) the automatic repeater would be placed in a buoy, A, the connecting cable, B, of which would be used as antennæ, covered with a very thick insulating material, C. Fig. 22 shows what would become of the transmitting post. The delicate point of such installations lies in the layer of insulating material, covering the antennæ, because one must guard against the passage of sparks between the antennæ and the water through the insulating matter. In the first place, the carrying out of this idea does not seem to us unsurmountable with a man so ingenious as M. Guarini. With this system no more cumbersome poles are required; moreover, the capacity obtained is considerable.

(To be continued.)

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

475. Two alternating-current transformers are to be connected in parallel on a low-tension network; it is found that one of the transformers is apparently short circuited when connected up, but upon changing either the high-tension or low-tension leads they are found to be correct. Why is this, and how could the proper connections be ascertained before connecting up?—T. H.

476. In a low-tension three-wire system, after a time the insulation on the negative side displays a persistent tendency to break down. This gradual deterioration is said to be due to osmosis; define the term when applied to the foregoing effects, and explain why the negative should exhibit such a tendency.—STUDENT.

ANSWERS.

Question No. 469.—What is the best 10-c.p. auxiliary standard for use with a photometer for incandescent lamps having regard to (*a*) very small changes of pressure on the lamp under test; (*b*) the type of screen used; (*c*) the colour of the light?

Best Answer to No. 469 (*awarded* 10*s.*).—An incandescent lamp can be used as an auxiliary standard for a photometer, on which the candle-power of other incandescent lamps are to be measured. It is a good plan to have the auxiliary standard working on the same voltage of supply as the lamp to be compared, as then very small changes of the voltage produce the same proportional effects on the two lamps, and will not give the trouble which would otherwise arise. It is best to select a lamp for the auxiliary standard with a treated filament, as the unflashed carbon filaments do not as a rule give such a regular and gradual change of candle-power with time. In any case, the auxiliary standard should be compared with an absolute standard after about five hours of use. The records of these comparisons at regular intervals will prevent the auxiliary standard being used too long. With respect to the colour of the light, it is well to keep the auxiliary standard and the lamps to be compared working at about the same watts per candle. This tends to minimise any differences due to variation in colour. If two different types of lamps are to be compared, say, for instance, the light from a Bremer arc lamp and an incandescent lamp, it will be necessary to introduce coloured screens so as to obtain the relative candle-powers of the various components of the light given out.—P. T.

Question No. 470.—Given two house services 50 yards long laid under the following conditions, what is the best way to calculate the drop? First condition—two service lines of $^{19}/_{16}$ cable in two 1½in. galvanised iron pipes; second condition—$^{19}/_{16}$ concentric cable in galvanised iron pipe. The supply is alternating in both cases at 115 volts, periodicity 50, demand 73 amperes. Can any empirical formula be worked out to apply to different sizes of single and concentric cables in iron pipes? If the service was laid in earthenware casing would the drop be due to copper resistance alone?

Best Answer to No. 470 (*awarded* 10*s.*).—The simplest general method of calculating the total drop due to the combined effect of copper resistance and inductance in alternating lines is a graphic one, and is indicated in Fig. 1. A horizontal line, A B, is drawn to represent the

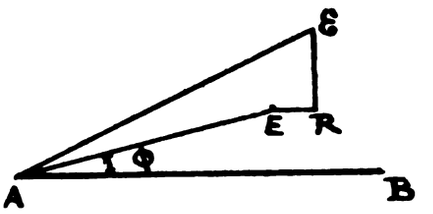

FIG. 1.

phase of the current. The line A E is then drawn at an angle ϕ to the line A B to represent the voltage required at the terminals of the lamps or other apparatus to any convenient scale. The angle ϕ is the angle of lag of the current behind the voltage, the power factor of the load being equal to cos ϕ. When the load consists of incandescent lamps alone the power factor may be taken as unity, or ϕ = 0deg., and the line A E is horizontal and lies along A B. From E draw the horizontal line E R to represent, to the same scale as before, the copper resistance drop, which is in phase with the current A B. From R draw the vertical line R *E* to represent the inductive drop in the line, which lags 90deg. behind the current. Then the distance A *E*, to the same scale, represents the voltage required at the generator end of the line to produce a voltage, A E, at the other end, and A *E* − A E is the total drop in the line.

When the load is non inductive, the length of A *E* can be readily obtained without actually drawing the diagram, as it is equal to $\sqrt{(A\,R)^2+(R\,E)^2}$ when ϕ = 0deg. A convenient method of determining the length of A *E* with any given values of ϕ, E R, and R *E*, by reference to a special chart, was given in the *Electrical Engineer* for June 25, 1897, p. 813. Before the value of A *E* can be obtained it is, of course, necessary to determine the amount of the

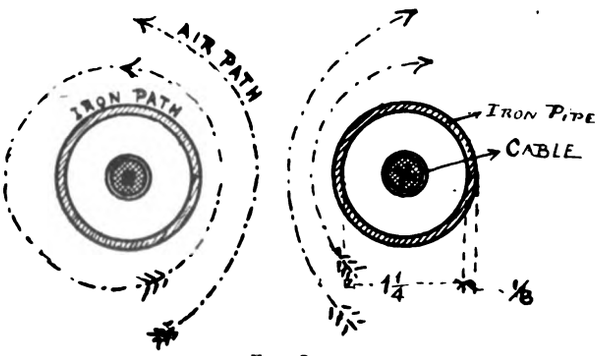

FIG. 2

inductive drop, R *E*. This depends on the length of line, distance between the two wires size of the wires, and the magnetic quality and arrangement of the material surrounding the wires. The line may be considered as a long choking coil, consisting of a single turn looped with a magnetic circuit, which may include a complete iron path, as in the first condition in the question (Fig. 2), or may consist entirely or partly of air or equally non-magnetic material, as in the case of a concentric cable, or two wires side by side in an earthenware conduit.

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The particulars given in the question will serve as an example of the calculation of the drop in the different cases.

1. Each of the two wires (leading and return) placed in a separate iron pipe of 1¼in. internal diameter and, say, ⅛in. thick. In this case the magnetic circuit round the wire consists of an iron path and an air path (Fig. 2), but the effect of the latter is negligibly small compared with that of the former, and so will not be considered. The mean length of the iron path surrounding the wires is 1⅜in. × π = 4·32in. The total number of ampere-turns acting round this circuit (allowing for the maximum value of the current) will be $73 \times \sqrt{2} = 103$, or $\frac{103}{4 \cdot 32} = 24$ ampere-turns per 1in. of path. Turning to a magnetisation curve of any average quality of iron, the flux density corresponding to this number of ampere-turns per 1in. will be found to be about 13,000 C.G.S. lines per square centimetre, or 84,000 per square inch. The whole area of the iron path looped with the wires (two tubes each 50 yards long) is 50 × 36 × ⅛in. × 2 = 450 square inches, and at the above density this would carry a total flux of 450 × 84,000 = 38 × 10⁶ C.G.S. lines. By the ordinary transformer formula (volts = 4·44 × periodicity × number of turns × total flux ÷ 10⁸), we find that the voltage choked by the line with this flux looped with it will be 4·44 × 50 × 1 × 38 × 10⁶ ÷ 10⁸ = 84 volts. The copper resistance of 100 yards of $^{19}/_{16}$ cable is ·04 ohm, giving a copper drop of ·04 × 73 = 2·9 volts. As the load is a lamp load it is practically non-inductive, and the angle θ (Fig. 1) = 0deg. A R = 115 + 2·9 = 117·9, R E = 84, and A $E = \sqrt{(117 \cdot 9)^2 + (84)^2} = 144 \cdot 5$ volts, making the total drop as much as 144·5 − 115 = 29·5 volts.

2. In the case of a concentric cable either laid in an iron pipe or in an earthenware conduit, the inductive drop would be entirely negligible (not exceeding ·1 to ·2 volts under the circumstances given), since the distance between the inner and outer conductors is usually too small to allow any appreciable flux to pass through it at the small number of ampere-turns existing. It is, therefore, sufficiently accurate for practical purposes to calculate the drop in small concentric cables of this sort simply with reference to the copper resistance, as for continuous currents.

3. In the case of two separate mains suspended in air or placed in a conduit of earthenware or other non-magnetic material, the inductive drop can be calculated by the following formula or by reference to the table in the above-mentioned article in the *Electrical Engineer*:

Inductive drop per 1,000ft. of single wire (or 500ft. of service)

$$= \frac{\text{Amperes} \times \text{periodicity} \times (\cdot 96 + 8 \cdot 8\, k)}{10^4}$$

where k is a variable depending on the ratio of the distance between the centres of the two wires to the diameter of the wire, and has the following values:

Distance between centres of wires / Diameter of wires	k.
5	1·15
10	1·3
20	1·6
30	1·77
50	2
100	2·3
200	2·64

Thus in the case mentioned in the question, suppose two $^{19}/_{16}$ cables are laid in an earthenware trough with their centres 6in. apart. The bare diameter of a $^{19}/_{16}$ cable is ·32in., giving a ratio $\frac{6}{\cdot 32} = 18 \cdot 7$, which corresponds to a value of 1·55 for k.

∴ Inductive drop per 1,000ft. of single cable

$$= \frac{73 \times 50\ (\cdot 96 + 8 \cdot 8 \times 1 \cdot 55)}{10^4} = 5 \cdot 35 \text{ volts},$$

or 1·6 volts for 50 yards of double line.

In this case, therefore, A $E = \sqrt{(117 \cdot 9)^2 + (1 \cdot 6)^2}$,
$= 117 \cdot 92$,

and the drop is 117·92 − 115 = 2·92, or practically the same as the copper resistance drop alone. In fact, unless the two wires are spaced very far apart, as in the case of high tension overhead conductors, the inductive drop, at least on non-inductive loads, is negligible.—Q.

Answer to No. 470 (*awarded 7s. 6d.*).—The extra voltage drop in a cable due to the current being out of phase with the voltage is rather hard to calculate. Self-induction causes the current to lag and capacity causes it to lead. Hence we must take the difference between these two, as they are both equally bad in causing voltage drop. The capacity is very difficult to calculate, but in any case its effect will be so small that we may neglect it, especially as the data given are insufficient for anything but the roughest guess. Mr. Mordey has written several most interesting papers on this subject. The two alternative services are shown in Fig. 1. The coefficient of induction (L) will

Fig. 1.

evidently be very much greater in (*a*) than in (*b*), as in (*b*), although the flux from both the lead and return conductors passes round the same circuit, yet as the two currents are flowing in opposite directions, the two fluxes will tend to cut one another out, so that the total voltage drop will be very little, if any, more than the C R drop. By definition, L represents the amount of self-enclosing of magnetic lines by the circuit when the current has unit value. Hence when current has value C, the induction will be C × L. Consider 1cm. length of cable, and assume the galvanised iron pipe to be ⅛in. = ·32cm. thick. Now

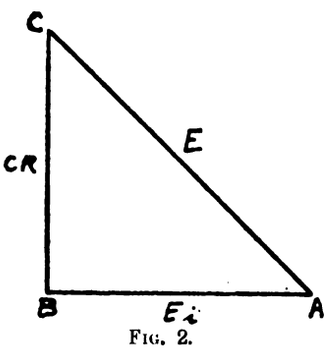

Fig. 2.

inside diameter of pipe = 1¼in. = 3·2cm. ∴ mean length of flux path round pipe = π (3·2 + ·32) = 11cm. Now, the ampere-turns acting on this circuit = current in the cable. ∴ for 73 amperes the H per centimetre length would be $= \frac{73 \times \cdot 8}{11} = 5 \cdot 3$. This in ordinary wrought iron would set up a density of about 8,000 lines per square centimetre.

However, owing to the high periodicity (50) this flux would, in changing so rapidly, set up fairly large eddy currents in the iron pipe, and the effect of these will be to choke back the flux to some extent, so that it only penetrates a thin skin on the outside of the iron circuit. It is impossible without lengthy mathematics to calculate the exact effect of this, but we will assume that it reduces the flux to an equivalent density of 5,000, spread all over the section.

∴ Total induction per centimetre length = 5,000 × 1 × ·32
= 1,600.

∴ Total induction for the 50 yards = 1,600 × 50 × 36 × 2·54
$= 7 \cdot 3 \times 10^6$;

or, $L = \frac{7 \cdot 3 \times 10^6}{73} = \cdot 1 \times 10^6$;

or dividing by 10^8, to bring it to henrys, we have L = ·001.

Now, as the inductive voltage is proportional to the rate of change of the induction, we may write

$$E_i = L \frac{d\,C}{d\,t},$$

where C is taken to be a sine function of the time having an instantaneous value = $C_m\ 2\,\pi\,n\,t$, where $n = \sim$ and C_m = the maximum value of C.

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Differentiating this with respect to time, we get

$$\frac{d\,C}{d\,t} = 2\,\pi\,n\,C_m \cos 2\,\pi\,n\,t.$$

The "virtual" values of cosine and sine being equal, we have $E_i = 2\,\pi\,n\,L\,C$.

Hence, in this case,

$$E_i = 2\,\pi \times 50 \times \cdot001 \times 73 = 23 \text{ volts.}$$

But E_i differs in phase from the current by a quarter period, hence we shall not require (copper drop) + 23 volts to send our current through. We can get the volts required from a geometrical construction.

The resistance of $^{19}/_{16}$ cable = ·02033 ohm for 50 yards; ∴ C R drop = ·02033 × 73 = 1·48 volts. Set off A B = E_i, the inductive voltage. At right angles draw B C to represent the copper drop. The A C will represent the actual virtual volts required across the terminals. By Euclid $(A\,C)^2 = (A\,B)^2 + (B\,C)^2$. ∴ $A\,C = \sqrt{1\cdot48^2 + 23^2} = 23$ (approx). So that in this case the copper drop is negligible compared with the self-induction drop. The voltage of supply will, therefore, have to be 115 + 23 = 138 volts.

In case (*b*) the effect of self-induction would be very much less, but would probably amount to from one to two volts. If earthenware ducts are used the drop would be practically that due to C R drop above, unless the two wires in case (*a*) are very close together.—T. SQUARE.

NEW MANUFACTURING WORKS.

We have to congratulate Messrs. D. Bruce Peebles and Co. on the announcement which they have sent us this week to the following effect—*i.e.*, that an agreement and contract have been entered into between them and Messrs. Ganz and Co., of Budapest, under which Messrs. Bruce Peebles and Co. will in the future be the sole manufacturers for Great Britain and the Colonies of all Messrs. Ganz and Co.'s three-phase plant. We understand that this well-known Scotch firm has secured a large tract of land on which they are about to erect works capable of building electric generators up to 10,000 h.p. The agreement includes a license to make the Ganz system of electric traction, as explained before the arbitrator appointed by the Board of Trade to investigate the best system to be used on the Inner Circle Railway. Although the decision in that case went against the Ganz system, the facts brought forward clearly showed the great advantage it would have over any long-distance line requiring an electrical equipment. We believe we are correct in stating that an example of this system of electric traction will shortly be laid down in this country, so that engineers may be convinced of its advantages. We wish this new departure of Messrs. Bruce Peebles and Co. every success.

Manufacture of Bisulphide of Carbon.—Under the above title Mr. Edward R. Taylor presented a paper to the American Electro-Chemical Society at its inaugural meeting on April 3 at Philadelphia, in which he described his process of the manufacture of bisulphide of carbon in the electric furnace. The author explained at the outset that the first electric furnace built was surrounded with an external sheet of iron, in which the sulphur was melted by heat radiated from the inner metal shell of the furnace, and admitted to the furnace proper by means of valves. This practice was found to be inconvenient, and has been superseded by a new arrangement in which brick walls are substituted for those of metal, and the sulphur fed directly to the furnace in the cold state, surrounding the interior so completely as to make a blanket of sulphur, which in melting carries the heat absorbed back to the furnace. There is practically no limit to the size of such furnaces. A furnace (of which diagrams and photographs were shown) is 16ft. in diameter and 41ft. in height. The operation of the furnace was stated to be extremely satisfactory. We understand from our contemporary the *Electrical World* that in the subsequent discussion several speakers, including Profs. Richards and Doremus, spoke in high terms of the merit of Mr. Taylor's invention.

THE DISTRIBUTION OF MAGNETIC FLUX IN LARGE ELECTROMAGNETS.*

BY W. M. THORNTON, M.SC. (MEMBER).

(Continued from page 557.)

4. THE RECORDING AMMETER, OR "MAGNETIC FLUX INDICATOR."

Although in its final form the galvanometer proved very reliable and convenient, yet its bulk and delicacy rendered it awkward to carry about. It was felt that something of the nature of an engine indicator was wanted—powerful, free from friction, having small inertia of the moving parts, and yet sufficiently damped to make its readings deadbeat. With these objects in view, various modifications of ordinary switchboard instruments were tried, but discarded because of the difficulty in obtaining records by means of a pen or pencil attached to the pointers, the leverage of the pencil friction being inevitably great compared with the radius of the pivoted coils, and the inertia of the coils greater than was desired when large currents were passed directly through them, instead of being shunted. In order that the instrument may be powerful, it is necessary to have a strong field, a large current-carrying capacity, and the length of coil in the field must be considerable. The resistance in the present instrument is ·003 ohm, and the safe current 50 amperes. The coil moves in a circular cylindrical gap, ·4cm. wide and 9cm. long, and to maintain a uniform strength of flux in the gap the magnetic circuit is made double, the radial field having everywhere the same direction in the gap, but the flux approaching from top and bottom the contracted section in the iron. The magnetism may be either permanent or separately excited. The coil is made of a strip of copper ·75cm. wide at the narrowest part, 1·5cm. elsewhere, and ·5mm. thick, formed into two turns insulated by silk tape and varnish. The current is led in at the top through the suspension of arc lamp flexible and out at the bottom in the same way, the section shown at *c* indicating the arrangement of the leads and the supports for the coil. The elastic control is provided by two watch-springs coiled inside light brass drums, and the spindles to which the springs are attached being fixed, the drum is free (as in an indicator) to rotate through an arc which depends upon the stroke of the coil and the radius of the drum. At rest the two springs are arranged to oppose one another, so that the suspensions are always in tension. The coil is made mechanically strong to resist deformation by a lapping of stout silk thread, and is tested to 10lb. pull. The position of the coil can be adjusted by means of ratchet wheels and purls, so that the whole stroke may be taken in either direction, or, when at the centre, to respond to currents of changing sign. The strength of the pull, F, varies with the strength of field, B_g, of the current, *i* amperes, and with the length of winding on the coil, *l*, according to the relation

$$F = \frac{B\,i\,l}{10} \text{ dynes, or } \frac{B\,i\,l}{4\cdot45 \times 10^6} \text{ pounds.}$$

The measured pull was 2lb. when a current of 40 amperes was passed through the coil. The length of strip in the coil was 35·4 cm. Thus the field in the gap with the instrument fully excited is 3,100 lines per square centimetre. This might with advantage be made very much stronger, but having been originally made with an 1½in. core, which was afterwards increased to 2in., there was not sufficient iron left in the shell to carry when saturated a greater flux.

The dimensions of the instrument depend entirely on the flux densities in the gap and iron. Thus, let *d* be the diameter of the inner iron cylinder, *b* the width of the gap, and *l* its half-length. Then through each half of the circuit the total flux must be $\pi\,(d+b)\,l\,B_g$. Either end of the core adjoining the covers must carry this also, and if B is the flux required to saturate the iron there, the total possible is $\pi/4\,d^2\,B$, if the core is solid, or less due to the area of the centre hole in the present form. Let this area be *a*. Then $(\pi/4\,d^2 - a)\,B = \pi\,(d+b)\,l\,B_g$.

$$\pi/4\,d^2B - \pi\,l\,d\,B_g - (\pi\,b\,l\,B_g + a\,B) = 0,$$

whence *d* can be found for any values of B and B_g.

Neglecting the area *a* and the breadth of gap *b*,

$$\pi/4 \cdot d^2\,B = \pi\,l\,d\,B_g$$

Thus $d = 4\,l \cdot \frac{B_g}{B}$, a first approximation to *d*.

If we want B_g = 7,000, B = 16,000. Then $d = 1\cdot7\,l$.

In the present instrument $\frac{d}{l} = 1\cdot7$, but the shell is of insufficient area to carry the flux, and the winding space is too small. From the shape of the magnetic circuit the reluctance may be readily calculated, and the winding space, instead of being eight square centimetres, should have been 12; this is in consequence of the air-gap, originally made ·3cm. wide, being bored out for greater clearance. The dead-weight of the moving parts, not including the wire on the drums, is 1·75oz., and in considering the motion the inertia of the drums must not be neglected.

In order to counteract the demagnetising effect of the coil current at one end of the circuit, and its distortion of the field from the other, the instrument was compound wound. Thin strips of copper were placed on top of the fine windings at both ends of the instrument and connected in series with the coil, only wound so that any change of flux was prevented, the same number of ampere-turns being given to each end as to the coil. Thus, with the exception of the stray local fields round each strip, the moving coil is free from self-

* Abstract of paper read before the Newcastle Local Section of the Institution of Electrical Engineers, March 24.

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induction, and the instrument can be used with alternating currents of moderate frequency provided the elastic control is stiffened and some method of optically multiplying the motion added, such as the following: A highly-polished stiff steel strip is bent twice at right angles and soldered to two steel pins at *a* and *b*; *a* is held by two end screws, and *b* is attached to the moving coil. A motion of a hundredth of an inch is sufficient to give an amplitude within the range of the breadth of the strip; thus an exceedingly stiff spring may be used, and the free period of the system made very high, 110 a second, with moving parts weighing 50 grm.

An important feature of the design is the straight-line motion. In records this is frequently useful, and it facilitates the working out of the areas in the magnetising curves greatly. The only other straight-line motion instrument of any accuracy is the Hartmann and Braun modified Kohlrausch ammeter. In this, however, the spring is weak relative to the weight of the moving parts. The damping in the first instrument is found to be enough without special provision by the back E.M.F. generated during the initial rush. If it were not, a copper ring former would be more than sufficient, except for very violent fluctuations in the coil current.

The permanent magnet form calls for no special remark, beyond noting that it also can be compound wound, and is much simpler than the separately excited to construct, probably the best method being to magnetise the sides to have consequent poles. With regard to putting the separately-excited form together, since, in order to get the supporting fins of the coil in, the centre core must be split, the diameter of the inside of the coil must be such that the two halves will slide into place. Again, since the return current passes under the entering in the slot, there is no tendency for the coil to rotate on its axis and so scrape against the sides of the slot. Rubber strips are placed at the ends of the slot to preserve the insulation or the fins from contact with the frame, though there is never any chance of a short-circuit. If the instrument were wound to record high voltages, special insulation would have to be devised for the centre hole and slots.

The recording apparatus is an ordinary drum clock-driven, mounted close to the top of the instrument, the records being made with a pen attached to a loosely-jointed rod pivoted on the suspension, or to a cord, which draws the pen against an antagonistic spring. The drum of a phonograph has been found very useful

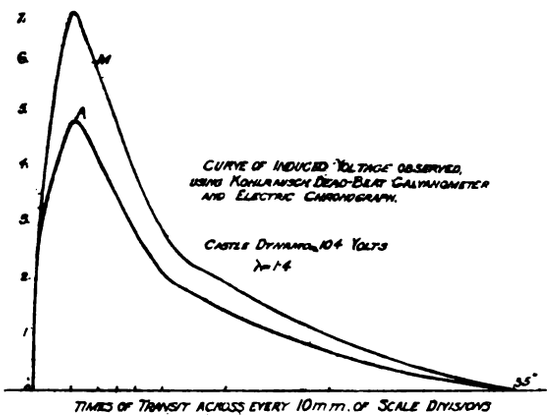

FIG. 10.

for records of rapid changes, as in the changing over in a double-carbon arc lamp, or the induced voltage curves in testing transformers by the "make" "short-circuit" method. The experiment may, however, be conducted without any special self-recording apparatus if a dead-beat galvanometer of any kind is available, such as the Kohlrausch moving-needle type, damped by currents induced by the motion of the needle in a copper block surrounding it The curves given below (Fig. 10)* were obtained with such an instrument by marking on a Wheatstone tape the times of transit of the spot of light across the tens of a millimetre scale. The readings were exact enough to show that the instrument was not dead-beat enough, but on the return swing the record dipped below the true curve. The apparatus is easily erected, an ordinary electric bell being readily converted into a chronograph by means of a pen attachment, and a drum driven by clockwork or falling weight providing the time displacement.

The most accurate of all recording ammeters is the Duddell oscillograph, and records taken by it have been regarded as final. Its difficulty in use, apart from its delicacy, is that the resistance of the strips and fuses is high compared with the very low voltage dealt with. Ten or more turns around a large core give a throw of 5cm. or 6cm. only. In observing the slow rise of current in a large winding with the instrument shunted in the current, the record is perfect. The oscillograph used was of the low-frequency double-suspension type.

§ 5. Further Tests on Large Machines.

The magnet cores of the 50-kw. Castle dynamo were the largest of circular section available for test. It was, however, desired to examine machines of large size chiefly for the slipping of the molecules effect. By permission of the Newcastle Electric Supply Company, through their consulting engineer, Mr. C. H. Merz, tests were made on one of the 500-kw. synchronous motor-generator sets in the Manors sub-station, the continuous side only being used. This consists of a six-pole machine by Brown-Boveri. It is designed to give 480 volts at 1,000 amperes with a speed of 300 revolutions per minute. It was excited from the 'bus bars at 480 volts, and the current was broken through a non-inductive resistance. The galvanometer being shunted across ·01 ohm, with 600 ohms in series, the curve of rise and fall (I. Plate XIII.*) was obtained. This was repeated with 300 ohms in, and II. recorded. A single turn of wire was then wound around the magnet at the centre of the winding, and with 500 ohms in series gave Curve B, Plate XIII., when the exciting current was switched on. A and Y, referring to armature and yoke, had 300 ohms in series. The areas as recorded and as reduced to the same resistance are

Windings ...	B	.....	21 square inches	.....	34·25 square inches
Yoke	Y	.....	15	.....	15
Armature ...	A	.....	14·4	.....	14·4

Thus $\lambda = 1{\cdot}19$; $^{*}\left(= \frac{N_B}{2\,N_a} \right)$.

As would be expected, the yoke flux is slightly greater than the armature, their ratio being 1·035. The average time-constant found from the curve of rise is 10 seconds; from B, 9·5″; γ, 10″; A, 9″; the method in the later cases being to find the time for the induced voltage to fall to $\frac{1}{e}$th of its maximum, since the flux follows the coil current closely after the first rush.

Mr. J. F. C. Snell kindly gave me leave and help to test two machines with large rectangular cores in the Sunderland Corporation Dunning-street station. The first taken—a Silvertown bipolar continuous-current generator for 250 volts, 544 amperes, at 400 revolutions per minute—was excited from the 'bus bars, then at 226 volts, and

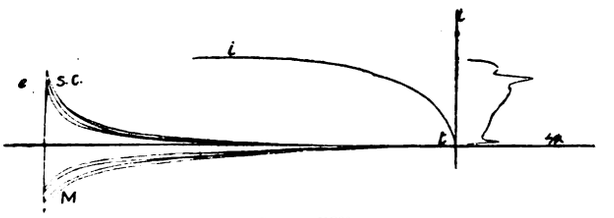

PLATE XIV.

the set of curves in Plate XIV. taken. Table VII. gives the values found from these.

TABLE VII.

Curve.	Make area in sq. in.	Resistance in galvanometer circuit.	Equivalent area.	λ.	N.	B per sq. in.
A	5·32	50 ohms	5·32	1	$32{\cdot}3 \times 10^6$	83,250
Y	2·95	200 ,,	6·1	1·145	37 ,,	87,250
B	3·86	200 ,,	6·85	1·29	41·6 ,,	98,000
P-F	4·92	50 ,,	4·92	·925	29·8 ,,	37,250

The armature carries 232 conductors, of which 116 are at present in one winding, the two being in parallel. The magnets and yoke are of Sir Alfred Hickman's special magnetic steel forging. Each bobbin carries 5,512 turns, of resistance 79 ohms cold, the maximum exciting voltage for each being 250 volts. An application of the above data to find the permeability of the steel under working conditions is given in § 6, together with the results from the second machine tested.

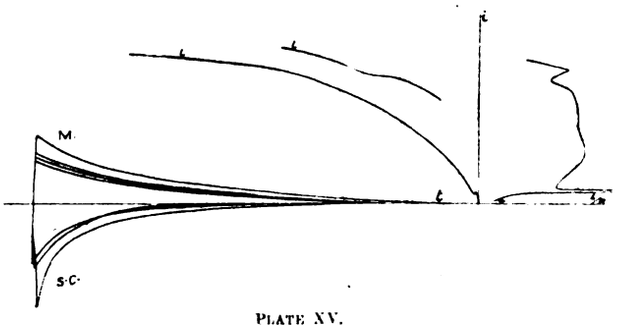

PLATE XV.

This was a Parker bipolar generator of similar pattern to the Silvertown. The same exciting voltage was used, and the curves of Plate XV. recorded, from which Table VIII. is compiled.

TABLE VIII.

Curve.	Area sq. in.	Resistance.	Equivalent area.	λ	N	B per sq. in.
A	5·2	200 ohms	5·2	1	$30{\cdot}7 \times 10^6$	66,750
Y	6·52	200 ,,	6·52	1·255	$38{\cdot}6 \times 10^6$	95,000
B	4·35	400 ,,	6·86	1·32	$40{\cdot}5 \times 10^6$	100,000
P-F	4·73	200 ,,	4·73	·91	$28{\cdot}0 \times 10^6$	39,700

This machine gives 250 volts, 500 amperes, at 360 revolutions per minute. There are 136 conductors on the armature, which, as the former machine, is double wound, to be converted to 500 volts when desired. The turns on each bobbin are 4,666, each coil having 43·5 ohms resistance cold.

The curves of rise of current at make in both machines differ from the circular core case in being much flatter. Since a flattening of the curve corresponds to an increase of permeability, this shows that the average permeability of the machine as a whole is higher than in the

* This was given in error in a previous issue as Plate V.

* Not reproduced here.

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Castle dynamo, probably because the reluctances of the air-gaps are so much less by reason of the large pole faces.

An attempt was made to photograph the induced voltage curve, as the machine, connected to be self-exciting, was run up under steam as rapidly as possible. The curves should be of the shape shown in Fig. 11, and, as such, would be free from most of the difficulties in

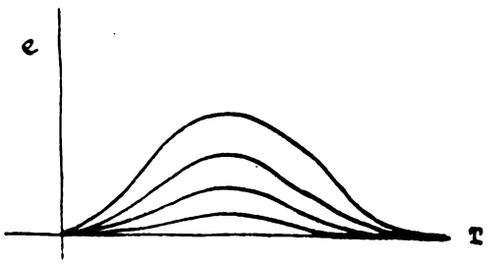

FIG. 11.

obtaining a dead-beat galvanometer record. The actual deflection with one turn around one of the Parker bobbins was ·3cm., and this being so small, the attempt was not proceeded with at the time, though with plenty of exploring turns the most reliable records should be made in this way.

From the variation of permeability with current we proceed to consider its change with time. This is done by plotting the value of the time constant or permeability, as found by the method of Fig. 3, with times as abscissæ. Plate V. shows two results for the Holmes machine.

In drawing the L/r curve (shown at M, Plate V.), it was found that as the current curve began to bend over the time constant began to increase, corresponding to an *increase* in the permeability of the machine, and on reaching the current which, by comparison with the curve of magnetisation is seen to coincide with the bending over of the voltage curve as the iron is saturated, a projection or hump was

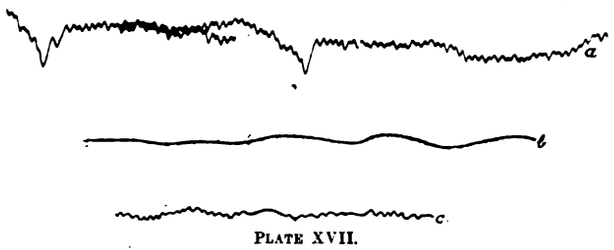

PLATE XVII.

obtained. It was seen that this, though unlooked for and hitherto unobserved, is a record of the molecular slipping at the point of saturation, and provides, if such is necessary, a direct proof of Ewing's theory of the magnetisation of iron. The flattening which in the current curve causes L/r curve to project is almost imperceptible, and might be due to a sticking of the galvanometer or an increase of the clockwork speed at this point. To check this, experiments were made at different excitations, and though the permeability was found to increase with time, the distinctive projection in the inductance curve was not obtained for low magnetisations. The gradual change before the sudden increase is no doubt in part accounted for by the dying away of the eddy currents in the core, and these would explain the rise observed even when the magnetism at its maximum cannot be near saturation. The time for the whole slip to take place is about four seconds in a core of 200 square inches section.

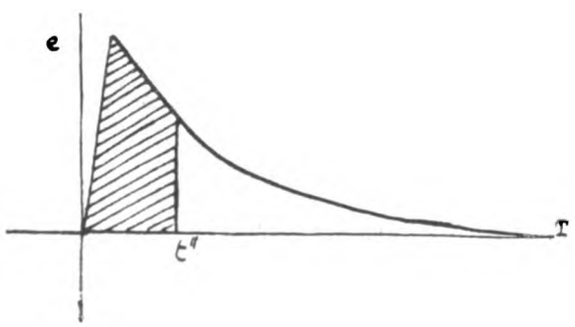

FIG. 13.

A repetition of the curves on the Holmes machine at 30 and 50 volts show that there is an approach to saturation in the cores at 50 volts (this might be expected since the flux density at 104 volts is 100,000 lines per square inch), but at 30 only a rounded top to the time constant curve is obtained. This is due to the flattening of the records by damping when the galvanometer is returning to its position of rest, and Plate VII. shows that the retardation is considerable, sufficient to account for the rounded shape. There can be no confusion between the two effects, the molecular slipping always showing as a projection from a smooth part of the curve some distance from the end. The make curves of the Silvertown and Parker machines also indicate very clearly the sudden rise of permeability at the point of slipping (see Plates XIV. and XV.). (The latest curves, taken with the drum revolving once in 10 seconds, show that the projection is double, the molecular slipping taking place first in the armature, then in the core of the bobbins at break or short-circuit.)

One may also determine the changes of flux with time by direct consideration of the induced voltage curves. At any instant the area of which the top has been recorded gives the magnetism which has entered the core; as, for example, the shaded area, N, represents the flux entering in time t (Fig. 13). A point to notice is that that which has entered when e is a maximum is a small portion of the whole. With constant permeability it would be zero, and its relative value is a guide to how far this is departed from in the earlier times, and it has been seen that the total height of the curve is practically independent of this magnetism. The absence of any marked deformation of the curve shows that the quantity of magnetism which is added during the molecular slipping at saturation is also a small portion of the whole, insufficient to be observed other than as a flattening of make curves at high values of the current.

(To be continued.)

PHYSICAL SOCIETY.

At the ordinary meeting on April 11, Prof. S. P. Thompson (president) in the chair, **Dr. R. A. Lehfeldt** exhibited an **"Electric Heater."** The apparatus consisted of a vacuum-jacketed glass tube containing water which was boiled by passing an electric current through a platinum spiral immersed in the liquid. Tap water is preferable to distilled water because the small electrolytic action in the former case causes the boiling to proceed quietly. Different temperatures can be obtained by using other liquids.

Mr. Watson gave a list of liquids which he had found suitable for boiling electrically. He had used this method of obtaining a steady temperature in an apparatus for comparing thermometers.

Mr. Grant exhibited and described **"An Apparatus for Vapour-Pressure Measurements."** The liquid of which the vapour pressure is required is introduced into the vacuum of a siphon barometer. This is mounted alongside an ordinary siphon barometer, and the upper extremities of both are surrounded by a bath, which can be kept at any desired temperature. The levels of the mercury in the open tubes are then adjusted until the upper mercury surfaces are at the same level. The vapour pressure is then measured by the difference of level in the open tubes. By a simple modification, it is easy to investigate the vapour pressure of a liquid in presence of air. The two chief advantages of the method are: (1) the simplification of the temperature correction and (2) the wide range of temperature over which it can be employed with the use of a small bath.

Prof. Callendar referred to the advantages of the apparatus, and said that it appeared specially suitable for elementary laboratory measurements.

Mr. J. T. Morris showed an experiment illustrating the use of cathode rays in alternate-current work. The usual form of Braun tube was used, the rays falling upon a luminescent screen and forming a blue spot. A solenoid conveying an alternating current was placed near the tube. The varying magnetic field caused the spot to oscillate about its mean position. To determine the maximum value of the current a switch should be arranged to rapidly replace the alternating current by a continuous one. The continuous current should then be adjusted until the maximum excursion of the spot is the same as before, and the value of the current read off from an ammeter in the circuit. For accurate work the frequency of the discharge from the induction coil exciting the tube should be adjusted until it is almost exactly in synchronism with the alternating current. The unsteadiness of the spot of light in the zero position limits the accuracy of the measurements. Mr. Morris has tried to reduce the vibration by using an earthed aluminium diaphragm instead of a glass one.

Dr. Harker thought the spot of light shown might have been made brighter by the use of a larger coil, and said the vacuum required careful attention in order to get the best results.

Mr. Duddell pointed out that the movement of the spot about its zero position might be due to the action of the earth's magnetic field upon the varying current passing through the tube.

Mr. Wilson Noble suggested that the irregularity in the position of the spot might be due to the irregular sparking of the coil and the consequent irregular magnetic field acting upon the rays.

The **Chairman** said the movement was probably due to internal and electrostatic causes. He suggested the use of yttria as a luminescent material.

Mr. Morris, in reply, said the earth's field was too weak to account for the variable zero position. He had tried shielding the tube with an earthed copper wire screen without any gain in steadiness.

Mr. Morris then showed an experiment **"On the Growth of Electric Currents in an Inductive Circuit."** An E.M.F. of 0·8 volt was applied to a coil wound on a ring-shaped laminated iron core. When the current had attained its steady value the E.M.F. was reversed, and the variations of the current strength shown by an ammeter. About 20 seconds were required for the current to attain its maximum value in the opposite direction. A secondary coil was also wound upon the same core, and the effect produced upon the growing current by the closing of this secondary circuit was shown. Mr. Morris has determined curves of growth for different currents, and he explained how similar curves could be used to determine experimentally the hysteresis loss in transformers.

Dr. Glazebrook drew attention to the fact that this method has been applied with some slight modifications to the determination of the hysteresis loss in some 3,000-h.p. transformers.

Mr. Croft showed some apparatus and devices useful in teaching. The method of determining graphically the focal length of a lens from the distances of conjugate foci from the centre was illustrated. The graphic solution of a quadratic equation was also shown. An apparatus for producing and demonstrating the properties of three-phase

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currents was exhibited and described. Mr. Croft then showed crystals illustrating the five regular solids, and an electric lamp with the filament in one plane—useful for optical work. The flatness of a piece of plate glass can be tested with a scribing block. The point is adjusted to touch the glass in one position. By breathing on the glass and moving the block about it is easily seen if the point leaves the surface.

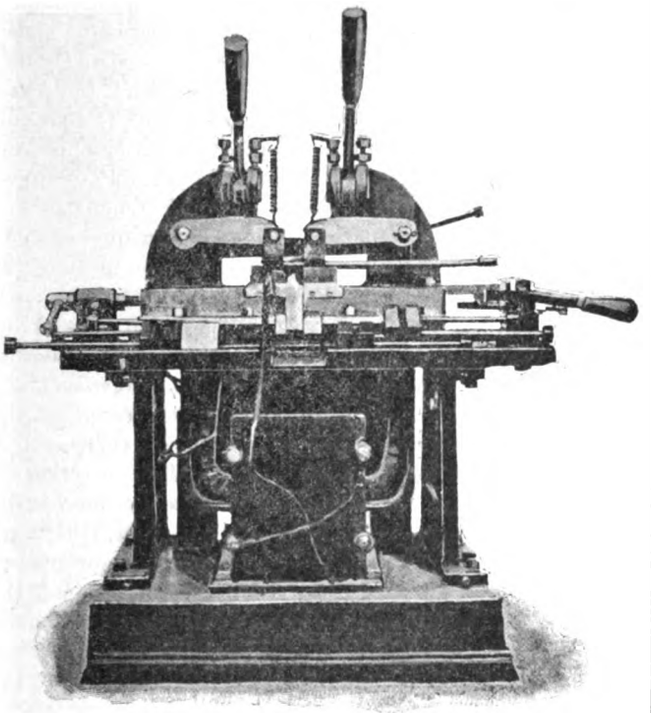
Mr. J. M. Barr said that the method could not be applied to steel. To test the flatness of a piece of steel he had made use of a small table with four legs placed upon the surface. One leg of the table was adjustable, and was made part of a circuit containing a microphone. If the ends of the four legs are placed in one plane, it is easy to test flatness by observing when the adjustable leg leaves the surface. The amount of the irregularity of the surface can be measured by having a micrometer attached to the movable leg.

The society then adjourned until April 25.

TRADE NOTICES AND NOVELTIES.

Electric Welding.

We have recently received from the Electric Welding Company, Limited, 28, Basinghall-street, London, E.C., a copy of an interesting catalogue of electric welding machines constructed on the Thomson principle. The machines shown are of compact design, as evidenced by the accompanying illustration, which is of a welder, with cover removed, especially adapted for angle work. This machine is capable



of an output of 18 h.p. for 35 seconds, and weighs approximately 900lb. Some of the numerous applications of electric welding are enumerated, while the complete outfit required is detailed. Appended to the catalogue is also a list of testimonials of some users. These testimonials are sufficiently conclusive as to the merits of the Thomson patent electric welding process.

Insulating Paints and Varnishes.

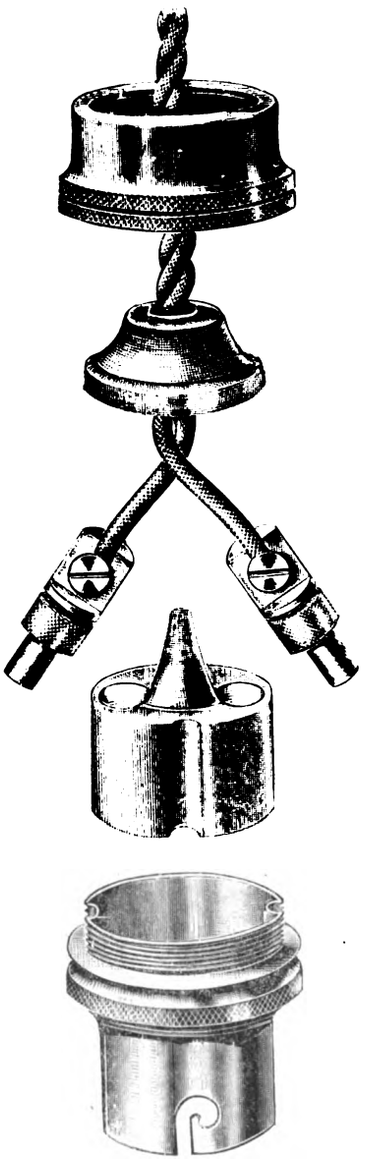
From Mr. Fred. J. Down, Harpenden, Herts, we have received a copy of his circular No. 2 dealing with special insulating compounds for all electrical purposes; also an illustrated booklet describing the method of their application. A compound called armalac claims first mention. This material is held to provide a unique combination of all the good qualities demanded by machine builders. It is unaffected by oleic acid or oils; it has a very high melting point (500deg. F.); it gives an exceptional initial insulation; it keeps its exceptional initial insulation; it dries quickly, but never becomes brittle, and retains its plasticity for years. These are the principal claims for armalac, and it must be admitted they are sufficiently comprehensive. G. E. cement—another compound listed—is, we are told, a form of armalac specially designed for sticking together in sheets the various layers of insulation used in connection with the building of dynamos or other electrical apparatus Armalac, we understand, is very largely used by American machine builders.

Nernst Lamps.

We are informed by the Electrical Company, Limited, 122-124, Charing Cross-road, London, W.C., that several corporations in this country, as well as H.M. Board of Works for Scotland, have already largely adopted Nernst lamps for indoor and outdoor lighting, while other corporations have placed orders. The lamps supplied are for half and one ampere, and of the continuous-current type.

"Stellite" Accessories.

From the Electric and Ordnance Accessories Company, Limited, Stellite Works, Aston, Birmingham, we have recently received a copy of Section "A" of their new catalogue dealing with electric light accessories. Lampholders of various types, wall plugs, ceiling roses of the looping-in high voltage, decorated, and other patterns, plain and decorated counter-weights, cut-outs, distributing boards, tumbler switches, lamp shades, brackets, and the firm's patent distributing system are listed, besides other articles, including a patent cable connector and terminal, which has already been described in these columns. We illustrate herewith the "Stellite" patent cord-grip lampholder. It is claimed that three of these lampholders can be wired in the time occupied in wiring one of the ordinary type; also that the method employed to connect the flexible ensures perfect contact. The terminals are completely enclosed in porcelain, while no



screws are embedded. We understand that the firm are prepared to send a copy of the list under notice to any member of the trade on application.

INSTITUTION OF ELECTRICAL ENGINEERS

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Vice-Presidents.—Major P. Cardew, S. Z. de Ferranti, John Gavey (remaining in office); Prof. O. Lodge, F.R.S. (new nomination).

Members of Council.—H. H. Cunynghame, C.B.; Hugo Hirst; J. E. Kingsbury; C. P. Sparks; H. E. Harrison; Lieut.-Colonel H. C. L. Holden, R.A., F.R.S.; the Hon. C. A. Parsons, F.R.S.; W. H. Patchell; J. H. Rider; Mark Robinson—remaining in office; Sir J. Wolfe Barry, K.C.B.; B. Drake; S. Dobson, R. K. Gray; A. A. C. Swinton—new nominations.

Associate Members of Council.—W. R. Cooper, M.A., B.Sc., and W. Duddell (remaining in office); S. Morse (new nomination).

Hon. Auditors.—F. C. Danvers (for re-election) and S. Sharp (new nomination).

Hon. Treasurer.—Prof. W. E. Ayrton, F.R.S., past-president.

Hon. Solicitors.—Messrs. Wilson, Bristows, and Carpmael.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE APPROVAL (?) OF THE LONDON COUNTY COUNCIL.

Elsewhere in this issue will be found the general conclusions of the Parliamentary Committee of the London County Council on the various schemes for constructing tube railways in London which are now before the committee of the House of Commons. The report in question was considered and adopted by the Council on Tuesday last, and may be roughly divided into two parts. The first deals with general conditions which the Council wish to impose upon all tube railway undertakings working with parliamentary sanction within the county of London; and the second deals with the individual schemes now under consideration. With the last of these parts we do not propose to deal here, but the general conclusions propose that new powers should be granted to the Council which are quite unnecessary. Apart from this, there is seen in these conclusions a general idea that the Council should not be prejudiced in any way in the future in carrying out their traction schemes, either above or below ground, by the fact that tube lines have been made under the Bills now under consideration—in other words, that the Council shall be allowed to compete with any successful undertaking in the future without making any compensation to the company in question. The first and the more pressing objection to the report before us is that the Council now seek by the adopted conclusions of the Parliamentary Committee to have the control of these deep-level lines within the county of London. For instance, one recommendation reads that "adequate accommodation for the public with respect to entrances to and exit from stations, booking offices, waiting-rooms, etc., should be provided, and that the Council should be empowered to decide whether such accommodation adequately meets the requirement of the public." There are other resolutions of a similar type which suggest the Council's interference "in the construction of the works, in the lighting of the tunnels, in the block working of the trains, in the design of the subways, in the ventilation of the tunnel, and last, but not least, that any articles of value from a geological or antiquarian point of view found by the company shall be at the disposal of the Council." It will be seen from these references that the London County Council wish to supersede the Board of Trade in its control of the working of railways, and even to dispossess his Majesty King Edward VII. of his regal rights to treasure trove. Up to the present the County Council have not had a *locus standi* over parliamentary companies, and even in those other cases where the consent of the Council has to be obtained to public works there has frequently been a reference to the Board of Trade in case of the consent being withheld. It is only fair to say that the history of the numerous instances in which the Council have refused consent to works in the streets required under electric lighting provisional orders is not to the credit of the Council, as their refusal to give consent has frequently been rendered of no effect on appeal to the Board of Trade. Again, in the question of the underground telephone wires, the consent of the Council was refused on grounds which we are sure were not contemplated when Parliament rendered this consent necessary—*i.e.*, that the Council wished to carry out the work themselves, and hence would not grant their consent unless the National Telephone Company worked to their calculated scales of charges. Reverting to the railway question, which requires expert control, the London County Council have not on their staff the trained experts in railway working which would be required to give reasonable decisions on

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the points over which it seeks jurisdiction. We see no reason why such experts should be employed by the Council, and, even if they were, no useful purpose would be served, as it would be simply duplicating the Board of Trade. We look upon these recommendations as insulting to the Board of Trade and to Parliament, and they would be, if passed, disastrous to the deep-level railway enterprises of London. If further examples were needed of the impracticability of the London County Council when new problems are brought before them, we need only mention the case of a proposed large new electrical factory in London, in which they insisted on a front garden being provided to the machine shop. The report in question also wishes to fix eighteen months as the maximum time for the completion of the railways after they have been authorised by Act of Parliament, and proposes that the powers should lapse if the work is not done in that time. Truly, the same clause suggests that the Board of Trade might extend the time. How inadequate the period suggested is will be obvious from the fact that under such a clause, even with a two-year period, the London County Council would lose the power to convert their Tooting tramways for electrical working, as is shown by the report of another committee of the Council appearing in the same agenda. To conclude, the London County Council tramway scheme will have to compete commercially with the new tubes, if made, and hence, if for no other reason, the Council are incompetent to interfere.

TELEPHONE STATISTICS.

As until a comparatively recent date all the telephone work in this country has been in the hands of the National Telephone Company, with the exception of the small amount done by the General Post Office, it has been exceedingly difficult to obtain any reliable data as to the cost of equipping and maintaining telephone exchanges. In this issue, however, we are able to give the full figures of the Guernsey States Telephone Department for the year ending Dec. 31, 1901, and at the end of the accounts will be found a comparative statement which shows the progress of the undertaking since its inception. These figures have been audited by a well-known firm in Guernsey, and are certified as correct. The following deductions from the past year's working will be of interest to all connected with municipal telephone undertakings, as they are not engineers' estimates, but actual results. We see, therefore, that on Dec. 31 last there were 881 subscribers' lines on the system, and that the capital expended on construction was some £15,332. This gives the actual cost per line at £17. 8s.. but we believe that the expenditure has also provided 100 spare or partially completed lines, which would bring the actual cost down to more like £16. 10s. As, however, spares have always to be provided, the first figure is the more useful. Again, by dividing the average revenue by the number of subscribers' lines we find that only £2. 19s. 8d. was the average return. In spite of this low figure, the department, after paying interest on loan, Post Office royalties, working expenses, etc., was able to set aside £1,752 for depreciation and sinking fund, which is practically 10 per cent. on the total capital expenditure for the construction of the works and for the land on which the buildings have been erected. After so doing there still remained a profit of about £117 to the undertaking. A careful perusal of the comparative figures for the various years since the undertaking was started will be of interest, as it shows which system of subscription finds most favour in Guernsey, as evidenced by the number of subscribers who have signed agreements. The success of this undertaking is a great credit to the department and to their consulting engineer, Mr. A. R. Bennett.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

STAFF ORGANISATION.

SIR,—Allow me to congratulate you on your excellent article of last week about "Staff Organisation" (Brush Company). This company gets orders without competition from associated companies, etc., the British Electric Traction Company, and yet they cannot pay a dividend. What would be the financial result if they had to compete in the open market for all their orders? Apart from this, the capital of the Brush Company seems too big, and there seems to be too much water in it, like the "patent account."

The final result of all such manufacturing concerns more or less associated with promising concerns has always been disastrous for both. This has been proved lately by numerous examples from Germany and from France.

The fact is that the connection between financing and manufacturing companies having in most cases the same directory becomes in the course of time so entangled that it is difficult to make out where one company begins and where the other ends. Orders are given to the manufacturing company, which makes a paper profit, as it is generally not paid in cash, while the financial concern makes a similar paper profit on the promotion, the capital, as a rule, not being taken up by the public or part of it only, so that the remainder has to be taken up by the promoting concern. In order to get fresh capital, the promoting concerns generally increase their own capital to the utmost limit. This is possible as long as the shares stand at a premium and a good dividend is paid, though part of this dividend may be made up of paper profits. But once this premium of the shares is lost, the raising of fresh capital becomes nearly impossible, and a "reconstruction" of both the promoting and manufacturing concerns becomes inevitable.

The recent examples from Germany and France should serve as a warning to the British investing public, and honest newspapers should not miss an opportunity to warn the public against investments in such concerns.—Yours, etc.,

M V².

FORTHCOMING EVENTS.

FRIDAY, APRIL 25.

Royal Institution.—At 9 p.m., Mr. J. M. Davidson on "X-Rays and Localisation."

Physical Society.—At 5 p.m. Papers: "An Exhibition of a Mechanical Break for Induction Coils," by Dr. Dawson Turner; "A Temperature Indicator for Use with Platinum-Thermometers, in which Readings are Automatically Reduced to the Gas Scale," by Mr. R. S. Whipple; and "Note on the Compound Pendulum," by Mr. S. A. F. White.

MONDAY, APRIL 28.

Society of Arts.—At 8 p.m., Dr. R. T. Glazebrook on "Glass for Optical Instruments" (Lecture III.).

TUESDAY, APRIL 29.

Institution of Civil Engineers.—At 8 p.m., annual general meeting.

WEDNESDAY, APRIL 30.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., ordinary meeting. Paper: "The Electro-Deposition of Metals," by Mr. R. Smith.

THURSDAY, MAY 1.

Institution of Electrical Engineers.—At 8 p.m., extra meeting. Paper: "Automatic Relay Translation for Long Submarine Cables," by Mr. S. G. Brown.

Rontgen Society.—At 8.30 p.m., ordinary meeting. Discussion on "The Relation between X-Rays and Allied Phenomena in Light and Electricity," to be opened by Mr. E. Payne.

FRIDAY, MAY 2.

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. Paper: "Some Factors in Colonial Railway Construction," by Mr. Lewis H. Rugg.

Royal Institution.—At 9 p.m., Mr. A. E. Tulton on "Experimental Researches on the Constitution of Crystals."

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TUBE BILLS IN PARLIAMENT.

PROCEEDINGS IN COMMITTEE.

FRIDAY, APRIL 18.

The Select Committee of the House of Lords appointed to consider the whole of the Bills promoted in this session for powers to construct underground railways in London resumed their sittings in the Grand Committee Room, Westminster Hall, Lord Windsor presiding. The consideration of the Charing Cross, Hammersmith, and District Electric Railway Bills (Nos 1 and 2) was proceeded with.

Mr. Baggallay, K.C., for the promoters, first called further evidence with regard to the financial position of the proposed line.

Mr. Hanson, of the firm of Messrs. Coates, Son, and Co., stock-brokers, Gresham-street, said he thought this was a scheme for which the capital would be found, and in which his firm had sufficient confidence to recommend it to their *clientèle*. Cross-examined, he said he did not know that the line was seriously over-capitalised, though he admitted that, if there was an excess of capital of £850,000 over the engineering requirements, it was a large and serious sum. He had no information as to the financial competence of the promoters.

Mr. Markham, M.P., was next called, and said that, speaking with considerable experience of electrical railways and engineering schemes, he was strongly of opinion that, all things being equal, it was in the interests of the trade of this country that these underground railways should be made by British capital. If they were made by American capital, the whole of the machinery and plant would be supplied from America to the great detriment of British trade. Cross-examined, witness said that to his own knowledge the whole of the order for the electrical machinery of the District Railway was going to America. He was perfectly well acquainted with the fact that the British Westinghouse Company were at the present time erecting shops in Manchester, but all the machinery was made in America.

Mr. Mark Robinson, chairman and managing director of Messrs. Willans and Robinson, and one of the promoters of the line, said that Mr. J. C. Cunningham, ironmaster, Mr. Noble, of Messrs. Armstrong, Whitworth, and Co., and Colonel Baring had, he understood, consented to join the board of directors. When he associated himself with this enterprise an agreement was made that his firm should obtain some of the engineering work in connection with it, and they had entered into a contract for executing part of the works.

Mr. Meik, joint engineer of the line, recalled, said his estimate of cost left a balance of £435,000 on the proposed share capital, and out of that they had to meet the cost of underpinning, which was an unknown quantity, compensation for constructional damage, and so on. His estimate for equipment was about £500,000, leaving a margin on the borrowing powers of £600,000.

Mr. Pember: That leaves them with over £1,000,000 to play with.

Mr. R. E. Middleton, C.E., joint engineer of the railway, said he believed the whole of the line would be constructed in the London clay.

Mr. A. A. Campbell Swinton, electrical engineer, and **Mr. J. Brunlees, C.E.,** also gave evidence in favour of the proposed line.

This concluded the promoters' case, and, after deliberating, the **Chairman** announced that the committee had reconsidered the position fully, and had resolved to hear the promoters' case on each of these competing Piccadilly schemes before giving any decision.

The case of the Piccadilly and City Railways (Nos. 1 and 2) was then taken.

Mr. Balfour Browne, K.C., for the promoters, said the proposal his clients now asked the committee to sanction was the construction of a railway commencing with a junction with the North-East London line, and running the whole way from Ludgate-circus, Fleet-street, past the Temple and the Law Courts, through Charing Cross, Piccadilly-circus, Albemarle-street, and so on, on the same route as that proposed in the Charing Cross Bill, to Hammersmith, terminating where the great system of electric tramways coming from the west terminated. The gentlemen who were promoting the Piccadilly and City Railway, in conjunction with the North-East London Railway, were a very strong financial group. The principal promoter of this Bill was Mr. Clinton Dawkins, who was an Englishman. The others included Mr. John Pierpont Morgan, jun., Messrs. Siemens Bros., Mr. von Chauvin, and the Hon. Egremont Mills, and there would be no difficulty whatever in raising the capital for this railway and for the North-East London line. The London United Electric Tramways Company and the Piccadilly and City Company had recognised that the railways from Charing Cross to Hammersmith would probably not be sanctioned. They had seen that it was most important that two great bodies of financiers should not fight if it was possible to come to some mode of living peaceably, and they had, therefore, arrived at an arrangement which would be submitted to the committee. The line of the London United from Hyde Park-corner to Hammersmith Broadway was practically identical with the line he was promoting. They did not, however, comply with the committee's report of last year, and make a through route, their line terminating by a loop at Charing Cross. The London United were now quite prepared to drop that portion of the line and to take instead the through route which his clients had proposed by Piccadilly. This carried them to Ludgate-hill and formed an end-on junction with the North-East London line. There would then be an absolute through route for their great tramway system, which was rapidly approaching completion, to the north-east of London and the City.

The **Chairman**: Then you have practically amalgamated?

Mr. Balfour Browne said that was so, and it had enormously strengthened their financial backing. The arrangement only related to the line between Charing Cross and Hammersmith. In the meantime the London United would promote the cross-line between Clapham Junction and the Marble Arch, while his clients would put their case before the committee with reference to the North-East London line; but ultimately they would be one undertaking. They had also tried to make some arrangement with the Brompton and Piccadilly Railway, but had not succeeded.

The committee adjourned.

MONDAY, APRIL 21.

The consideration of the Piccadilly and City scheme was continued. At the outset the **Chairman** said the committee desired to have further information with regard to the amalgamation of the Piccadilly and City with the London United scheme, as it appeared that the latter made provision for a tunnel of smaller diameter than the former.

Mr. Moon, K.C., for the Piccadilly and City scheme, was of opinion that provision would have to be made by an alteration of the Bill to bring the amalgamating company into line.

For the London United Company, **Mr. Lewis Coward, K.C.,** said that that would be done, and the diameter of the tunnel would be increased to 13ft. 6in.

Mr. Moon then announced that the promoters of the North-East London Railway had abandoned the proposed Walthamstow branch, and had agreed to support the proposal of the City and North-East Suburban Company.

Sir Douglas Fox, the engineer for the North-East London and Piccadilly and City Railways, and also associated with the engineers of the London United and the City and North-East suburban lines, expressed the opinion that to ensure the successful working of tube railways in a city like London the lines should be of considerable extent and not in short pieces, and that so far as possible they should be under one control. The diameter of the tunnel throughout the whole amalgamated scheme as proposed was 13ft. 6in. By this width the line would have an emergency platform, as suggested by Colonel Yorke, and the trains would run at a greater speed. There would be greater air space, better haulage, and better ventilation. The line had been extended from Hammersmith to Shepherd's Bush by a loop, and alternate trains would run in opposite directions round the loop, and then away to the eastward. The Piccadilly and City would run deep under Piccadilly, having stations at Hyde Park-corner, Albemarle-street, and Piccadilly-circus, where they would be in connection with the Waterloo and Baker-street Railway. At Charing Cross there would be an exchange station with the Charing Cross and Euston Railway, and also with the South-Eastern Railway by means of a subway. The line then ran under the Strand to a very excellent site on the County Council's new property—namely, at the south end of their new avenue on the north side of the Strand, in close touch with the Law Courts. The next station would be Ludgate-circus, and then at the Mansion House the station would immediately adjoin that of the District Railway. The line would then continue under the District Railway to the Monument, where there would be an exchange station with the City and South London, and then up Gracechurch-street to Liverpool-street, where it was hoped the Central London would join them. Then it would proceed to Hackney, Shoreditch, Stamford Hill, and Tottenham. At the Monument there would also be a connection with the City and North-East Suburban, which would run to Bethnal Green, Victoria Park, Leyton, Walthamstow, Chingford, and away to the north. There were 9½ miles of tunnel proposed from Hyde Park-corner to Southgate, and four miles open line; the cost of the tunnels was estimated at £4,512,715, and of the open part £337,000, making a total of £4,900,000. The portion of the London United Company's scheme, which would be worked in conjunction with the Piccadilly and City, was 10 miles 3 furlongs long, with an estimated cost of £3,677,000. City and North-East Suburban, with whom the Piccadilly and City had joined, had a line of 15½ miles, 4 miles 1 furlong tunnels and 11 miles 3 furlongs open. The estimate for this was £2,532,988. The total, therefore, for the three lines was £11,110,000, exclusive of works and lands, for the last-named lines. They proposed an eight-car train, divisible into two parts, each half consisting of two motor-cars and two trailers, so that it could form a complete train if necessary. In cross-examination, Sir Douglas Fox said the promoters had agreed with the Office of Works, for the protection of the National Gallery, that they should not come nearer the surface than 30ft. from the top of the London clay. The tunnel would be 78ft. below the surface at the old Lowther Arcade.

Mr. C. Jenkin, electrical engineer, associated with Messrs. Siemens Bros., said it was proposed to have 102 trains, so as to give a 2½ minutes' service over the whole line. The average speed over the whole system would be 18 miles an hour. It was proposed to make an arrangement whereby, if a train did not arrive to its time at any station, the whole of the tunnel could at once be lighted up.

The committee adjourned.

TUESDAY, APRIL 22.

The committee continued their enquiry into the scheme of the Piccadilly and City Bill.

Mr. C. Jenkin, electrical engineer, gave further evidence as to the electrical equipment, power stations, and rolling-stock of the line proposed jointly by the Piccadilly and City, London United Electric Railways, North-East London, and City and North-East Suburban Companies. As a result of the combination it had been possible to introduce certain economies, and he placed the total estimates at £2,700,000.

Major Cardew, consulting electrical engineer, said he had examined the arrangements for the equipment of this line from Hammersmith to Charing Cross and the City, and considered them satisfactory. The proposed wider tunnel was a distinct advantage. It very much reduced the vibration, and from the point of view of the passenger was a great deal healthier.

Mr. R. E. Cooper, C.E., having considered the engineering details of the line, expressed the opinion that the scheme was well laid out. Mechanical ventilation would be introduced into all the tunnels.

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Mr. Clinton Dawkins, senior partner, in the absence of Mr. Pierpont Morgan, in the firm of J. S. Morgan and Co., merchants and bankers, Old Broad-street, said his firm were willing to guarantee to find the whole of the capital, but, at the same time, they had made a bargain with the London United Electric Railways by which they undertook to raise a certain amount. He considered that the capital could be provided in England. The orders for material for various projects had been placed largely in the United States because the material could not be supplied here. His firm had been interested in developing the undertaking of Messrs. Siemens, on the Thames, and also a firm at Rugby, so that in the future they might be able to supply all the materials for the tube railways without having recourse to America. The basis of the arrangement with the London United Company was that there should be through routes and through rates between the tubes and the tramways. They endeavoured to make an arrangement with the Central London Railway, but the two parties came to a friendly understanding that there was nothing to do but fight. They differed on a question of principle—namely, the desirability of a closed-circuit system as against a long through route from the north-east to the south-west. As regarded the District Railway, he had had formal communications with Mr. Yerkes and Mr. Perks, but without result. He thought the route proposed would provide a fair return on the capital and a safe investment for the investing public. By their Bill they were asking for powers sufficient to enable them to provide the capital which would be necessary to place the whole line of 38 miles on a thoroughly satisfactory and dividend-paying basis. The total share capital required was £12,000,000, and £4,000,000 of borrowing powers. The total estimates for construction and equipment were £13,759,801, to which must be added £825,584 for interest at 3 per cent. paid out of capital for two years. This left them with a margin of just less than £1,500,000, and he did not think that margin could possibly be reduced further in view of the contingencies of a work of this kind. He did not think they could go direct into the market and raise £16,000,000. There was not a single one of these tube projects in London that had gone direct to the public, except the City and Waterloo, which had the guarantee of the South-Western Railway Company of 3 per cent. on the capital behind it. The cost of raising the capital of £16,000,000 would work out at something like 8 per cent. Under cross-examination the witness denied that Mr. Yerkes's scheme would have any influence at all upon the raising of capital.

In answer to Viscount Knutsford, the witness said there would be four companies and four sets of shareholders unless they applied for powers to amalgamate.

Mr. G. White, chairman of the London United Tramways, said the promoters of the London United Electric Railways were, in fact, his company. In reply to a question as to the future management, the witness said that their view was that there would be a joint board of directors, representing the four companies, and they would manage the whole undertaking.

Mr. J. Clifton Robinson, managing director and engineer of the London United Electric Tramways Company, described the scheme before the committee in relation to the existing and authorised tramways of the company, and expressed the opinion that the linking-up of the trams with the railways to Charing Cross and the City, as well as to Piccadilly and the West, would be a great convenience to the public. He estimated a traffic over the 38 miles of railway of 252,750,000 passengers per annum. On that basis the earning capacity of the line would be £1,505,988 per annum. Taking the working expenses at 50 per cent., though he had no doubt they would be lower, the estimated profit would be £752,944, or 4·7 per cent. on the capital outlay of £16,000,000.

The committee adjourned.

WEDNESDAY, APRIL 23.

The consideration of the competing Bills of the Piccadilly group was continued.

Mr. J. Clifton Robinson, continuing his evidence, said that he did not see how they could give the District Railway through bookings over the proposed line at any point. He did not admit that the absolute result of the present scheme would be to establish a monopoly in favour of their tubes. So far as the route from Hammersmith to the City was concerned, there would be a healthy competition. He was not aware that Colonel Yorke had stated that an all-night service of trains on tubular railways was an impossibility, and that an interval of four hours at least was absolutely essential for the inspection of the permanent way and the execution of repairs. It was proposed to have differential fares on the railway.

Mr. Fraser, engineer of the London United Electric Railways in conjunction with Mr. Clifton Robinson, and joint engineer for the City and North-East Suburban Railways, gave evidence in relation to so much of the combined scheme as is promoted by the London United. He gave it as his opinion that the combined route proposed offered exceptional advantages in economy of working and to the public in the matter of routes and fares. Questioned as to whether any danger to the Albert Hall was to be anticipated by the boring of the tubes, the witness explained that the centre line would be about 150ft. away from the Albert Hall, and at that point about 75ft. under the surface, and well into the London clay. He thought the insertion of a compensation clause in the Bill was unnecessary in this respect. Such a clause was a dangerous obligation for a company to undertake, as it lasted for all time. He objected to it most strongly, even though it was inserted in the City and North-East Suburban Bill for the protection of the City and Waterloo Railway.

Evidence having been given in favour of the scheme, on the ground that it would help to relieve the congestion in the centre,

Mr. Buckland, surveyor, said his valuation of the necessary land and easements for the combined line of the North-East London and the Piccadilly and City Companies from Southgate to Hyde Park-corner was £1,810,000.

Mr. W. J. Bull, M.P., supported the scheme. He was strongly of opinion that there should be competition, rather than amalgamation, with the Central London along this route.

This concluded the case for the London United Electric Railways Company, and

Mr. Balfour Browne, K.C., then briefly opened the case of the North-East London and the City and North-East Suburban lines. Last year these companies were opposing each other. The total length of the City and Suburban line was 15½ miles, only four miles of which were in tube, while the North-East London line was 13¾ miles long, of which 9½ were in tube. The remaining length in each case ran in the open. These lines might be useful even without the connection with the main line from the City to the West-end, but they would not be nearly so useful as with it, and it was for that reason that the combination with the Piccadilly and City and the London United Electric Railways had taken place. The central line from Hammersmith to Charing Cross was, of course, the pivot on which the whole scheme, to a large extent, depended. The only real opposition they had to meet was that from competitive railway companies.

The committee adjourned till to-day (Friday).

THE LONDON COUNTY COUNCIL AND THE BILLS.

At this week's meeting of the London County Council the Parliamentary Committee presented a long report on the action they are taking with regard to the Tube Bills now before Parliament. As showing the exhaustive nature of the report, it may be mentioned that it occupies eight pages of the Council's agenda. Having enumerated the steps they took in order to obtain the fullest information as to the various schemes proposed for London, the committee give the following as their general conclusions:

"That confluent junctions should not be allowed. That, as far as possible, stations should not be constructed in such positions as would result in the discharge of passengers into very crowded thoroughfares. That a model workmen's train clause, in a form which we have settled, should be inserted in the Bills. The effect of this clause will be to require workmen's tickets to be issued at all stations availlable by all trains timed to arrive up to 8 a.m., at fares not exceeding 1d. for the single journey and 2d. return, the return tickets being available by any train starting the same day from any station within the distance covered by the ticket. In cases where two or more schemes are to be worked in connection with one another this clause should apply to such schemes taken together as if they were one line. That in no case should there be any interference with or damage done to any of the Council's parks and open spaces. That unless promoters have within 18 months from the passing of the Act conferring statutory powers upon them substantially commenced to carry out their undertaking, and have completed and opened their undertaking for the use of the public within the period prescribed by such Act, their power shall cease to be exerciseable except as to so much of the undertaking as shall then have been completed, unless the time allowed be prolonged by the special direction of the Board of Trade, the exercise of the powers with regard to the works completed being left to the decision of the Board of Trade. That all tunnels should be properly ventilated. That adequate accommodation for the public with respect to entrances to and exits from stations, booking offices, waiting-rooms, etc., should be provided, and that the Council should be empowered to decide as to whether such accommodation adequately meets the requirements of the public. That a system of electric lighting in tunnels should be provided by the company in such a manner as to enable lights to be turned on from any signal box in the event of an accident or stoppage of trains occurring in the tunnel, so that passengers would be enabled to see to walk to the nearest station, the current supplying these lights not being liable to be cut off in the event of any accident to the main supply of current for electrical traction. That a footpath should be provided along the tunnels between the metals so that, in the event of any accident or stoppage of trains, passengers could walk in safety to the nearest station. That the use of any inflammable materials in the construction of cables, platforms, carriages, and other things in or about the tunnels and stations should be avoided as far as possible. That, if practicable, some automatic arrangement should be provided so as to render it impossible, in the event of a train being stopped between two stations, for the following train to run into it. That the fact of parliamentary powers being given to the promoters of a tube railway scheme should not prejudice the Council's interests when seeking powers at any future time to construct tramways or shallow tramways along the same routes. That the Council's approval to the design of all buildings, structures, and works proposed under the Bills and fronting upon public road or streets should be required. That buildings used partly as stations and partly as domestic buildings should be in accordance with the provisions of the London Building Acts relating to domestic buildings. That where it was proposed to break up the public way to carry out works, moving machinery should be screened from view, and the disfigurement of the locality by the erection of unsightly hoardings should be prevented. That where any proposed railway would intersect lands in London likely to be developed by the formation of streets thereon, the company should be required to make bridges of sufficient width and headway or such other provisions as would admit of new streets on either side of such railway being constructed. That the promoters should undertake to facilitate the construction of interchange stations with tube railways existing, or proposed, or to be hereafter proposed and constructed, and through booking on the lines with which opportunities for interchange are

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afforded. That the Council should have control over the subways to be constructed under the Bills for the use of the public."

The committee go on to express the opinion that the Council should not seek to endeavour to obtain the insertion of any clauses in these Bills which would hamper promoters and place difficulties in the way of the carrying out of their undertaking; yet in addition to the more or less general requirements set out above, they recommend that in many of the Bills clauses are needed to effect the following, among other, objects:

"To protect the Council's existing sewers and such new sewers as may be constructed; to apply the provisions of the London Building Acts; to prevent the construction of buildings beyond the general line of building in any street; to require companies to obtain the Council's consent to the construction of works at a less depth than 25ft. below the surface of public thoroughfares or open spaces, and to provide for such works to be in accordance with plans approved by the Council's engineer; to prescribe conditions to be observed in cases where companies desire to carry out borings from the surface of streets and to provide for the Council to be furnished with information as to the strata traversed in any borings; to provide that roads or streets to be carried over bridges to be constructed in connection with the railway shall not be of a less width than at present, and that such bridges shall be 40ft. in width between parapets, and should be so constructed as to prevent the escape of steam, smoke, etc., into any such road or street; to prevent the dripping of water from bridges to be constructed over streets, and to require the use of white glazed bricks to face the abutments of bridges; to provide for the setting back of the line of frontage of stations and buildings so as to increase the width of thoroughfares and spaces in front of stations; to prevent flanks of buildings partly demolished being left in an unsightly condition for a period longer than is necessary; to enable an officer duly appointed by the Council to enter upon and inspect underground works of the company within the county; to provide for objects of geological or antiquarian interest discovered by the company in the execution of their works in London, and not being proved to be the property of any other person, to be at the disposal of the Council; to prevent the construction of ventilators or air shafts, etc., in any roadway or footway; to protect the Council's tramways where they may be affected by the works proposed in the Bills; to prevent the company from generating or supplying electrical energy otherwise than for the purposes of their authorised undertaking; to require companies to obtain the Council's consent to the exhibition of placards or advertisements within view of any public street."

The report goes on to give in detail the decisions arrived at with regard to the individual schemes, grouping into four classes as follows: (1) schemes which, subject to certain conditions, should not be objected to by the Council; (2) schemes which, subject to certain conditions and to the attention of the Select Committee being drawn to the financial proposals contained therein, should not be objected to by the Council; (3) schemes which, subject to certain conditions, might be considered satisfactory, except for the financial proposals which they contain, but which on that account require to be strenuously opposed by the Council; and (4) schemes which on general grounds are unsatisfactory, and consequently should be opposed for the most part *in toto*. Under the first head are included the following schemes: Baker-street and Waterloo Railway, Central London Railway (New Lines), Edgware and Hampstead Railway, Great Northern and City Railway, Great Northern Railway (No. 2), Great Northern and Strand Railway, Islington and Euston Railway, and North-West London Railway. The next group of Bills which the committee recommend should not be objected to, subject to the attention of the Select Committee being drawn to the financial proposals (Class 2), contains only three Bills as follows: City and Crystal Palace Railway, City and North-East Suburban Electric Railway (Nos. 1 and 2), and North-East London Railway (Nos. 1 and 2). In the first of these schemes the capital sought to be raised is at the rate of about £695,000 a mile, and the committee consider that this is too heavy, having regard to the fact that part of the line will be in open cutting. As regards the City and North-East Suburban line, they state that the proposed capital of £4,000,000 is somewhat excessive. As to the last of this group—*i.e.*, the North-East London scheme—the committee state that the £500,000 per mile as proposed is an excessive rate of capitalisation, and in addition to this, they consider that the amount of interest proposed to be paid out of capital (£900,000) is far too large. The next group comes under the third head given above, and these are to be "strenuously opposed" by the Council on financial considerations. They are: King's-road Railway (No. 1) and King's-road Railway (Putney Extension), and West and South London Junction Railway. In the first of these two schemes capital powers to the extent of £3,332,000 are sought, and it is provided that interest to the amount of £350,000 may be paid out of capital during the construction of the line. The capital proposed would work out at no less than about £800,000 per mile, at which figure the committee think the line would be very much over-capitalised. As regards the other Bill included in this paragraph, capital powers are sought to the extent of £3,000,000, which works out at about £677,000 a mile. This appears to the committee to be an excessive capitalisation. They also think that £416,000 as the amount of interest which may be paid out of capital is too large.

Under the fourth class come the following Bills: Brompton and Piccadilly-circus (New Lines and Extensions), Charing Cross, Euston, and Hampstead (Nos. 1, 2, and 3), Charing Cross, Hammersmith, and District Electric Railway (Nos. 1 and 2), City and Brixton Railway, London United Electric Railways, and Piccadilly and City Railway. These are to be opposed by the Council on general grounds.

As to the Brompton and Piccadilly-circus scheme the promoters have not yet commenced to carry out any portion of their undertaking first authorised in 1897, and this is the main ground of the Council's opposition to the railway. In the case of the Charing Cross, Euston, and Hampstead Railway the committee states that the total capital proposed to be raised under the three Bills of the promoters amounts to £5,200,000. This is at the rate of nearly £1,000,000 per mile for the new lines and, so far as they can judge, there does not appear to be any explanation for this extremely high rate of capitalisation. On other grounds as well the committee have decided to oppose this scheme so far as new lines are concerned. The promoters of the Charing Cross, Hammersmith, and District Electric Railway propose to raise capital at the rate of about £520,000 a mile, which amount the committee consider to be unduly large when compared with the scheme of the Central London Railway Company (£465,000 per mile). They are of opinion that this scheme should be rejected. As to the City and Brixton Railway, the promoters have not carried out any part of their already authorised undertaking, and on this and other grounds the committee consider that Parliament should refuse to grant an extension of time to the company. In regard to the London United scheme, the committee say that the route to be traversed to a very great extent is similar to that covered by the new proposals of the Central London Railway Company. They do not think Parliament should sanction the north to south communication, and, having arrived at the conclusion that the scheme of the Central London Railway Company is more calculated to meet the public requirements, they are of opinion that Parliament should be asked to reject the other portion of this scheme.

In the Piccadilly and City Railway Bill capital powers are sought to the extent of £6,800,000, which works out at the excessive rate of no less than £975,000 per mile. This is another scheme which seeks to traverse a route similar to that covered by proposals put forward by the Central London Railway Company. With a view to arrangements being come to with promoters, and the insertion of amendments to give effect to the conclusions which they have set out above, the committee have given instructions for negotiations to be entered into with the several companies concerned, with a view to avoiding as far as possible contests before the committees of Parliament on the Bills.

The Highways Committee also presented a report on the same subject, in which they urged the necessity of some specially constituted body being established to which new schemes for the provision of means of transit in London may be referred, in order to secure uniformity and systematic action in this matter; and expressed their regret that his Majesty's Government have not seen their way to take some action on the line of the suggestion made by the Joint Committee. It appeared to them that the course taken of referring the various schemes for tube railways to separate committees of Parliament will tend to make the task of the Council in dealing with, and if necessary opposing, the proposals a somewhat difficult one. The committee expressed no opinion as to the composition of such a body as suggested, but the object they have principally in view is uniformity with regard to a question in which a definite and well-considered policy is of vital importance.

During the course of a long discussion on the above reports at the meeting of the Council on Tuesday, members of both parties concurred in the opinion that the tubes should be under the control of a central body; and it was also suggested, as all were agreed that there should be some uniform system, that the Council should represent their views to the Lords' Committee now considering the 26 Bills before Parliament, even if such a course would have the effect of delaying the completion of the proposed new lines for 12 months or so. Both reports were ultimately adopted.

WALSALL ELECTRICITY ACCOUNTS.

From the accounts of the Walsall electricity department (just issued) it appears that the total expenditure on capital account to Dec. 31, 1901, amounts to £43,339. Appended are abstracts of the revenue account, general balance sheet, and statement of electricity generated, sold, etc., for the past year.

Dr. REVENUE ACCOUNT.	£	s.	d.
Generation of electricity	1,776	8	7
Repairs and maintenance of buildings, plant, etc.	714	15	11
Distribution of electricity	101	13	4
Attending and repairs to public lamps	82	12	10
Rents, rates, and taxes	335	18	8
Management expenses	359	14	11
Special charges—insurance	23	9	3
Total expenditure	3,394	13	6
Balance carried to net revenue account	2,196	19	2
	£5,591	12	8

Cr.	£	s.	d.
Sale of current for lighting and power, less discount	5,003	15	2
Public lighting	488	0	0
Rental of meters	99	17	6
	£5,591	12	8

Dr. GENERAL BALANCE-SHEET.	£	s.	d.
Sundry creditors on open account	2,092	16	5
Deposits returnable	78	16	6
Amount due to borough treasurer on wages account	12	19	6
Sinking fund—less loans paid off	3,528	9	7
Reserve for discount on current	200	0	0
Balance at credit of capital account	2,158	14	4
Balance at credit of net revenue account	106	6	1
	£8,178	2	5

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Cr.	£	s.	d.
Stock on hand	54	10	2
Sundry debtors for current, meter rents, etc.	2,184	2	8
Amount in hands of engineer	5	0	0
Amount due on current account	3,297	13	11
Amount due on loans sinking fund	600	8	10
Consolidated loans fund	2,036	6	10
	£8,178	2	5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated, B.T. units		479,865
Quantity sold: Public lamps	29,280	340,232
Quantity sold: Private consumers by meter	310,952	
Quantity used on works		18,510
Total quantity accounted for		358,742
Quantity not accounted for		121,123
Number of public lamps		19
Total maximum supply demanded (kilowatts)		347

GUERNSEY STATES TELEPHONE DEPARTMENT.

We give herewith the balance-sheet, revenue statement, and statistics of the above department for year ending Dec. 31, 1901. The council consists of Major-General F. B. Mainguy, R.E. (president); Rev. G. E. Lee; Captain Carré, R.N.; John Leale; D. C. Le Pelley; A. C. Quick; C. J. Watts; J. H. Parsons. Mr. A. R. Bennett, M.I.E.E., 65, Renfield-street, Glasgow, is the consulting engineer; and Mr. Robert McLean, Clifton, St. Peter-Port, Guernsey, manager and engineer.

BALANCE-SHEET.

Dr. Liabilities.				£	s.	d.
Capital account—advances from States				19,085	0	0
Reserve account for depreciation	£1,482	11	9			
Capital sinking fund account	269	16	4			
				1,752	8	1
Sundry creditors—On stores account	75	15	11			
On construction account	79	13	2			
On royalty account	34	16	5			
For expenses and generally	29	4	6			
				219	10	0
Net profit for year ended Dec. 31, 1901	117	11	2			
Less loss to Dec. 31, 1900, £300. 19s. 6d.; and adjustment account, being calls for one quarter ended Dec. 31, 1900, not included in revenue account for 1900, £221. 15s. 8d.	79	3	10			
				38	7	4
				£21,095	5	5

Cr. Assets.				£	s.	d.
Construction account—viz.:						
Land and permanent buildings	£2,241	18	11			
Works completed and in course of construction	15,292	3	8			
Expenses incurred in connection with above	39	19	9			
				17,574	2	4
Stores on hand	705	9	0			
Tools on hand	133	9	10			
Stationery on hand	31	7	3			
				870	6	1
Office furniture				100	10	2
Sundry debtors	136	8	8			
Sundry debtors for calls, one quarter to Dec. 31	287	19	6			
				424	8	2
Seventeen Guernsey 3 per cent. States bonds at cost				1,700	0	0
Cash at bankers on deposit account	66	0	11			
Ditto on current account	352	15	4			
Cash in hand	7	2	5			
				425	18	8
				£21,095	5	5

REVENUE ACCOUNT.

Dr. Expenditure.				£	s.	d.
Working expenses: Salaries of operators	£405	5	11			
Line repairs	110	3	8			
Instrument repairs	98	1	10			
Roof repairs	21	19	8			
Wayleave rentals	2	2	2			
Written off tools account	14	16	7			
				652	9	10
General expenses—Management	55	5	5			
Rent, rates, gas, etc.	42	14	8			
Interest on capital	425	2	8			
Post Office royalty	251	4	5			
Commission on public telephone receipts	24	5	11			
Repairs to premises	15	19	9			
Auditors' fees	17	13	9			
Law charges	1	2	6			
				833	10	1
Office expenses—Salaries	128	17	6			
Books and stationery	84	19	9			
Postages	22	0	5			
Written off furniture account	5	5	10			
				241	3	6
Depreciation 4 per cent. on amount charged to construction account, calculated monthly	628	9	9			
Capital sinking fund account 1 per cent. on the amount charged to construction account, calculated monthly	157	2	5			
				785	12	2
Balance, being net profit for the year				117	11	2
				£2,630	6	9

Cr. Receipts.	£	s.	d.
Revenue receipts—Public telephones	189	9	3
Exchange rentals	1,279	6	4
Private rentals	41	10	0
Sundry rentals	13	3	9
Calls	1,059	18	1
Advertisements	2	2	0
Shifts	1	18	2
Sales	1	6	4
	2,588	13	11
Interest on deposit account	3	10	2
Interest on States bonds	38	2	8
	£2,630	6	9

Statistics to Dec. 31, 1901.

Description and number of	From July 28 to Dec. 31, 1898.	1899.	1900.	1901.	Inc. for 12 mo.
Subscribers' lines	217	423	606	770	164
Extension lines	10	21	32	41	9
Private lines	2	5	6	14	8
Public telephones	9	20	26	34	8
Sundry lines	3	3	3	15	12
Service lines	3	3	5	6	1
Free lines	—	1	1	1	—
Junction lines	7	14	16	22	6
Switchrooms	3	6	7	8	1
Poles	255	773	916	1,062	146
Standards on roof	9	11	9	9	—
Fixtures to buildings	275	742	1,000	1,241	241
Underground cables	3	9	11	13	2
Underground cables (distributors)	6	18	22	22	—
	Miles.	Miles.	Miles.	Miles.	
*Metallic circuit wire, overhead	146½	293½	423	581	158
Metallic circuit wire, underground	2¼	62¼	132	140½	8½
Metallic circuit, leading in cables	5¾	9¾	16	18.490y	2.490y
Metallic circuit, from outside wires to subscribers' instruments—	1⅛	2½	4	6¾	2¾
Metallic circuit from cables to switchrooms—	1	1¾	3¼	4.280y	1,600y
Average number of subscribers' and public telephone connections per day (excluding Sunday)	146	449	804	1,170	366
Average number of connections per subscriber and public telephone per day (excluding Sunday)	·9	1·26	1·5	2·1	·6
Total number of subscribers' and public telephone calls in the year—	23,172	143,530	257,138	379,342	122,204
Total number of telegrams, express and ordinary letters telephoned to Post Office—			From Aug. 10.		
	—	—	363	2,373	2,010
Number of subscribers on No. 1 tariff (£1. 10s. per annum and 1d. per call)	181	383	559	678	119
Number of subscribers on No. 2 tariff (£5 per annum and 3,200 calls without further payment)	17	21	24	39	15
Number of subscribers on No. 3 tariff (£2. 5s. and ½d. per call)—	19	19	23	53	30
Employés—Engineer	1	1	1	1	—
Manager	—	—	1	1	—
Clerks	1	1	1	2	1
Inspectors	2	4	4	6	2
Operators (female)	6	12	13	15	2
Operators (male)	2	2	3	3	—
Foremen	2	2	2	2	—
Linesmen, labourers, etc.—	12	11	14	13	1 dec.

* The mileage of single wire is double this.

APPOINTMENTS VACANT.

Clerk, York Corporation, £120 per annum, May 12. Full particulars in our advertisement columns.

Resident Electrical Engineer, Falkirk Town Council, £160 per annum. Full particulars in our advertisement columns.

Junior Assistant Engineer, York Corporation, £78 per annum, May 12. Full particulars in our advertisement columns.

Inspector of Fire Alarms, Bradford Corporation fire brigade department, £95 per annum, April 26. Full particulars in our advertisement columns.

Chief Assistant Engineer, Devonport electricity works department, £130 per annum, April 30. Croydon Corporation, £200 per annum, May 8. Full particulars in our advertisement columns.

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LEGAL INTELLIGENCE.

TUBE COMPENSATION CLAIM.

On the 17th inst. in the London Sheriffs' Court, before Mr. Under-Sheriff Burchell and a special jury, Mr. Wm. Howard, the holder of the premises, 11, Cornwall-terrace, Regent's Park, made a claim against the Baker-street and Waterloo Railway Company for compensation for damage alleged to be due to vibratory causes.

The claimant's counsel explained that the case was one of exceptional interest. Mr. Howard had held the premises in question on a 20 years' lease since 1892. the annual rental being £200, and he entered into a covenant to spend £500 on repairs. In August, 1900, he became aware that a subsidence was taking place, and that the walls of the house were cracking. This deterioration, said counsel, was unmistakably to be attributed to borings that were being made beneath the property by the company. In the course of the borings they had taken away part of the subsoil of the claimant's premises without having given notice to treat, and this, counsel submitted, constituted a distinct trespass. The company afterwards refused to entertain any claim for the soil so interfered with, consenting only to patch up the ground and do some papering and things of that sort. The value of the property, counsel contended, had been deteriorated to the extent of at least £50 per annum, and he asked the jury to award the claimant a minimum sum of £500 as damages.

The defence put in denied the allegation of trespass. It further disputed the claimant's alleged ownership of the piece of ground 69ft. below his premises. On behalf of the railway company it was stated that they would fight this question in the High Courts, as it was one affecting all the tube railway schemes in London. The damage done to the claimant's premises by vibration counsel characterised as infinitesimal, and a number of expert witnesses gave evidence in support of the plea that only trifling damage had been sustained by the claimant.

In the result the jury awarded the claimant £357 damages.

A DISPUTED AGREEMENT.

A curious case came before Judge Emden in the Lambeth County Court on the 16th inst., in which the South London Electric Supply Corporation, Limited, sought to recover from Wm. Bell, fishmonger, of Herne-hill, the sum of £1. 3s. 4d. for electric light supplied from August to December last. The defendant's case was that he only agreed to take the light for a period up to Sept. 29, 1900, and that he signed a document to that effect. The company, however, produced an agreement which purported to bind the defendant to take the electric light for a period of three years, the actual words being, "and this agreement shall be operative under any circumstances for a period of not less than three years." At the trial the defendant swore that these words had been printed into his agreement after he had signed it. The representative of the plaintiff corporation, on the other hand, stated that after the forms of agreement had been printed it was decided to insert the clause in question, and that was the reason for its being in smaller type than the other matter. The clause, however, was printed in before the agreement was signed.

The judge remarked upon the serious nature of the charge made by the defendant.

The representative of the company then asked for an adjournment in order to produce the printer. Some hundreds of cases, he remarked, would be affected by the decision in this action.

The judge eventually granted an adjournment for a fortnight.

COMPANIES' MEETINGS AND REPORTS.

BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS.

The annual general meeting of the shareholders in this Company took place on the 17th inst. at River Plate House, Finsbury-circus, Mr. J. B. Concanon presiding.

The **Chairman** moved the adoption of the report, which was abstracted in our issue of the 11th inst. Dealing with the accounts, he reminded the shareholders that the directors had placed £3,000 to the renewal account, raising that fund to £6,000, and £2,500 to suspense account as provision for compensation cases which were pending at the date of the balance-sheet. That sum, together with the £1,012 charged in the accounts, would probably meet all the liabilities under that head up to Dec. 31 last. The year under review was the first complete year of working electrically, and they had good cause for congratulation on the results. The total receipts for the year exceeded those of 1900 by £20,115, whilst the expenditure was £1,425 less than in 1900, thus showing a net increase of profit of £21,540. All the other principal tramway undertakings in Buenos Ayres showed a very considerable decrease in traffic. As to the prospects for this current year, they had started the first three months with receipts in currency amounting to 420,000dol., compared with 419,400dol. for the corresponding quarter of last year. That showed a small increase in paper, but, unfortunately, the depreciation in the dollar or the premium on gold had been more unfavourable than it was for the corresponding quarter, and their weekly and monthly statements would show that for the three months there appeared to be a sterling loss in traffic of about £1,000, but that was not a real loss. As a matter of fact, a great portion of their expenses were paid in currency—something like 64 per cent.—and the loss on exchange did not affect that figure. Assuming their traffic in currency remained the same for the whole of the year, and that the exchange averaged 140, there would be a nominal apparent loss of £4,000 sterling, but really that net loss would not amount to more than £2,600, for the reason that a great deal of their expenses were paid in currency. The present outlook, however, seemed to point to the fact that there would be a saving of something like 6 or 7 per cent. upon the price of coal for this current year, added to which, owing to their feeder system having been perfected in July last, and to the fact that their motormen were becoming more accustomed to the driving of the cars and more economical in the use of current, they thought they should have a saving under that head also. Under those two heads there would be a saving of perhaps the £2,600 lost in the traffics. With regard to competition, they suffered, and were likely to suffer, less than any other company, for they traversed the principal streets and ran a direct route from the city to Palermo and Belgrano.

Mr. William Wilson seconded the motion, which was agreed to, and the dividends were afterwards declared.

A vote of thanks to the chairman concluded the meeting.

BRITISH INSULATED WIRE.

The report of the directors for the year ended Dec. 31, 1901, states that the gross profits for the year amount to £106,427. 10s.; to which has to be added the balance brought forward from the previous year, £6,763. 15s. 4d.; making a total of £113,191. 5s. 4d. From this have to be deducted the total cost of administration, legal expenses, patent fees, etc., £28,510. 13s. 3d.; depreciation off the buildings, plant, and machinery, £12,000; written off patents and goodwill, £5,000; written off expenses of debenture issue, £1,669. 9s. 11d.; debenture interest for the year, £7,587. 5s. 9d.; interest on preference capital for the year, £21,000; leaving available for dividend, etc., £37,423. 16s. 5d.; of which the interim dividend at the rate of 10 per cent. per annum already paid on the ordinary shares absorbed the sum of £17,500, leaving a balance of £19,923. 16s. 5d. The directors recommend that there be distributed in dividend, making with the interim dividend already paid a total dividend for the year of 10 per cent. on the ordinary shares, £17,500, carrying forward to next account a balance of £2,423. 16s. 5d. During the year the 5 per cent. debentures, maturing on Dec. 31, 1900, were replaced by a larger issue of £250,000 4½ per cent. debenture stock, which was considerably over-subscribed. The addition to the copper mill, anticipated in last year's report, has been carried out with entirely satisfactory results. As the Company's present land was becoming so fully occupied, the directors thought it essential to secure further space for future extensions, therefore a strip of land in front of the Company's property, and also a large field adjacent, have been acquired. Negotiations have been in progress for some time past for a union of interests with a strong and successful company carrying on a business which is, in the opinion of the directors, peculiarly well suited for working in unison with this Company's business, to the great advantage of both. It has been an essential part of the negotiations that the Board shall consist in the first instance of only three representatives from each company. Messrs. John E Pearson and Thomas Snape, whose term of office has expired, have kindly agreed that, if re-elected at the ordinary meeting, they will resign their seats on the completion of the purchase agreement, and their colleagues recommend that the shareholders should authorise the Board to pay to Messrs. Pearson and Snape on their retirement the sum of £500 each, in recognition of their voluntary resignation of office and of their services to the Company.

The annual general meeting of the shareholders in this Company was held on Wednesday at Liverpool, Mr. E. K. Muspratt presiding.

The **Chairman**, in submitting the above report for adoption, remarked that the decreased dividend was due to a considerable decline in the business of the Company in the autumn. Large orders, however, were subsequently secured, and were now being well maintained. A considerable sum had been devoted to the acquisition of two concessions in Australia for electric lighting and electric traction. The object of the directors had been to secure markets for their goods. Up to the present the enterprises had not arrived at a profit-yielding point, but the directors regarded them as of a highly valuable nature, and had no doubt that very shortly they would yield handsome returns. For some time past negotiations had been in progress with the Telegraph Manufacturing Company, of Helsby, for an amalgamation, and he was glad to say that since the issue of the report the negotiations had been carried through, and the amalgamation was now completed. The Helsby Company was a highly prosperous concern, which manufactured not only cables, but electrical accessories. The amalgamation would have the important result of doing away with competition, and, further, of enabling the British Insulated Company to tender for electrical installations from beginning to end instead of, as hitherto, for the cable portion only.

Having been seconded, the motion was agreed to.

NORWICH ELECTRICITY.

The annual general meeting of the shareholders in the above Company was held at the works at Norwich, Sir Chas. Gilman presiding. The report of the directors called attention to the provisional agreement entered into between the Company and the Norwich Town Council, providing for the taking over by the latter of the assets and liabilities of the Company, as of a going concern, from Dec. 31 last, subject to the payment of a dividend of 6 per cent., free of income tax, for the year 1901, which would absorb £4,776. 0s. 10d., out of the balance of £5,113. 15s. 2d. standing to the credit of the net revenue account. Dividend warrants for this amount would be sent to the shareholders immediately after the annual meeting. Three and a quarter per cent. interest, free of all expense and of income tax, was to be paid by the Corporation on the amount agreed to be paid for

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the undertaking from Jan. 1, 1902, to the date of the completion of the purchase. The Bill which the Corporation were promoting before Parliament, upon the carrying of which the ratification of the agreement depended, was practically unopposed, and there seemed every prospect that it would receive the Royal assent. The directors desired to thank the shareholders for the confidence and support they had given them during the past 10 years, and to congratulate them upon the success of the Company, and to express the hope that they considered the terms on which its business had been transferred to the city satisfactory. As the management of the affairs of the Company would not pass out of the hands of the Board for some months, the shareholders were asked to re-elect the Mayor (Mr. R. J. Colman) and Mr. A. R. Chamberlin, the two directors who retire this year by rotation.

Sir Charles Gilman formally moved the adoption of the above report, **Mr. E. Wild** seconded, and it was adopted unanimously.

The **Chairman** next moved that a dividend of 6 per cent. for the year ending Dec. 31 last be paid to the shareholders, in accordance with the agreement made with the Corporation

This was seconded, and agreed to.

DUDLEY, STOURBRIDGE, AND DISTRICT ELECTRIC TRACTION.

The ordinary general meeting of the shareholders in this Company was held at Donington House, Victoria-embankment, on Monday, Mr. C. H. Hilton presiding.

The **Chairman,** in moving the adoption of the report, congratulated the shareholders upon the result of the year's working. For the year the traffic receipts amounted to £34,500, being an increase of more than £16,000 over the preceding year, and the net profit was £11,743, as against £6,900 for the previous year. In dealing with the balance-sheet, he noticed that the debenture stock authorised of £100,000 appeared on the debit side for the first time. The directors, as he stated at the last meeting, only proposed to issue £60,000 of this stock at present, and this had been issued since the date of the present balance-sheet. This money would be applied to the extension to Lye, for increasing the power of the output to keep up with the increase of service. The directors had had many schemes before them for this purpose, and had adopted the most economical which would efficiently cope with the increase which might be caused by the extended system and the increased service now being run. The system adopted after great consideration had been the installation of a battery sub-station near the junction of the Kinver line with their main line.

Mr. A. H. Marks seconded the motion, which was agreed to.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION.

A special meeting of the above Company was held in Cardiff on the 17th inst., when the following gentlemen were appointed directors: Mr. Robert Forrest, Mr. Archibald Hood, Mr. W. S. Bright McLaren, Lieut.-General Sir Richard Hieram Sankey, K.C.B., R.E., Mr. J. Weston Stevens, and Mr. Hugh Watts. Mr. Archibald Forbes was appointed chairman. The capital of the Company as authorised by Act of Parliament is £750,000, divided into 75,000 shares of £10 each, with power to issue £250,000 debenture stock. The trustees for the debenture stockholders are Sir W. T. Lewis and Mr. Ernest Ruffer.

BAKER STREET AND WATERLOO RAILWAY.

The report of the directors for the half-year ended Dec. 31 last states that effect has been given in the accounts to the terms of the agreement for the transfer of the contracts so far as they relate to the old contractors, although the agreement was not actually sealed until after the end of the half-year. Owing to the limited funds at the disposal of the Company during the past half-year the directors were not able to proceed with the works as rapidly as they would have wished, but a contract having been entered into with the Metropolitan District Electric Traction Company, Limited, as stated in the circular issued on March 7 last, the works are now being pushed on as rapidly as possible. Under an agreement with the Metropolitan District Electric Traction Company, Limited, that company will pay interest at the authorised rate of 3 per cent. per annum during construction. The necessary steps are being taken to safeguard the Company's interest where they may be affected by Bills now being promoted in Parliament. The balance-sheet shows cash at bankers, in hand and on deposit, £23,399; accounts outstanding, £1,314; parliamentary deposits, £107,735; balance at debit of capital account, £22,238. The engineers report that since the date of the last half-yearly report the progress made with the works is as follows: The western station tunnel at Waterloo has been completed. The eastern running tunnel under the river, which was then 90 yards south of the shaft, has been continued, and has reached a point on the south side of the river where it is clear of the water-bearing strata, and safely situated in the London clay. Northwards the eastern tunnel has been continued from the point in Regent-street, near the junction of Conduit-street, to the north side of Oxford-street-circus, where it will join the large station tunnel. The western tunnel remains as last reported. On the northern section of the line the work stands as reported last half-year. At the station works at Waterloo considerable progress has been made with the lift chamber, which will shortly be completely covered in and the surface restored. The underground passages from the shafts to the tunnels are well advanced. At Piccadilly no further work has been done, but it is intended to start the underground passages round the shafts as soon as the contractor can make the necessary arrangements. At Oxford-street the 18ft. shaft has been sunk to the full depth, and the underground passage connecting it with the eastern tunnel has been constructed.

ORIENTAL TELEPHONE AND ELECTRIC.

The report of the directors states that the revenue account shows a credit balance of £14,591. 10s. 1d., transferred to profit and loss. Including £2,673. 15s. 6d. brought forward from 1900, and after deduction of £4,287. 12s. paid as interim dividend on Nov. 1, there remains £12,977. 14s. 7d. for disposal. The directors propose to deal with this sum as follows: to pay a final dividend of 3½ per cent., free of income tax, which will absorb £6,002. 12s. 9d., making with the interim dividend of 2½ per cent. already paid, 6 per cent. for the year; to transfer to reserve £4,000; and to carry forward £2,975. 1s. 10d. The directors much regret to have to record the death in July last of Mr. William Addison, who was for 12 years chairman of the Company, but, owing to failing health, resigned in 1898 in favour of the present chairman. The Indian subsidiary companies have both maintained their dividends of 6 per cent., which have, as usual, been brought into the accounts, and have since been received in cash. The adoption of metallic circuits has for some time back been under consideration, and as the installation of cables would involve large expenditure, negotiations have been entered into with the Government of India for an extension of the licenses of the various companies interested. These negotiations, it is believed, will soon be brought to a conclusion. The Telephone Company of Egypt, Limited, has again been enabled to declare the full dividend of 7½ per cent. on its preferred shares. During the past year a contract was entered into for the underground cabling of Cairo and Alexandria, which it is hoped will be completed during the current year. The Egyptian Government are erecting trunk telephone circuits between these two cities, and when the Company's reconstruction is completed facilities will be afforded to its subscribers for telephonic intercommunication. The China and Japan Telephone and Electric Company, Limited, has paid its debenture interest, but the accounts have not yet been audited. The business at Hong Kong continues to make progress. At this company's own stations the increase of business has been steady, and a license has been granted by the Government of India to open an exchange at Bangalore. The electric lighting branch of the Company has made satisfactory progress during the year, but more capital is required to work this branch with success.

NEW COMPANIES REGISTERED.

P. and R. Syndicate, Limited. - Capital, £5,000. Objects: to carry on the general business of a land development company in London or elsewhere, as producers and suppliers of electricity, etc.

Provincial Electric Construction Company, Limited.—Capital, £3,000. Objects: to acquire the business of G. F. Rimmer, at 19, Minster-buildings, Church-street, Liverpool, and to manufacture and lay down cables, wires, etc., lamp manufacturers, to produce and supply electricity, etc.

Hintze, Limited.—Capital, £2,000. Objects: to adopt an agreement with J. W. Hintze and H. T. Cramp, and to carry on the business of turners, fitters, telegraphic, telephonic, electrical, and general engineers, manufacturers of and dealers in electric and other bells, telephones, lamps, and other apparatus connected with the above, etc.

Reno Electric Stairways and Conveyors, Limited.—Capital, £80,000. Objects: to acquire the benefit of certain inventions for constructing inclined elevators and in the means of transport by ascension; to adopt an agreement with J. G. Wainwright, W. H. Aston, and C. T. Aston, and to carry on the business of electrical engineers, etc.

Thermal Storage, Limited.—Capital, £12,000. Objects: to acquire any patents, licenses, etc., for the United Kingdom and the Isle of Man with regard to inventions relating to thermal storage; to adopt an agreement with D. Halpin, and to carry on business as manufacturers of and dealers in all kinds of boilers, furnaces, cylinders, pumps and tanks, and all machinery used in connection with any system of thermal storage; and as ironfounders, shipbuilders, tram and railway constructors, electricians, etc.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Copenhagen.—The Government Railways invite tenders for incandescent electric lamps. Tenders by May 1.

Edinburgh.—The Corporation invite tenders for annual supplies from May 15 for the electric supply department.

Alicante (Spain).—The Harbour Board require tenders for the supply of two movable cranes. Tenders by May 14.

Shanghai.—The last day for receiving tenders for the proposed municipal tramway and motor 'bus service is June 30.

Walsall.—The Corporation invite tenders for a battery of accumulators. Tenders by April 30. Details in our advertisement columns.

Stepney.—The Electrical Committee invite tenders for the supply of meters and demand indicators. Tenders by May 1. Details in our advertisement columns.

Erith.—The Urban District Council invite offers from firms willing to take up free wiring in the district. Offers by May 5. Details in our advertisement columns.

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Lytham.—The Urban District Council invite tenders for a 300-kw. plant complete for electric lighting. Tenders by April 26. Particulars may be obtained from the Clerk.

Fulham.—The Board of Guardians invite tenders for the supply, delivery, and erection of a switchboard. Tenders by April 29. Details in our advertisement columns.

Cleckheaton.—The Council invite tenders for the supply, delivery, and erection of continuous-current electric motors. Tenders by May 3. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of motor-driven boosters and relative switching apparatus. Tenders by May 5. Details in our advertisement columns.

Edinburgh.—The Corporation invite tenders for the supply of electricity meters for 12 months from May 15 next. Tenders by April 28. Particulars in our advertisement columns.

Hartlepool.—The Corporation invite tenders for one 200-kw. to 250-kw. high-speed steam-engine, continuous-current dynamo, extension to switchboard panel, etc. Tenders by April 30.

Glasgow.—The Corporation invite tenders for the supply of electricity meters required for the year from June 1 to May 31, 1903. Tenders by May 3. Details in our advertisement columns.

Manchester.—The Corporation invite tenders for the erection of an electricity sub-station at Withington. Specifications, etc., can be obtained at the office of the City Surveyor, Town Hall. Tenders by April 30.

Rhyl.—The Urban District Council invite tenders for the wiring of the town hall, etc., for electric lighting. Specification, etc., may be obtained from Mr. E. H. Wright, Electricity Works. Tenders by 28th inst.

Glasgow.—The Corporation invite tenders for the supply, delivery, and erection complete of material for the extension of switchboard at Coplawhill sub-station. Tenders by May 7. Details in our advertisement columns.

Bedford.—The Electricity Committee invite tenders for the supply and delivery of economisers. Specification, etc., can be obtained from the Borough Electrical Engineer, Cauldwell-road, Bedford. Tenders by May 17.

West Ham.—The Council invite tenders for two steel chimneys, four fans and engines for induced draught, all brickwork in connection with the flues, and economisers. Tenders by May 13. Details in our advertisement columns.

Bury.—The Corporation invite tenders for supply, delivery, and laying in the borough of Bury (Lancs.) of tramway feeder and pilot cables, conduits, and accessories. Tenders by May 8. Details in our advertisement columns.

Manchester.—The Corporation invite tenders for the erection of an electricity sub-station at George Leigh-street, Oldham-road. Specifications, etc., can be obtained at the office of the City Surveyor, Town Hall. Tenders by April 28.

Chili.—The Embassy of the Republic of Chili at 18, Rue Pierre Charron, Paris, invite offers for the electric lighting of the track of the electric tramways of Valparaiso. Particulars are to be obtained from and tenders addressed to the same.

Mansfield.—The Corporation invite tenders for the construction and erection of pipework, valves, and tanks, steam, exhaust, water, and other pipes, valves, tanks, foot-plates, and accessories. Tenders by May 1. Details in our advertisement columns.

Oldham.—The Electricity Committee invite tenders for the supply, delivery, and erection, complete, of lighting and traction switchboards, with connections and instruments comprised in Specification No. 5. Tenders by May 6. Full details in our advertisement columns.

London, S.W.—The London County Council invite tenders for wiring and fittings for the electric lighting of the Euston-road fire station. Specifications, etc., can be obtained from the Chief Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by May 1.

Glasgow.—The Parish Council invite tenders for engines and dynamos, underground cables, electric elevators, and hydraulic elevators. Specifications, etc., can be obtained on application to the engineer, Mr. W. Arnot, 79, West Regent-street, Glasgow. Tenders by April 28.

Sydney.—The Municipal Council invite tenders for supply and erection of plant and machinery required for the complete equipment of their proposed electricity supply stations and sub-stations. Particulars may be obtained from Messrs. Preece and Cardew, Westminster. Tenders by May 7 at noon.

Fulham.—The Establishment Committee invite tenders for the supply, delivery, and erection of one 600-kw. two-phase steam alternator, with Willans, Belliss, or Allen engine; or one 600-kw. two-phase Parsons turbo-alternator. Tenders by May 5. Details in our advertisement columns.

Manchester. The Tramways Committee invite tenders for the supply of special (permanent way) track work, cross-over roads, and points and crossings. Specifications, etc., may be obtained on application to Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders by May 3.

George Town (Penang).—The Municipal Commissioners invite tenders for the supply and delivery, f.o.b., of boilers, etc., ejector condenser, pumps, tanks, etc., pipes, steam dynamos and balancer boosters, switchboards, batteries, cables, junction boxes, &c., and arc and glow lamps, posts, and accessories. Tenders by April 28. Details in our advertisement columns.

Aberdeen. The Electric Lighting Committee invite tenders for the supply and erection of a 20-ton electrically-driven overhead crane, with the necessary supporting columns and girders, for their Dee Village electricity works. Specification, etc., may be obtained from Mr. J. Alex. Bell, city electrical engineer. Tenders by May 7. Details in our advertisement columns.

Grimsby.—The Corporation invite tenders for 10-ampere and six-ampere continuous-current arc lamps for working 10 in series on 460 volts, arc lampposts, stoneware pipes for conduits, and cables, etc., paper-covered distributors and service cables. Specification, etc., can be obtained from the Borough Electrical Engineer, Corporation Electricity Works, Grimsby. Tenders by May 5.

Trowbridge.—The Trowbridge Urban District Council having obtained a provisional order for the supply of electricity in their district, are prepared to receive applications for a lease of their powers under the said order. A plan of the district can be seen at the offices of the Council. Applications to be sent to Mr. T. S. Hill, clerk, Council Offices, Town Hall, Trowbridge, by April 30.

Nelson (Lancs.).—The Tramways Committee invite tenders for the supply and fixing of rails, overhead equipment, etc., for the light railways to Colne and Barrowford boundaries, comprising rails, fish-plates, crossings, etc., overhead equipment, bonds, feeding pillars, etc., 1,000 yards ·25 cable, and laying, and tramcars. Specifications, etc., may be obtained from Mr. B. Ball, borough engineer, Nelson, and Mr. W. A. Fraser, electrical engineer, Electricity Works, Nelson. Tenders by 28th inst.

Sudbury.—The Corporation invite tenders for the supply and erection of water-tube boiler, with fittings, feed-water heater, feed pumps, etc.; pipework, etc., in engine and boiler house; two steam dynamos (vertical enclosed high-speed engines) and motor boosters; storage batteries, main switchboard and connections; underground mains, conduits, and roadwork for private and public lighting; and station lighting. Copies of specification, etc., may be obtained at the offices of Mr. W. B. Ransom, town clerk, Town Hall, Sudbury, Suffolk, on and after April 14. Tenders by May 1. Full particulars in our advertisement columns.

RESULTS OF TENDERS.

Stepney.—The Borough Council have accepted the tender of the British Insulated Wire Company, at £14,309, for the supply of cables.

Erith (Kent).—The Urban District Council have accepted the tender of H. J. Creffield, at £16, for maintenance of telephones, etc., for one year.

Llandudno.—The Urban District Council have accepted the tender of Babcock and Wilcox, Farringdon-street, at £1,951. 10s., for supply of two Babcock and Wilcox water-tube boilers and necessary steam exhaust pipes.

Bridgwater.—The Town Council have accepted the tender of the National Telephone Company, at £169. 10s., for telephonic communication between the surveyor's office, the police station, the reservoir, and the pumping station.

Bengal-Nagpur Railway.—The order for the electrical power equipment of the new workshops at Khagour for this railway has been placed with Messrs. D. Bruce Peebles and Co., of Edinburgh. The order includes 80 motors of an average size of 15 b.h.p.

Shoreditch.—The St. Helens Cable Company, Limited, Warrington, have obtained the annual contract for Shoreditch supply of cables, jointing material, etc., and also the contract for the cables at Oban, insulated with their patent dialite bitumen without lead covering. The same firm also recently received a contract for 6½ miles of the same class of cable for the Liverpool Overhead Railway, as well as the extensions for mains at the works of Messrs. Lever Bros., Limited, Port Sunlight.

London.—The Metropolitan Asylums Board have received the following tenders for re-wiring head office for electric lighting purposes:

Buchanan and Curwen, 68, Victoria-street, S.W. (accepted)	£380	0	0
Rashleigh Phipps and Co., 102, Oxford-street, W.	420	0	0
Eastlakes, Limited, 5A, Cowley-street, Westminster, S.W.	522	0	0
National Electric Wiring Company, Limited, 34, Victoria-street, S.W.	544	10	0
Wenham and Waters, Limited, Paragon Works, Croydon	835	0	0
Marryat and Place, 28, Hatton-garden, E.C.	1,195	0	0

Sunderland.—The Corporation have received the following tenders: Indiarubber-covered cables—W. T. Glover and Co., Trafford Park, Manchester (accepted); Johnson and Phillips; Connolly Bros.; Isidor Frankenburg, Limited; Union Cable Company; St. Helens Cable Company; Henley's Cable and Telegraph Company; India Rubber and Gutta Percha Works, Silvertown; Western Electric Company; Telegraph Manufacturing Company; W. Rickard, Limited; Liverpool Electric Cable Company; Anchor Cable Company. Cast-iron piping, etc.—Watson, Gow, and Co., Etna Foundry, Glasgow (accepted); R. MacLaren and Co., Glasgow; and Rowland Carr and Co., London, E.C. Stoneware casings—Doulton and Co. (accepted, without competition). Machine tools, etc.—T. Lumsden, Coulthard's-lane, East-street, Gateshead (accepted); G. Addy; Atlas Engineering Company; G. Birch and Co.; R. Bowran and Co.; Britannia Engineering Company; G. W. Burton, Griffiths, and Co.; Clifton and Wardell; Cook and Nicholson; Crozier, Stephens, and Co.; Easterbrook Allcard, and Co.; J. Holyrod and Co.; Isdale and Farrow; Newbold Machine Company; J. C. Nicholson Tool Company; Noble and Lund; Pitt Yorkshire Machine Company; Pollock and McNab; T. Proctor and Son; A. A. Rickaby; T. Robinson and Son; Selig, Sonnenthal, and Co.; J. Spencer and Co.; Tangye Tool Company; and Ward, Haggas, and Smith. Oil for ensuing 12 months—Vacuum Oil Company, Limited, London (accepted, without competition).

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Name of firm tendering.	Price for 100 cars.	Period for delivery after date of order.	Names of proposed sub-contractors for various parts of the cars — Truck.	Body.	Plough.	Equipment and motors.
British Thomson-Houston Company, Rugby	£65,880	36 weeks.	Brush Electrical Engineering Co., or European McGuire Manufacturing Co.	British Electric Car Company	None	None.
Do. (alternative)	70,330	36 ,,	J. G. Brill Company, Philadelphia	G. F. Milnes and Co., Birkenhead	J. G. White and Co., London	None.
British Electric Car Company, London	69,994	36 ,,	None	None	Do.	British Thomson-Houston Co.
Dick, Kerr, and Co., London	71,754	24 ,,	J. G. Brill Company	Electric Railway and Tramway Carriage Works	Do.	English Electric Manufacturing Co., Preston.
Witting Bros., London	71,802	32 ,,	Brush Electrical Engineering Co.	G. F. Milnes and Co., Birkenhead	Electricite et Hydraulique, Charleroi, Belgium	Electricite et Hydraulique, and British Thomson-Houston Co.
Do. (alternative)	71,102	32 ,,	Do.	Do.	Do.	Electricite et Hydraulique.
Siemens and Halske, Berlin	73,704	32 ,,	Do.	Do.	None	None.
British Westinghouse Electric and Manufacturing Company, London	77,252	33 ,,	Do.	G. F. Milnes and Co., Birkenhead, or Brush Electrical Engineering Company, or British Electric Car Company	J. G. White and Co.	None.
Brush Electrical Engineering Company, London	78,380	39 ,,	None	None	None	None.
British Schuckert Electric Company, London	81,506	70 ,,	J. G. Brill Company	G. F. Milnes and Co., Birkenhead	J. G. White and Co.	None.
Gottfried Lindner, Halle, Germany	83,500	48 ,,	(*Tender incomplete.*)			

London County Council.—The tenders given in the accompanying table (see above) have been received for the supply of 100 double-decked, double-bogie, electrically-equipped cars for use on the portions of the London County Council Tramways between (*a*) Westminster and Tooting, (*b*) Elephant and Castle and Kennington, and (*c*) St. George's-circus and Waterloo-road when they shall have been reconstructed for electrical traction.

The Improved Electric Glow Lamp Company.—We are informed that the contracts for arc lighting at Islington and for the trolley lighting at Dudley have been placed with the Improved Electric Glow Lamp Company, Limited, of 7, Great Newport-street, W.C.

London, S.W.—The following is a full list of the tenders received by the Guardians of the Fulham Union for the supply of electrical plant. The accepted tenders were given in our issue of the 11th inst.

Contract No. 1.—Two 50-kw. steam dynamos and boosters.
Alternative tender No. 1.

Electric Construction Company	£1,850	0	0
Paterson, Cooper, and Co.	1,802	0	0
Lister Electric Manufacturing Company	1,792	0	0
Lister Electric Manufacturing Company	1,762	0	0
F. A. Glover and Co.	1,740	0	0
Electrical Company, Limited	1,737	10	0
Lancashire Dynamo and Motor Company	1,734	0	0
British Schuckert Electric Company	1,733	0	0
Mather and Platt	1,730	0	0
Brush Electric Engineering Company, Limited	1,725	0	0
Ernest Scott and Mountain, Limited	1,712	0	0
Bruce Peebles and Co.	1,702	0	0
Laurence, Scott, and Co.	1,684	0	0
J. and H. Gwynne, Limited	1,675	0	0
Lancashire Dynamo and Motor Company	1,670	0	9
Lahmeyer Electric Company, Limited	1,669	0	0
Geipel and Lange	1,667	0	0
Bruce Peebles and Co.	1,653	0	0
J. Fowler and Co.	1,650	15	0
J. and H. Gwynne	1,648	0	0
Lister Electric Manufacturing Company	1,645	0	0
H. von Kramer and Co.	1,632	0	0
Mather and Platt	1,610	0	0
Sunderland Forge and Engineering Company	1,608	0	0
Lancashire Dynamo and Motor Company	1,605	0	0
British Schuckert Company	1,595	0	0
Mather and Platt	1,590	0	0
Lahmeyer Electric Company	1,581	0	0
International Electric Engineering Company	1,580	0	0
International Electric Engineering Company	1,580	0	0
Electric Construction Company	1,574	0	0
Rosling and Fynn	1,570	0	0
H. F. Joel and T. Potter and Sons	1,567	0	0
Lahmeyer Electric Company	1,567	0	0
W. H. Allen and Co.	1,562	0	0
Warrington District Electric Light and Power Company	1,561	0	0
British Thomson-Houston Company	1,561	0	0
Laurence, Scott, and Co.	1,560	0	0
Sunderland Forge and Engineering Company	1,551	0	0
Lancashire Dynamo and Motor Company	1,547	0	0
Scott Anderson	1,540	0	0
Laurence, Scott, and Co.	1,539	0	0
Johnson and Phillips	1,536	0	0
Mavor and Coulson	1,522	10	0
General Electric Company	1,510	0	0
Laurence, Scott, and Co.	1,506	0	0
Crompton and Co.	1,506	0	0
British Schuckert Company	1,489	0	0
Bruce Peebles and Co.	1,482	0	0
Mather and Platt	1,480	0	0
Paterson, Cooper, and Co.	1,465	0	0
Turner, Atherton, and Co.	1,463	0	0
Armstrong, Whitworth, and Co.	1,463	0	0
Electrical Company, Limited	1,460	12	0
International Electric Engineering Company	1,460	0	0
Crompton and Co.	1,455	0	0
Electric Construction Company	1,446	10	0
British Schuckert Company	1,446	0	0
International Electric Engineering Company	1,445	0	0
Royce, Limited	1,428	0	0
Lahmeyer Electric Company	1,424	0	0
Sunderland Forge and Engineering Company	1,422	0	0
Johnson and Phillips	1,415	0	0
Laurence, Scott, and Co.	1,405	0	0
Johnson-Lundell Electric Traction Company	1,404	0	0
Beaver, Dorling, and Co.	1,397	10	0
Newton Electric Works, Limited	1,392	0	0
G. H. Woods and Co.	1,390	0	0
Electric Company, Limited	1,387	10	0
Mavor and Coulson	1,375	10	0
Johnson-Lundell Company	1,365	0	0
Johnson-Lundell Company	1,347	0	0
Laurence, Scott, and Co.	1,331	0	0
Greenwood and Batley (accepted)	1,301	0	0
Laurence, Scott, and Co.	1,297	0	0
J. Howden and Co.	1,290	0	0
Morley Electric Engineering Company	1,290	0	0
J. Howden and Co.	1,265	0	0
B. Thomas	1,244	0	0
Crompton and Co.	1,235	0	0
International Electric Engineering Company	1,210	0	0
Greenwood and Batley	1,207	0	0
Laurence, Scott, and Co.	1,205	0	0
Laurence, Scott, and Co.	1,205	0	0
Vauxhall Ironworks Company	1,200	0	0
J. Howden and Co.	1,191	0	0
B. Thomas	1,146	0	0
International Electric Engineering Company	1,140	0	0
Greenwood and Batley	1,121	0	0
International Electric Engineering Company	1,035	0	0
Clayton Engineering Company	999	0	0

Engineer's estimate, £1,700.

Contract No. 1.—Two 50-kw. steam dynamos and motor boosters.
Alternative tender No. 2.

F. A. Glover and Co	1,986	0	0
Electric Construction Company	1,896	10	0
Paterson, Cooper, and Co.	1,881	0	0
British Schuckert Company, Limited	1,817	0	0
Lister Electric Manufacturing Company	1,815	0	0
Bruce Peebles and Co.	1,802	0	0
Lancashire Dynamo and Motor Company	1,786	0	0
Mather and Platt	1,780	0	0
Laurence, Scott, and Co.	1,779	0	0
J. H. Gwynne and Co., Limited	1,775	0	0
Geipel and Lange	1,737	0	0
Brush Electric Engineering Company	1,720	0	0
Electrical Company, Limited	1,717	14	0
Lister Electric Manufacturing Company	1,712	0	0
Bruce Peebles and Co.	1,702	0	0
Lister Electric Manufacturing Company	1,693	0	0
J. Fowler and Co.	1,686	0	0

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Mavor and Coulson	1,685	10	0
J. H. Gwynne, Limited	1,682	0	0
Sunderland Forge and Engineering Company	1,677	0	0
H. von Kramer and Co.	1,670	0	0
Lancashire Dynamo and Motor Company	1,670	0	0
British Schuckert Company	1,658	0	0
H. F. Joel and T. Potter and Sons	1,651	0	0
W. H. Allen and Co.	1,638	0	0
Mather and Platt	1,635	0	0
Lancashire Dynamo and Motor Company	1,635	0	0
Laurence, Scott, and Co.	1,635	0	0
Lancashire Dynamo and Motor Company	1,627	0	0
Laurence, Scott, and Co.	1,623	0	0
Lahmeyer Electric Company, Limited	1,612	0	0
International Electric Company	1,605	0	0
Armstrong, Whitworth, and Co.	1,601	0	0
Bruce Peebles and Co.	1,592	0	0
Rosling and Fynn	1,590	0	0
Electric Construction Company	1,580	0	0
Johnson and Phillips	1,575	0	0
Mather and Platt	1,570	0	0
General Electric Company	1,570	0	0
Paterson, Cooper, and Co.	1,564	0	0
Laurence, Scott, and Co.	1,562	0	0
Beaver, Dorling, and Co.	1,555	10	0
Crompton and Co.	1,553	0	0
Crompton and Co.	1,553	0	0
Warrington and District Electric Light and Power Company	1,546	0	0
British Thomson-Houston Company	1,546	0	0
Turner, Atherton, and Co.	1,543	0	0
Sunderland Forge and Engineering Company	1,536	0	0
Lahmeyer Electric Company	1,534	0	0
Johnson and Phillips	1,506	0	0
Laurence, Scott, and Co.	1,504	0	0
Electric Construction Company	1,501	10	0
Royce, Limited	1,494	0	0
Scott Anderson	1,490	0	0
British Schuckert Company	1,489	0	0
Electrical Company, Limited	1,483	14	0
G. H. Woods and Co.	1,481	0	0
International Electric Company	1,480	0	0
Electrical Company, Limited	1,473	14	0
Mather and Platt	1,470	0	0
Laurence, Scott, and Co.	1,466	0	0
Sunderland Forge and Engineering Company	1,461	0	0
Laurence, Scott, and Co.	1,460	0	0
Mavor and Coulson	1,452	0	0
British Schuckert Company	1,446	0	0
Laurence, Scott, and Co.	1,402	0	0
International Electric Company	1,385	0	0
Lahmeyer Electric Company	1,384	0	0
Johnson-Lundell Electric Traction Company	1,370	0	0
Johnson-Lundell Electric Traction Company	1,364	0	0
Crompton and Co.	1,364	0	0
Johnson-Lundell Electric Traction Company	1,363	0	0
International Electric Engineering Company	1,360	0	0
J. Howden and Co.	1,345	0	0
Laurence, Scott, and Co.	1,340	0	0
Newton Electric Works	1,333	0	0
J. Howden and Co.	1,295	0	0
Greenwood and Batley	1,292	0	0
Lahmeyer Electric Company	1,285	0	0
International Electric Engineering Company	1,285	0	0
Greenwood and Batley, Limited	1,278	0	0
B Thomas	1,275	0	0
Laurence, Scott, and Co.	1,270	0	0
Morley Electric Engineering Company	1,240	0	0
L. Thomas	1,240	0	0
Vauxhall Ironworks Company	1,235	0	0
International Electric Engineering Company	1,230	0	0
Greenwood and Batley	1,192	0	0
J. Howden and Co.	1,155	0	0
Clayton Engineering Company	1,137	0	0
International Electric Engineering Company	1,095	0	0
International Electric Engineering Company	1,065	0	0

Engineer's estimate, £1,700.

Contract No. 2.—Boilers.

Richardson, Westgarth, and Co.	2,975	0	0
F. A. Glover and Co.	2,020	0	0
Riley Bros.	1,962	0	0
G. H. Woods and Co.	1,844	0	0
E. Danks	1,835	0	0
Davey, Paxman, and Co.	1,788	0	0
Tinkers, Limited	1,780	0	0
Davy Bros., Limited	1,780	0	0
J. Fraser and Son	1,740	0	0
Fraser and Fraser	1,736	0	0
G. Sinclair	1,677	0	0
R. Taylor and Sons, Limited	1,545	0	0
H. and T. Danks, Limited (accepted)	1,465	0	0

Engineer's estimate, £1,880.

Contract No. 3.—Storage battery.

Albion Battery Company	£993	0	0
D.P. Battery Company	831	3	0
Tudor Accumulator Company	823	0	0
Chloride Electric Storage Company	815	10	0
Glover and Co.	729	15	3
Vereinigte Elluger und Co., Berlin	705	0	0
Verity's, Limited	697	7	6
Pritchetts and Gold	697	7	6
G. H. Woods and Co.	684	0	0
Ashmore, Benson, and Co.	678	0	0
E. P. S. Company	666	19	0
E. Lomer	657	0	0
G. H. Woods and Co.	641	0	0
Glover and Co.	635	0	0
G. H. Woods and Co.	624	0	0
Scott Anderson Company	620	0	0
Hart Accumulator Company	615	0	0
Verity's, Limited	607	2	6
Hart Accumulator Company	581	5	0
B. P. Traction and Light Company (accepted)	562	18	0
Accumulatorenwerke E. Schultz, Witten, Germany	510	0	0
Petry	447	11	6

Engineer's estimate, £750.

Contract No. 4.—Wiring and fittings.

South-Western Contracting and Maintenance Company	5,348	6	9
Tamplin and Makovski	4,830	13	10
Jackson Bros.	4,050	2	6
Wenham and Waters	3,886	0	0
A. V. Gifkins	3,562	10	0
W. Mossop and Co.	3,523	12	6
Barlow Bros.	3,484	4	5
T. L. Hellyar	3,468	18	6
T. Scott Anderson	3,400	0	0
H. F. Joel and Co. and T. Potter and Sons United, Limited	3,289	16	0
F. A. Glover and Co.	3,019	0	0
W. J. Fryer and Co.	2,992	9	0
Lighting Corporation	2,991	12	0
Tyler and Duncan	2,928	0	0
Wells and Co.	2,878	10	0
Buchanan and Curwen	2,613	0	0
G. H. Woods and Co.	2,470	14	6
H. Gibson and Co.	2,394	0	0
Johnson and Phillips	2,384	0	0
H. Gibson and Co.	2,343	10	0
R. Dawson (accepted)	2,250	0	0
Fenton and Barnes	2,002	1	4
Warrington and District Electric Light and Power Company	1,963	4	3

Engineer's estimate, £2,240.

Contract No. 5.—Chimney shaft.

Pollard and Brand	1,050	0	0
W. Neil and Co.	1,000	0	0
R. H. B. Neal	960	0	0
T. G. Sharpington	937	0	0
W. Brown	872	10	0
Wilson Bros. and Lamplough	849	0	0
F. G. Minter	849	0	0
Cammack-Dennis	820	0	0
Smith Bros. (Burnley), Limited	795	0	0
Myles and Warner	790	0	0
D. R. Paterson	775	0	0
T. Bendon	774	0	0
Alphons Custodis Company	773	0	0
J. Pennington	749	0	0
Universal Engineering Company, Nottingham (accepted)	685	10	0
Danton-Lee	494	0	0

Engineer's estimate, £800.

BUSINESS NOTES.

TRACTION.

Wigan.—It has been decided to equip all the Corporation electric cars with Tidswell's lifeguards.

Levenshulme.—The tramways at this place are almost finished The first trial trip is announced for June 1.

Middlesex.—The County Council Tramways Bill was read a second time in the House of Commons on Monday.

Dundee.—The Tramways Committee have adopted a scale of charges for the Fairmuir route, which includes ½d. fares.

Singapore.—A Bill has been introduced in the Legislative Council for powers to lay down an electric tramway system in the town.

Warrington.—In accordance with expectation, the Corporation tramway from Latchford to Sankey Bridges was opened for traffic on Monday.

Bath.—Sir Frederick Bramwell has been appointed by the Board of Trade arbitrator on the price to be paid for the present horse tramways.

Scarborough.—All opposition to the Scarborough Tramways Bill having been withdrawn, the Bill will now pass through Parliament unopposed.

Halifax.—Arrangements have now been made by which special tramcars may be hired from the Corporation at the rate of 2s. per stage travelled.

Calcutta.—The electric car service was recently inaugurated on the Kidderpore-Maidan section of the tramways, after inspection by the Lieutenant-Governor.

Exeter.—In the House of Lords the Exeter and District Tramways Bill has been read a second time, all the provisions for tramways within the city having been struck out.

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Haslingden.—A conference has been held between the authorities concerned with reference to the proposed purchase of the Haslingden and Accrington tramways by the respective corporations.

Saltaire.—In order that the conversion of the tramways to electric traction may be the more expeditiously carried out, the steam car service between Frizinghall and Saltaire has been suspended.

West Bromwich.—The Corporation are recommended by the Finance Committee to raise the estimated expenditure of £178,000 on the tramway conversion by the issue of 3 per cent. redeemable stock.

Northfleet.—As a result of negotiations, the District Council have now agreed to allow the tramway company to lay their cables under the inside margin of the footpaths except at The Hill and in High-street.

Ossett.—The Town Council have passed a resolution that the action of the Great Northern Railway Company in opposing a light railway from Ossett to Dewsbury is detrimental to the best interests of the borough.

Lambeth.—The Borough Council have agreed to oppose the proposed London County Council tramways along Denmark-hill. The Council object to being compelled to contribute one-third of the cost of the road widening.

Berlin.—In order to successfully compete with the electric tramways, a correspondent says, the fares on the Berlin Electric Overhead and Underground Railway have been lowered to a 1d. for the distance between every five stations.

Appointment.—Mr. R. Blackmore, who has been electrical engineer to the Wakefield Corporation for the last two years, has received an appointment under the Ashton-under-Lyne, Stalybridge, and Mossley Electrical Tramway Board.

Blackpool.—The past year's figures of the working of the Corporation electric tramways are said to be disappointing. From information received we understand that, instead of an estimated profit of £8,000 on the whole system, there will not be more than half that amount.

Beckenham.—The tramway situation was discussed at length at a meeting of the Kent House Improvement Association last week, and a resolution was adopted welcoming the proposed introduction of tramways into Beckenham by the British Electric Traction Company.

Walsall.—The Town Council have approved the plans prepared by the borough surveyor of the offices, workshop, and sheds to be provided at the central tramway depôt at the Birchills, and the town clerk has been directed to advertise for tenders for carrying out of the work.

Bray.—Last Friday Mr. James Dillon, Board of Works engineer, held an enquiry in the town hall, Bray, concerning the merits, from an engineering point of view, of the proposed Bray electric tramways as defined by the plans lodged at the offices of the Board of Works. The decision of the Board on the scheme will be communicated.

Battersea.—The Law and Parliamentary Committee reported to the meeting of the Borough Council on Wednesday that the proposal to construct a tramway along Clapham Common north side, Battersea-rise and north side, Wandsworth Common, has been withdrawn from the London County Council (Tramways and Improvements) Bill.

Beckenham.—It is reported that an arrangement has been come to between the Corporation of Croydon and the promoters of the Croydon and District Electric Tramways Bill, now before Parliament, by which the refusal of the Beckenham Council to consent to a proposed tramway affecting the local authorities of Croydon, Penge, and Beckenham has been rendered futile.

Private Bills.—In the House of Lords the Manchester Corporation Tramways Bill was read a second time on Tuesday. In the Commons the Southport and Lytham Tramroad Bill was read a third time, and the Croydon and District Electric Tramways Bill a second time. The Liverpool Electric Express Railway Bill has been read a second time in the House of Commons.

Bournemouth.—Steady progress is being made with the work of laying the tramways in the main thoroughfares. The scheme involves street widening and other desirable improvements which would probably not have been otherwise carried out. It has been decided to ask the Board of Trade for an extension of the time in which to complete the tramway system.

Teddington.—A deadlock has arisen between the District Council and the London United Tramways Company. The former body have refused to approve the company's plans for electric tramways in the district, and the company have written to the effect that if the Council persist in their resolution there will be no alternative but to apply to the Board of Trade for an arbitrator to settle the dispute.

Shields.—Five petitions have been deposited in the Private Bill Office of the House of Commons by parties praying to be heard against the South Shields, Sunderland, and District Tramways Bill. The petitioners are the National Telephone Company, the Sunderland and South Shields Water Company, the North-Eastern Railway Company, the South Shields Corporation, and the Harton Coal Company.

Manchester.—On Saturday a new section of the Corporation electric tramway system was opened for traffic. The new line runs from Albert-square, along Princess-street, Brook-street, and Upper Brook-street to the terminus at High-street. The route had previously been examined by the Board of Trade inspectors. It is expected that by June 1 the electric cars will be running along Stockport-road to Stockport, and along Hyde-road past Belle Vue.

Wolverhampton.—Great progress has been made along the various portions of the tramway route leading from the centre of the town to the exhibition buildings in the work of putting the boxes down for the Lorain system. There seems to be good reason to believe that by the end of the month the whole of the boxes as far as New Hampton-road East will have been put into position, and that the electric cars will be running at the opening of the exhibition.

Pontypridd.—It is stated on authority that notwithstanding that the Board of Trade have not sanctioned that part of the tramways scheme which would join the Rhondda and Pontypridd lines, the District Council will proceed with the scheme from Cilfynydd, through Pontypridd, and down to Treforest. By the time that is ready they will again apply to the higher authorities to give them power to construct the connecting link between Pontypridd and the Rhondda.

Cardiff.—On Tuesday the official inspection by the Board of Trade of the greater portion of the Cardiff electric tramways, power station, and equipment took place. The inspectors were Major Druitt, R.E., and Mr. Trotter. It is regarded here as almost certain that both inspectors will certify the lines for immediate use. Arrangements are being made to hold a demonstration in Roath Park on a Sunday to be yet fixed in favour of the running of electric cars on the Sabbath.

Brighton.—Since the first cars on the Corporation electric tramway system started running on Nov. 25 last year, the service has been maintained with gratifying results. At the end of March last the total receipts stood at £9,168, as against payments amounting to £5,477. The Corporation have received the sanction of the Board of Trade to an extension of the electric tramways along the Grand Parade, round Old Steine, and along London-road, Cork-place, and St. George's-place.

Southend.—A special meeting of the Town Council has been held, in private, to discuss the proposed extensions of the tramway system. We understand that the three routes not already dealt with were put before the meeting, and all were thrown out. They are the Wakering, Rochford, and High-street sections. The only two routes adopted are those from the Marine-parade to Shoeburyness, passing the Halfway House; and an extension from the present terminus at Southchurch Church to Whittingham's Corner.

Sheffield.—The extensions of the Abbeydale section of the Corporation tramways to Millhouses, and of the Intake section to Intake village, have been opened for public traffic. The lengthening of the Abbeydale route to Millhouses is regarded as a great boon, not only to residents along Abbeydale-road, and in the district of Millhouses, but also to people living at the north and east of the city anxious to spend an hour or two in Derbyshire. There will be a five minutes' service along this route. On the extension to Intake a 12 minutes' service has been established.

Cheadle.—The tramway order which has just been confirmed by the Board of Trade authorises the Cheadle and Gatley Urban District Council to construct a tramway from the boundary of the district on the Stockport-road to Gatley. The tramway will be 1 mile 5 furlongs and 0·98 chains in length, and nearly half will be double lines. The line will be joined to the Stockport line, and when completed there will be tramway communication between Stockport and Gatley. The Cheadle and Gatley lines will be leased to the Stockport Corporation, and will practically be an extension of the Stockport system.

Aberdeen.—The electric cars have commenced running on the Bridge of Dee route as far as Fonthill-road. In regard to the electrical equipment of the Albyn-place and Queen's-road route, it is understood that an effort is yet to be made with the view of obtaining the sanction of the whole of the frontagers for the placing of the poles within the gardens. The number of objectors is so small that the hope has been expressed that unanimous acquiescence in the proposal of the Town Council may yet be obtained. The enquiry into the suburban tramways scheme was opened at Edinburgh this week.

Weston-super-Mare.—The electric tramway from Locking-road to the pier was inspected on Saturday by the officials of the Board of Trade. The route covers 3½ miles, and the work was commenced at the end of January last, but a strike caused some delay. The paving of the permanent way consists of basalt lava setts, which have been specially imported. This is claimed to be the best paving, and very durable. The overhead trolley system has been adopted. The 16 cars are capable of carrying 50 passengers each, and the service will be a five minutes' one. The line from the sanatorium to Oxford-street will be finished in three weeks.

The Electric Cars v. Cabs.—The great success achieved by the Liverpool Corporation electric tramways has been the undoing of the Liverpool cabman. Recent statistics show that the electric car is slowly but surely driving him off the streets. For example, last year the number of cabs in Liverpool decreased from about 960 to 600, due almost entirely to the rapid spread of electric traction into all parts of the city. Now that the automobile is coming into such general use as well, we are afraid there is not much life left for the provincial cabman. This in one way is not to be deplored, and it will undoubtedly tend to lessen the evil of congestion in the busy streets of our provincial cities and towns.

Scottish Motorcar Contest.—At the end of last week a motorcar contest from Glasgow to London took place under the auspices of the Scottish Automobile Club. It was intended as a test of reliability rather than as a trial of speed. The route was divided into sections, the principal stages being from Glasgow to York (first day), and from York to London (second day). The maximum time allowed was 22 hours 50 minutes from Glasgow to York, and 18 hours 20 minutes from York to London. The speed was limited to 12 miles an hour in the open country, and to eight miles an hour within towns and villages. There were nine entries. The first to reach London was Mr. S. F. Edge, who drove a 16-h.p. Napier car of English manufacture. Mr. Edge left York at 5.10 a.m., and drew up in Whitehall at 4 50 p.m., thus completing the last stage of the run in 11 houses 40 minutes.

Cosham and Horndean Light Railway.—This railway will be opened for traffic on or before July 1. It has been constructed by the Provincial Tramways Company. The line is six miles in length—viz.,

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three miles from Cosham to Waterloo, and three from Waterloo to Horndean. The Portsmouth Corporation are under an obligation to run all their Cosham cars to the base of the downs, and so form a connection with the light railway. The overhead trolley system has been adopted. The gauge is 4ft. 17½in., and in this, as in other respects, the line will be exactly similar to the tramways at Portsmouth. The cost of the line will be between £60,000 and £70,000. The current is to be supplied by the Portsmouth Corporation from their generating station at Fratton. It is proposed to run a 10 or 15 minutes' service if the traffic justifies it, and the fare will be 1d. a mile. The cars will run on Sundays as long as the Corporation cars do, and when the Corporation are supplying current.

London County Council Tramways.—It now appears improbable that the work of reconstructing for electrical traction the London County Council's tramway between Westminster Bridge and Tooting will be completed within the time prescribed—*i.e.*, by Jan. 1, 1903. The Parliamentary Committee report that every effort has been made to expedite the progress of the work, but owing to circumstances which will cause delay it appears clear that a short extension of time will be necessary for the completion of the work, and should be sought in the present session of Parliament. The matter is therefore one of emergency, and as it may be possible to obtain the sanction of an additional provision for the purpose in the Council's Tramways and Improvements Bill now before Parliament, the committee have given instructions for all necessary steps to be taken to secure the insertion of such a provision. The extension of time sought is for one year. A special meeting of the Council is to be called to consider the desirability of acquiring the undertakings of the London, Deptford, and Greenwich Tramways Company, the South London Tramways Company, and the Woolwich and South-East London Tramways Company.

The Proposed Embankment Tramway.—Within the last 30 years there have been no less than 10 applications to Parliament for powers to construct a tramway along the Victoria-embankment. The tenth application, however, has been successful, and it received the approval of the House of Commons when the London County Council Tramways and Improvements) Bill was read a second time on Monday and sent to a committee. There was, however, considerable opposition to this course, and a long discussion took place in the House on an amendment by Mr. Boulnois that it should be an instruction to the committee to omit from the Bill the clause relating to the proposed tramway along the Embankment from Westminster to Blackfriars. The opposition was based chiefly on the grounds that the tramway would divert the ordinary carriage traffic from the Embankment to the Strand and so augment the congestion of the latter thoroughfare, that the line started from nowhere and led to nowhere, and on the sentimental ground that the Embankment was one of the finest boulevards in the world. Eventually the amendment was rejected by a majority of 19—a result which we think will be generally welcomed in London.

Liverpool.—The necessary leave of the Standing Orders Committee of the House of Commons having been obtained, the Corporation have now deposited the clause they propose to insert in their omnibus Bill of this session in order to deal with the surplus revenue arising from their tramway undertaking. The clause proposes to repeal so much of the Liverpool Tramways Act of 1897 as required the Corporation to place the surplus to a reserve fund until January, 1912. In lieu of these repealed powers it is now proposed to pay each year into a reserve fund any sum not exceeding £30,000 from the surplus revenue, but should the surplus in any year exceed the sum of £30,000 the "excess of the sum of £30,000 is to be paid to the credit of the general rate, provided nevertheless that the amount to be so paid shall not in any year prior to Jan. 1, 1912, exceed one-third of the total amount of such surplus. Any balance which may remain after the allocation of these sums to the reserve fund and the general rate, is to be applied to a renewal fund, or carried to a suspense account, or expended in the development of the undertaking, or in increasing the amount required to be paid into the sinking fund or redemption fund. According to a petition deposited by the Corporation with this proposed clause "the profits have exceeded all expectations."

Dover.—The Light Railway Commissioners at the end of last week held an enquiry with reference to an application by Sir William Crundall, Sir John Jackson, Sir Weetman Pearson, and other gentlemen to extend the Dover electric tramways into the country in the direction of Kearsney Abbey, and also along the East Cliff towards the holiday resort of St. Margaret's. Mr. Dickens, K.C., for the promoters, declared that with the construction of these tramways and the completion of the great national and commercial harbours Dover would develop enormously, and become not only one of the most important, but also the most attractive town along the coast. It was announced that the scheme would cost over £60,000, and it was supported by practically all the public bodies in the town and district. After a lengthy hearing the Commissioners announced their intention to recommend the Board of Trade to sanction the schemes almost in their entirety. It was reported at the last meeting of the Town Council that the town clerk had provisionally agreed with the promoters of the light railways scheme for the insertion of a clause by which the promoters should be allowed to lay down their lines in the borough, but should not exercise the power for two years in case the Corporation obtained power to extend their tramways to the borough boundary.

Cavehill and Whitewell Tramways.—The Select Committee of the House of Commons of which Sir Samuel Hoare is chairman, on Wednesday passed the preamble of the Bill promoted by the above company for powers to convert their line of tramways between Cavehill and Whitewell, near Belfast from horse to electric traction. Practically the only opposition to the Bill was by the Belfast Corporation, who asked for the insertion of a purchase clause, giving them the right of purchase after a certain number of years. In the course of the proceedings, it came out that the real promoters of the measure are the British Electric Traction Company, who have agreed to turn the present capital of the Cavehill and Whitewell Company into 6 per cent. preference shares, and to find £45,000 additional capital to electrify the lines. The case for the promoters was that as the Corporation of Belfast had elected to take no action in the matter for all these years—the original powers were granted in 1881, no provision being made for purchase by the Corporation—they were not entitled to take advantage of the present opportunity to acquire a right to purchase the company's undertaking in view of the great expenses of electrification. In the result the committee upheld this contention, and declared the preamble proved. The Bill will be reported to the House for third reading.

Bradford.—On Tuesday this week Major Pringle, of the Board of Trade, made an inspection of the following tramway routes: Forster-square to Frizinghall and Leeds-road, which have been converted for electric traction, and the new short length of line in Godwin-street connecting Sunbridge-road with Westgate. The conversion of old lines and the laying of new ones will, however, occupy the attention of the Bradford tramway authorities for some time to come. The work of constructing the extension from Park-avenue along Little Horton-lane to the end of Southfield-lane has been already begun. Given favourable weather, it is hoped to have the Oak-lane and St. Mary's-road line ready next week, though the cars on this route will at first have to run to Forster-square, pending the relaying of the track in North-parade. The reconstruction of the section between Wibsey Bankfoot and Odsal Top is being undertaken, and it will not be long before the line through to Wyke is open for electric trams. The Tramways Committee have decided to abolish the gangways recently brought into use to regulate the entrance of passengers to the electric cars. These wooden passages or gangways had been placed at the starting places in Tyrrel-street and Leeds-road, at the bottom of Manchester-road, and outside the police station. They will, however, still be used on busy days, such as bank holidays. The decision is the outcome of complaints by shopkeepers.

Shallow Underground Tramways.—On Wednesday the Select Committee of the House of Commons of which Mr. Hobhouse is chairman, had under consideration the London County Council (Subways and Improvements) Bill. Mr. Erskine Pollock, K.C., said the proppsal was to construct a tramway, worked by electricity, commencing at Theobalds-road, where it would form a junction with an existing tramway, now the property of the London County Council, though it was not worked by them. Thence it would fall in level until in Southampton-row it would be below the level of the street, and it would then in a shallow subway pass along the site of the supposed new street from Southampton-row to the Strand until it met the crescent near the Strand, which the Council have power already under an Act of 1899 to construct. There it would turn towards the Embankment, on reaching which, near Waterloo Bridge, it would come out on the level. The tramway was an attempt to deal with the problem of the congestion of the streets. Mr. Alfred Baker, manager of the tramways worked by the London County Council, described the system of tramways in Boston, America, very similar to that now proposed, the results being most satisfactory. Mr. Fitzmaurice (chief engineer to the London County Council), Mr. Joseph Baker (vice-chairman of the Highways Committee of the London County Council), and Mr. J. H. Rider (electrical engineer to the Council) also gave evidence for the Bill. The committee adjourned.

Salford.—At the last meeting of the Tramways Committee it was reported that the Tramways Bill before Parliament was proceeding very satisfactorily. As the report stated, counsel for Manchester had accepted the Salford clause in its amended form as follows: "There shall be an interchange of through traffic, so far as is reasonable, upon such routes or portions of routes and upon such terms and conditions as may be agreed, or, failing agreement, as shall be settled by the Board of Trade." The report continued: "It was further agreed that the two Corporations should withdraw their respective applications for running powers, and that the Manchester Corporation should reconstruct and electrically equip the tramways in Bury Old-road, and that the Salford Corporation should have running powers thereover, so as to connect the Salford tramway system with the Prestwich tramways in Bury Old-road." On the question of the Manchester and Liverpool Electric Express Railway scheme, it was stated at the same meeting that the promoters had been asked to leave the site of such houses as they acquired on the Barracks site as an open space under the control of the Corporation, and that they had agreed to the following clause: "Notwithstanding anything contained in this Act, the company shall not widen Tatton-street on the northern side, and if for the purposes of this Act the company purchase or acquire any lands of the said mayor, aldermen, and burgesses on the north side of the portion of Tatton-street which lies between Oxford-street and Gloucester-street, and remove the buildings, they shall erect on the site new buildings of the same value, having a frontage to Tatton-street."

District Railway Bill.—The Select Committee of the House of Commons charged with the consideration of this Bill gave their decision on Wednesday. After hearing Mr. Freeman, K.C., for the London County Council, and Mr. Pember, K.C., for the promoters, in reply, the Chairman said the committee were prepared to pass the preamble of the Bill, subject to certain conditions. They had no desire to hinder what was an important public enterprise; but they thought, considering the magnitude, novelty, and peculiar character of this enterprise—he referred to the question of carrying this mass of cables under the public streets—that the works ought to be subject to the supervision of some competent public authority, and they consider the most suitable authority in this matter would be the Board of Trade. Therefore, they proposed to insert a proviso, the substance of which would be that as regards the works authorised in Clause 5, the detailed plans, including the mode of construction

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and the position in the street, should be subject to the approval, before actual construction, of the Board of Trade, and that future enlargements and alterations should also be subject to such approval, and that in giving such approval the Board of Trade should have regard not only to the safety of the public, but to the convenience of the road authorities. They did not propose to give the London County Council any power to approve of the plan of the generating station, or to regulate its building line, but they proposed to insert some words carrying out a proposal made by the promoters as to the kind of materials to be used in the building. Mr. R. W. Perks, M.P., then formally proved the unopposed parts of the Bill. The committee postponed the consideration of the clauses.

London County Council Car Tenders.—In another column this week we give the full list of tenders received by the Highways Committee of the London County Council for the supply of electrical cars, the successful tender being that of Messrs. Dick, Kerr, and Co. at £71,754. The considerations which led the committee to recommend the acceptance of this tender will be gathered from the following report, which they submitted to the Council at the usual weekly meeting on Tuesday: "We have considered the tenders referred by the Council on March 4 for the supply of 100 double-decked, double-bogie, electrically-equipped cars for use on the portions of the London County Council tramways between (*a*) Westminster and Tooting, (*b*) Elephant and Castle and Kennington, and (*c*) St. George's-circus and Waterloo-road, when they shall have been reconstructed for electrical traction. Tenders were invited for the supply of 50 cars, and also for 50 more if so required by the Council, making the total of 100 above specified. Nine firms have sent in tenders, but as in several instances alternate prices were given, the actual number of tenders is about 25. The tenders have been carefully examined by Dr. Kennedy (the electrical engineer who is responsible for the work in connection with the adoption of electrical traction for the tramways above specified), especially as regards the manufacturers of the various parts of the work proposed to be the subject of sub-contracts; and we have had before us a report by him with reference thereto. He is of opinion that the best make of truck included in the tenders is that of the J. G. Brill Company of America; that the best makers of car bodies are Messrs. Milnes and the Electric Railway and Carriage Works; that the plough should be that of Messrs. J. G. White and Co. (the contractors for the conduits), which is practically in accordance with the specification on which the tenders were based, and if this be adopted no question can hereafter be raised by Messrs. White and Co. as to its suitability for its purpose; that as regards wheels and axles there is no special difference between those specified in the different tenders; and that for the electrical equipment and motors those of Messrs. Dick, Kerr, and Co. are the best, as their motors are the most powerful and give better acceleration than any others. Dr. Kennedy's opinion with regard to these matters is shared by the tramways manager and the Council's electrical engineer. The two lowest tenders which provide for (*a*) Brill trucks, (*b*) approved car bodies, and (*c*) White's ploughs, which in the opinion of Dr. Kennedy are essential to the efficiency of the service, are those of the British Thomson-Houston Company, £70,330; and of Messrs. Dick, Kerr, and Co., £71,754. Messrs. Dick, Kerr, and Co.'s motors are, however, so much the more effective that Dr. Kennedy considers them worth more than the difference in price, which amounts to about £7 per motor. Moreover, that firm is prepared to deliver the whole of the 100 cars within 24 weeks from the date of the order, instead of the 36 weeks specified by the other firm, and the difference in time for delivery is somewhat important, having regard to the desirability of the tramways being worked by electrical traction at the earliest possible time. We are, therefore, of opinion that, having regard to all the circumstances, the tender of Messrs. Dick, Kerr, and Co. should be accepted; and we may mention that, should the Council adopt that course, the whole of the works, with the exception of the trucks, which will be made in America, will be of British manufacture. Provision for this expenditure was made in the estimate for £478,000, approved by the Council on Feb. 19, 1901, in respect of rails, machinery, rolling-stock, etc., required in connection with the reconstruction of the tramways above referred to."

Huddersfield.—The figures we gave in these columns last week, showing a deficit of £3,359 on the working of the steam tramways for the year ended March 31 last, and a deficit of £5,775 on the electric sections, were brought up for consideration at the monthly meeting of the Borough Council last week. Towards meeting the deficiency in the revenue account the Tramway Committee requested provision for an amount equal to a rate of 3d. in the pound, and a lengthy debate took place upon that issue. Councillor Moore, in asking the Council to sanction the rate, gave a brief *résumé* of the tramway situation in Huddersfield. Referring first to the accounts, he stated that during the year just closed somewhere about 10 millions of passengers had been carried, which was equal to two journeys per week for every man, woman, and child within the borough. The number of miles run had been 1,001,933, against 634,289 the previous year, or an increase of 377,644. The income from all sources—passengers, parcels, and advertisements—had been £49,011, as against £37,498 last year, or an increase of £11,513. The usual annual increase in receipts during the previous five years had been from £1,000 to £3,000. These satisfactory results had been obtained with an actually diminished working expenditure. The propelling power had cost: for steam, £8,156, or 5d. per car mile; and for electricity, £2,184, or 1·1d. per car mile; or the two together a total of £10,340 against £19,982, or 5·4d. per mile last year. This was a saving of £3,682, which afforded a strong proof of the soundness of the recommendation of the Investigation Sub Committee which sat last year—a recommendation heartily supported by the then chairman and vice-chairman of the Tramways Committee—that the sooner the conversion to electricity was completed the better. The item of "traffic," which was chiefly made up of wages to motormen and conductors, however, amounted to £10,009, or an increase of £5,366. This was due to the largely increased number of cars now on the road. The whole of the working expenses totalled up to £32,102 for the year, as against £32,737 for the previous year, or a saving of £635. But they could not spend the money they had been doing upon conversion without increasing their liabilities for interest on money borrowed and for a sinking fund to ultimately extinguish such debt. This item had increased £2,858 during the year to £17,719, and next year would show a further increase of some £5,000 or £6,000. If this £17,779 were added to the £32,102 total working expenses they got £49,821, or £810 in excess of their income, and that amount would represent the extent of their loss this year if their balance-sheet were made up in the manner that has been customary hitherto. But the Investigation Committee which sat last year recommended, and the Council decided, that henceforward and until the income warranted a larger payment an amount equal to 3 per cent. on the capital outlay should annually be set aside for depreciation. The contribution due this year amounted to £8,334, and inasmuch as there are no funds to meet the liability, it is being carried forward as a debit against next year, when they hoped to be in a position to liquidate some portion of it. The expediency of going to the rates to obtain money to build up a fund for depreciation when, failing sufficient revenue, the ratepayers were liable for such depreciation when it occurred, was open to question. Therefore, the Tramways Committee asked for no assistance from the rates to make good any deficiency incurred during the past year. But the previous year was a most unfortunate one financially, and showed a net loss of £10,100 without any allowance for depreciation. A small depreciation fund was in existence—the accumulation of several years—amounting to £7,000. This fund was robbed to the extent of £5,000 to make good one-half the year's loss in revenue. The balance of £5,100 was brought forward as a debit against the year just closed. Undoubtedly the proper course was to have gone to the rates last year, but it was not adopted, and unfortunately this year had not been equal to carrying the burden in addition to its own responsibilities, so there was no alternative but to ask the Council to sanction a rate of 3d., which was estimated to yield about the amount of the legacy bequeathed to the present committee by its predecessors. Councillor Moore went on to state that this was the fourteenth time the tramways undertaking had had to be subsidised out of the rates, and that when this 3d. was obtained something like £46,000 would have been received from that quarter. Nor could he hold out much hope that in the near future the undertaking would be in a position to commence repaying its obligation. When they considered that in the borough of Huddersfield they had one mile of tram route for every 3,454 population, against one for every 8,641 in Glasgow, 7,149 in Leeds, 5,672 in Halifax, 15,863 in Sheffield, and 25,328 in Hull, it would be seen at a glance that they could not expect the same satisfactory results that were obtained in these towns. But with judicious management and the exercise of proper economy he was satisfied about the ultimate result. The increase of £11,513 in the receipts this year showed what could be done if cars were provided when and where needed. An even larger increase again was not too much to expect next year, and whilst he did not think they could overtake their arrears of contributions to the depreciation fund either this year or next, he confidently believed that, bar accidents, this would be the last time it would be necessary to ask the Council to sanction a rate in aid. The discussion was taken up by several other members of the Council, and eventually the motion sanctioning a rate of 3d. in the pound in aid of the tramways was agreed to

LIGHTING AND GENERAL.

Luton.—We notice that the Bute Hospital authorities are purchasing an X-ray apparatus.

Stourbridge.—The question of providing a destructor and the electric light is still under discussion.

India.—The South India Railway Company have recently fitted their mail trains with the electric light.

Ilfracombe.—A site has at length been secured for an electric light station, and work will be started at once.

Penarth.—The Bill to extend the Penarth electric lighting order for 10 years has been reported for third reading.

Accrington.—An enquiry has been held into the Town Council's application for sanction to borrow £2,525 for electricity supply.

Barnes.—An enquiry has been held into the Urban District Council's application to borrow £1,300 for electric street-lighting.

Tipton.—The Bill confirming an electric lighting provisional order granted by the Board of Trade to Tipton has passed the House of Commons.

Wakefield.—The Corporation have appointed Mr. Cyril Morley Shaw, of the Leeds electricity works, and formerly of Dewsbury, electrical engineer.

Ealing.—The Town Council are making further enquiries concerning the use of mechanical stokers at electric lighting stations in and around London.

Wigan.—The Electric Light and Tramways Committee have resolved that the appointment of Mr. T. Lymn, jun., as assistant engineer-in-charge, be reaffirmed.

Gillingham.—An enquiry is to be held into the application of the District Council for power to borrow £58,015 for the purchase of the electric light undertaking.

Welshpool.—Enquiries are being made with regard to connecting the town by telephone with Montgomery on the trunk line, and of establishing local connections.

Cuba Submarine Telegraph Co.—The directors recommend a dividend for the half-year to Dec. 31 on the ordinary shares at the rate of 4 per cent. per annum, tax free.

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Walsall.—An additional main is to be laid in Bradford-street at an estimated cost of £241, and another main extended along Station-street at an estimated cost of £337.

York.—The Council have decided that no tenders for buildings for the extension of electrical machinery be invited until plans of such buildings have been approved by them.

Swinton.—The Council are considering a reply of the Electricity Committee of the Salford Corporation to the application for a quotation for the supply of electricity in bulk.

Blackpool.—Messrs. Ashmore, Benson, Pease, and Co., Limited, Stockton-on-Tees, have obtained the order from the Blackpool Winter Gardens for two storage batteries, each consisting of 60 cells.

Dover.—At the last meeting of the Council intimation was received of the Local Government Board's approval of the Council's resolution giving notice of intention to oppose the Kent Electric Power Bill.

The Temple.—It is reported that the Benchers of the Middle Temple have refused permission to the Post Office authorities to open the roads and lay their telephone wires within the precincts of the Middle Temple.

American Marconi Company.—The Marconi Company of America has reduced its capital from 10,000,000dol. to 6,500,000dol. The preferred stock is withdrawn, and only ordinary stock will be issued.—*Laffan.*

Eastern Extension Telegraph Co.—The directors announce a dividend of 2s. 6d. per share for the quarter ended Dec. 31, 1901, together with a bonus of 4s. per share, making a total distribution of 7 per cent. for the year.

Broughty Ferry.—The Town Council intend to apply for sanction to borrow £25,000 for the equipment of the electricity works to be built near the gasworks, mains, etc. Mr. Waddell, the gas engineer, is to direct the undertaking.

Gloucestershire Electric Power Bill.—This Bill passed the examiners of petitions for private Bills, for proof of compliance with the Standing Orders of the House of Lords, on Friday last, and will now go before a committee.

Teddington.—The Council have adopted a report of the Lighting Committee recommending that the Council should take into consideration at an early date the question of utilising the powers obtained under their electric lighting order.

Aberdeen.—The lighting of the clock in the tower of Ferryhill United Free Church has now been referred to the electrical engineer and the keeper of the city clocks for a report as to the practicability of the proposed lighting scheme and the cost.

Motors.—Messrs. D. Bruce Peebles report an exceptionally heavy trade in motors for power development, having at the present moment on order an equivalent to 20,000 h.p. for every variety of power transmission both for Colonial and home orders.

Camberwell.—At the last meeting of the Borough Council it was stated that the Board of Trade had so amended the electric lighting order sought by the Council that they would be obliged to consider the purchase of other companies if this was pressed.

Brierfield.—The cables for the supply of the electric current have now been laid along Colne-road and down Railway-street to the Leeds and Liverpool Hotel. The Wesleyan Chapel has been fitted the electric light and was used on Sunday evening last with satisfactory results.

Croydon.—The price charged for current supplied for motive power (other than the tramways) has been reconsidered, and in lieu of the present method of charging by maximum demand indicator at 7d. and 1d., a flat rate of 2½d. per unit is to be charged as from the last meter reading.

Whitehaven.—Electric current will be supplied free of charge to burgesses requiring light for the purpose of illuminating the exterior of their premises on the occasion of the Coronation celebrations, the devices and arrangements to be subject to the approval of the electrical engineer.

Oban.—At a recent meeting of the Finance Committee the draft minute of agreement between the Council and the National Telephone Company with regard to wayleaves as revised on behalf of the company was discussed. It was agreed to insist on the terms of the draft as it stood before revisal.

Auckland.—The Urban District Council are getting impatient about the lighting of their compulsory area, which should be completed by June. They threaten the contracting company that they will apply to the Board of Trade if something more definite is not undertaken at once.

Victoria-embankment.—On Tuesday the London County Council commenced to remove the old gas standards on the Victoria-embankment, their electricity works being now considered to have proved their capacity to provide for the electric lighting of the Embankment without risk of interruption.

Coventry.—The Electric Light Committee have decided to extend the mains to Lockhurst-lane to supply Messrs. White and Poppee's works. The last progress report shows 42,967 units sold during March, as against 31,747 last year, and total number of lamps connected 26,963, against 23,363 last year.

Ainsdale.—After consultation with the National Telephone Company with regard to their providing a telephone exchange or call office in Ainsdale, it has been ascertained that the company are willing to proceed if seven subscribers are found. The Parish Council are endeavouring to collect that number.

Weybridge.—The Telephone Company have agreed to erect one pole only at the termination of the underground cable at Weybridge Bridge. A site has been selected for feeder pillars at points near the Yool Memorial, the Quadrant, and the station. The size of the pillars is 2ft. by 1ft. 6in., and 4ft. in height.

Bridgwater.—The Town Council have agreed to an application of the Bridgwater and District Electric Supply and Traction Company for consent, subject to clauses being agreed to, to an application to the Board of Trade for a provisional order for electric supply for lighting and power purposes in the ensuing session of Parliament.

Creswell.—Mr. J. C. Pottinger has held an enquiry into an application of the Council for sanction to borrow £650 for the introduction of an electric lighting system. Mr. R. Wood Haggie, of Derby, gave details of the scheme. The Bolsover Colliery Company are to supply the current, which will supply 68 incandescent lamps of 32 c.p.

Great Northern Telegraph Co.—The accounts for the year 1901 show an available balance which will permit of the payment of a further dividend of £1 per share, making 30s. per share for the year, an addition of £150,000 to the reserve and renewal fund, and a transfer of £27,777 to the renewal fund for cable steamers, and leave £64,871 to be carried forward.

Burley-in-Wharfedale.—Part of the new lunatic asylum which the West Riding County Council are building at Scalebor Park, Burley-in-Wharfedale, for the treatment of private patients, will be opened in course of a few months. The lighting will be by electricity, generated on the premises. The sole contractor for the principal blocks is Mr. Isaac Gould, of Leeds.

Copper.—A very large deposit of copper ore has been recently discovered at Montercy, Mexico, the assays of which gave 60 per cent. of pure copper. It is also reported that in consequence of some alleged default in complying with their mining lease of the English Panuco Copper Company, the two rich mines of this company, estimated at over 2,000,000dol., have fallen into the hands of a native.

Kingstown.—The Urban District Council have decided to return the money deposited by parties submitting tenders for various works in connection with the proposed installation. The Council have not yet decided whether they will proceed with the electric lighting scheme prepared by Mr. Manville. Messrs. Beckett and Metcalfe have taken out bills of quantities for the proposed generating station.

Windsor.—At their next meeting the Guardians will consider estimates for the lighting of the workhouse from the Egham Gas Company and the Windsor Electrical Installation Company. The Rural District Council have sanctioned the National Telephone Company's application for permission to erect a line of poles along the Bagshot-road, Sunninghill, from the Brockenhurst-road to the railway on the usual terms.

Brighton Telephones.—The Hove Town Council are unwilling at present to commit themselves to any scheme for telephones which would involve underground works. Their present intention is to apply for parliamentary powers to lay ducts under the roadways for the purpose of telephone and other wires should they deem it desirable to take this course at any future time. The receipt of the letter was acknowledged.

Fylde.—The recently opened isolation hospital is lighted throughout by electricity generated on the premises. The installation includes engine, dynamo, and accumulators. There is telephonic communication between the different blocks and to the central exchange. The architects were Messrs. Haywood and Harrison, of Accrington and Lytham. Mr. Wilson, of St. Annes, was the sole contractor for the work.

Leith.—At a meeting of the Corporation Electric Lighting Committee on Wednesday Mr. A. Peden Rutherford was appointed burgh electrical engineer, a post which was rendered vacant by the resignation of Mr. J. Gray Scott, whose appointment to Croydon we have already referred to. Mr. Rutherford has been employed as an assistant at the electric lighting station since the undertaking was commenced.

Power Distribution.—The *South Wales Daily News* in its issue of April 14 discusses the utility of the big power schemes from the user's point of view. It shows that in the case of a colliery the power as at present used is derived from small units scattered over a large area. It discusses point by point how such machines are used and for what they are used, and the losses to which they are subjected because of the smallness of the units, coming to the conclusion that the substitution of electrical energy derived from big central power stations will be altogether more economical and satisfactory. Such articles as these are of the greatest service, in that they educate the local people who are potential users of the energy to be generated in the big power stations.

Llangollen.—The Urban District Council have adopted an agreement, upon the recommendation of Messrs. Burstall and Monkhouse, with Mr. Bremner Smith, of Oswestry. The terms proposed are: (1) that the Council should assign to Mr. Smith the powers vested in them under the provisional order so far as might be necessary to the due execution of the various works and the generation and distribution of electricity; (2) that he should repay the Council all the costs and charges they had incurred in connection with the provisional order, and in each year a further sum of £2 per cent. upon the net profit earned in such year; (3) the price to be paid by the Council for electricity supplied for public lighting to be at the rate of 3d. per Board of Trade unit; (4) the Council to have the option at the end of 10 years, and of each subsequent five years, of purchasing the undertaking as a going concern, plus an amount equal to the profits of the three years immediately preceding such purchase, the price to be determined by an arbitrator; (5) the Council to undertake to light by electricity the streets within the compulsory area. It was estimated that the cost would be 22s. for each 16-c.p. electric lamp; to this is to be added, say, 2s. for lamp renewals, making 24s. in all.

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Dartmouth.—The Town Council have bound themselves for the public lighting of the town to the Urban Electric Supply Company for the next 10 years at a yearly figure of £364. With the public lighting contract assured for 10 years, and the lighting of the new naval college and the cadets' hospital, the electric company have made a good start. The public lighting has to be carried out by Aug. 15, on which date the gas contract will expire.

Wireless Telegraphy.—The Royal Engineers are carrying out an exhaustive series of experiments in wireless telegraphy on the Marconi system. The permanent station is at St. Mary's Barracks, Chatham, and a body of the Royal Engineers has been detailed to represent a moving column in the field. Communications with the permanent station have so far been successfully established by the moving column at Darland, Maidstone, and Farningham.

Shrewsbury.—The Electric Lighting Committee have made an offer of free current to the county authorities if they are prepared to illuminate the Guildhall and Shire Hall at the Coronation. The committee also propose to supply current for illuminating the public buildings of the borough free of charge. An electric light main will be extended so as to supply residents on the Mount and for street-lighting at an approximate estimated cost of £480.

Southport.—The estimate for gas, electric current, new lamps, and conversions into incandescent lamps for the last year was £4,540. The expenditure has been £4,481. 4s. 10d., an excess of £41. 4s. 10d. The considerable saving which was effected in consumption of gas was far more than counterbalanced by the large cost of converting the old lamps into incandescent lamps, but as this class of expenditure is practically over, future estimates should obtain the benefit.

Rushden.—The chairman and Mr. F. Knight, who, together with Mr. G. Miller, attended on behalf of the Urban District Council the recent conference at Wellingborough with regard to forming a joint Board in the Northampton area of the National Telephone Company for the promotion of municipal telephones, have made their report. No joint Board has been yet constituted, and further enquiries are being made. The chairman and Mr. Knight have been asked to continue as a sub-committee on the matter.

Extension.—We have received a new catalogue describing and illustrating the well-known Heathman's patent extension ladders, telescopic ladder towers, and other specialities so indispensable to electric lamp repairers, firemen, and window cleaners. These specialities are, amongst many others of a similar kind, manufactured by the patentees, Messrs. J. H. Heathman and Co., at 72, Rectory-road, Parson's Green, Fulham, S.W.; local depots exist at 37, Endell-street, Long-acre, W.C., and 7, Pentonville-road, Angel, N.

Cardiff.—The electrical engineer in his last report mentions that, compared with the figures of last year, there was now an increase of 159 in the number of consumers supplied by the Corporation. Plans are being prepared showing the proposed extended system of electric lights for lighting the streets. We understand that the Council will proceed no further with its scheme for municipal telephones. The Council have obtained sanction to the borrowing of £20,910 for electric lighting—viz. (1), for defraying excess expenditure over and above loans previously sanctioned of £6,844, less £399 costs, and (2) for defraying further expenditure amounting to £14,460 for extensions in connection with the existing generating stations.

Southwark.—At the last meeting of the Borough Council the town clerk reported the receipt of a letter from the Board of Trade declining to proceed with the application of the Council for a provisional order to enable them to supply electricity in the portions of the borough outside the parish of Newington. The Board of Trade were of opinion that Parliament was not likely to grant an order allowing a local authority to compete in cases where a company was already supplying a sufficient supply for the consumers. In the parish of St. George's there were already two companies actively supplying electrical energy, while in St. Saviour's there were two companies supplying, and a third had a right of way through a portion of the district. The letter was referred to the General Purposes Committee.

New Issue.—The Electrolytic Alkali Company, Limited, are issuing 50,000 7 per cent. cumulative preference and 50,000 ordinary shares, both of £1 each, forming part of the authorised capital of £500,000, of which £202,218 has already been issued. The company was formed in November, 1899, to acquire the Hargreaves-Bird and other electrolytic patents for the United Kingdom, and the first section of the works was completed in April, 1901, when the manufacture of bleaching powder and soda crystals was commenced. According to the prospectus the profit on this section is at the rate of £7,314 per annum, and it is calculated that five sections of plant, the second of which is in course of construction, would produce sufficient to pay upwards of 15 per cent. on the ordinary shares.

Cheshire and North Staffordshire Electric Power Scheme.—A company intend to apply on behalf of a local syndicate for parliamentary powers to erect electric generating stations and lay mains throughout a district comprising the county of Chester and North Staffordshire. The area of the district is 1,500 square miles and the population about 1½ millions, and within the area there are four county boroughs, 11 boroughs, 41 urban districts, and 25 rural districts, making 81 local authorities. The scheme is to be on the same lines generally as in the Lancashire Electric Power Act and other similar Acts already granted by Parliament. The chief object is to apply electricity for power purposes, although the company would be prepared to supply local authorities with electricity in bulk for lighting and other purposes within their own areas at what they consider a much cheaper rate than the authorities could produce it themselves.

Cults.—About a month ago intimation was made to the consumers of the electric light at Cults that the supply was to be discontinued, and the announcement excited not a little disappointment and concern. The *Aberdeen Daily Journal* reports that several well-known gentlemen, however, took the matter in hand, with the result that the liquidators of Messrs. P. C. Middleton and Co., at the request of the heritable creditors, and having received a guarantee from Mr. John Whyte, of Dalhebity, agreed to keep the Cults electric station working for three weeks from March 28, to give a further opportunity for the efforts which were being made by some of the consumers to purchase the undertaking. The three weeks have now expired. It is understood that Mr. Whyte has intimated to the creditors that his efforts have not received sufficient support, that he and those acting along with him have had to abandon the idea of purchasing the concern, and that his guarantee will terminate to-day. In these circumstances the liquidators, through their agents, Messrs. Wilsone and Duffus, advocates, have intimated to the consumers that they are not to carry on the station longer than to-day, and that the light will be cut off to-morrow.

Swansea.—The Telephones Committee propose to rent, for the purposes of the proposed municipal telephone exchange, a site on the north side of Pier-street. The following scale of additional tariffs has been approved in connection with exchange lines: extra instruments in same building per annum—wall 16s. 6d., table 20s. 3d.; extra instruments in another building, the same, plus 4s. per 110 yards of wire or fraction thereof—extra receiver 4s., extra bell 4s., indicator 4s., switch 2s. 9d. These are the same prices as private lines, plus 10s. for Post Office royalty. All the above prices, private as well as exchange, apply only when the lines can be carried, at least in great part, on existing poles or in existing conduits. When special works are necessary, special prices will be quoted. Extras—private wire on three years' agreement: wall instruments (per annum) £1. 3s., table instruments (per annum) £1. 5s. 6d., metallic circuit (per 110 yards) 3s. 9d.; extra instruments in same building—wall instruments (per annum) 15s., table instruments (per annum) 16s. 6d., extra receiver 3s. 6d., extra bell 3s. 6d., indicator 3s. 6d., switch 2s. 6d. No Post Office royalty is payable in these. The time within which subscribers to the municipal telephone service must sign their applications to be entitled to three months' free user has been extended from March 31 to April 30.

Battersea.—The estimates for the year ending March 31, 1903, contain the following item: for working expenses, etc., electric lighting, £7,460. The electrical engineer has devised a patent ladder for use in attending to arc lamps, whereby it is claimed that the lamps in question can be dealt with by one man instead of two, as at the present time. One of these is now to be made at the works department of the Council according to Mr. R. H. F. Mackay's specification, and 50 of the arc lamp-posts erected in the borough are to be drilled to be ready for the use of the appliance. We extract from the agenda the following report from the Law and Parliamentary Committee: "We have had under consideration the Electric Lighting (London) Bill now before Parliament. The Bill, which is promoted with the object of making the electric lighting areas of London coterminus with the local government areas as far as possible, has received the attention of the Lighting Committee, who reported to the Council fully on the Bill on Feb. 26 last. That committee have endeavoured to secure an amendment of the Bill upon the lines of the Bill introduced by the Board of Trade last session (the provisions of which would more probably have achieved the object in view), but have been unsuccessful, and they have requested us to take such further steps in the matter as may be advisable, at a reasonable cost. We recommend that a petition be presented against the Bill."

Stock Exchange.—The Stock Exchange Committee have appointed May 7 a special settling day for London United Tramways (1901), Limited, 51,501 5 per cent. cumulative preference shares of £10 each fully paid, and 30,999 5 per cent. cumulative preference shares of £10 each £5 paid, within Nos. 1 to 82,500; £655,341 4 per cent. first mortgage debenture stock; and provisional certificates (£50 per cent. paid) for £169,659 4 per cent. first mortgage debenture stock; and Notting Hill Electric Lighting Company's further issue of 2,200 ordinary shares of £10 each fully paid, Nos. 12,201 to 14,400; and have ordered the undermentioned securities to be quoted in the official list: Buenos Ayres Grand National Tramways Company's further issue of £9,800 5½ per cent. preference debentures, Nos 1,139 to 1,236, of £100 each; London United Tramways (1901), Limited, 51,501 5 per cent. cumulative preference shares of £10 each fully paid, and 30,999 5 per cent. cumulative preference shares of £10 each £5 paid, within Nos. 1 to 82,500; £655,341 4 per cent. first mortgage debenture stock, and provisional certificates (£50 per cent. paid) for £169,659 4 per cent. first mortgage debenture stock; Notting Hill Electric Lighting Company's further issue of 2,200 ordinary shares of £10 each fully paid, Nos. 12,201 to 14,400; Willans and Robinson's further issue of 26,666 ordinary shares of £5 each fully paid, Nos. 90,001 to 116,666, and 16,666 6 per cent. cumulative preference shares of £5 each fully paid, Nos. 125,001 to 141,666.

Portsmouth.—The new naval barracks at Portsea are nearing completion. The electric light is being fitted throughout by Messrs. Bergtheil and Young, of Camomile-street, Mr. W. H. Walker representing the Admiralty for the electric light contract. The current is to be supplied from the borough electric light station in Gunwharf-road, Portsmouth, from which a special high-tension cable is being laid to a specially-constructed transformer chamber in the barrack yard, where the current is stepped down from the 2,000 volts, at which it is supplied, to 230 volts. Externally the lighting will be by 20 arc lamps of 12 amperes each, the lamps being placed on the buildings where possible and upon standards only where absolutely necessary. The internal lighting will be by 3,000 16-c.p. incandescent lamps, 24 being fitted up in each room, which is supposed to hold 125 men. Everywhere the fittings will be substantial. Iron T-shaped pendants will hold the lamps, and the same class of fittings will be provided in the petty officer's room on each of the barrack-room floors. In the chief petty officers' block the electric fittings will be of rather better material, and this, of course, applies to the warrant officers' cabins and their messroom, which is a spacious apartment capable of dining at

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least 100 persons. In the theatre, to accommodate 1,500 persons, and in the canteens, special arrangements are being made for securing effective lighting, and some hundreds of lamps will be provided for each building. Provision is made for a main switchboard to control the entire range of buildings, and there are also smaller switchboards for each block. In the officers' quarters and the captain's official residence, which are also to be supplied with the electric light, the work is not far enough advanced.

South Wales Electrical Power Co.—This Company have deposited the amendments which they propose to insert in their Bill as an "additional provision" for powers to absorb electric lighting undertakings within their area of supply. The proposed addition to the preamble is as follows: "Whereas provisional orders under the Electric Lighting Acts have been granted to local authorities and other undertakers for the lighting of several districts and places within the Company's area for the supply of electricity, and the Company are desirous of having power to acquire by agreement such of the undertakings authorised by the said provisional orders as the undertakers may be willing to transfer to them, and to supply electric energy in and to the districts and places to which the undertakings so transferred relate, and it is expedient that the necessary powers should be conferred on the Company and such undertakers respectively . . ." The clause proposed to be inserted in the Bill to carry out the proposed new recital in the preamble is as follows: "The Company may by agreement (but not otherwise) acquire from any local authority or other undertakers to whom a provisional order under the Electric Lighting Acts, 1882 and 1888, shall have been granted relating to a district or place within the Company's area of supply, the undertaking authorised by such provisional order, and any such undertakers may, with the approval of the Board of Trade, transfer their undertaking to the Company on such terms and conditions as may be agreed upon, and, in the event of the Company so acquiring such undertaking, they shall be entitled, in respect of the supply of electric energy to and within the district or place defined by such provisional order, to charge rates or prices not exceeding those limited by such provisional order." The Bill has been reported for third reading.

Stretford.—Colonel Durnford has held an enquiry into the application of the District Council for sanction to borrow £54,000 in order to provide the district with an electrical supply for lighting and traction. Mr. W. H. Norton represented the District Council; Mr. Langdon, along with Mr. Spencer Hogg, appeared for a number of ratepayers and landowners in Trafford Park, including the British Westinghouse Company, the Electrical Manufacturing Company, Glover and Co., and the Grain Elevator Company; Mr. Marshall Stevens was present on behalf of the Trafford Park Estates Company. Mr. T. Johnston, chairman of the Electric Lighting Committee, and Mr. C. H. Wordingham, electrical engineer, stated that there was a great demand in the district for electricity. Mr. Abraham, clerk to the Council, said there were 6,900 houses in the district, of which 670 were rented at £30 and upwards. Five years ago the population was 30,436, the ratable value in 1897 amounted to £143,156, and to-day the total was almost double—being £280,445. The development of the district had been general. Industrial development had taken place to a great extent in Trafford Park. There were 8½ miles of tramway, and the trams were at present worked by the Manchester Carriage and Tramways Company. The Council had given notice to the company to purchase the tramways. The arbitration on the purchase price was held some months ago, and they were now waiting the award. Mr. S. V. Clirehugh, Manchester, was of opinion that the demand for electricity did not warrant so large an expenditure, and that the undertaking would not for some years be profitable, and would necessitate a charge being made on the rates. Considering the character of the district, the growth of the demand for electric lighting must necessarily be slow, and if the Council must establish their own works instead of taking a supply from either the Manchester Corporation or the Trafford Power Company, they ought not to embark on so large a scheme until satisfactory evidence was produced that the necessary demand existed to warrant such expenditure.

Manchester.—The Bill for establishing a joint Telephone Board for the Manchester telephone area will probably not be proceeded with during the present session. At the recent ratepayers' meeting, called to sanction the Bill, a poll was demanded. The expense of this would be considerable, and it is believed that other arrangements can be made to obtain a license for the provision of a municipal service for the area that would be affected by the Board. The Electricity Committee have been discussing the annual estimates. On revenue account an expenditure of £175,459 is anticipated, as against probable receipts amounting to £166,447, leaving a balance of £9,012 as estimated loss, which loss it is proposed to meet out of the reserve fund. According to the *Manchester Guardian*, last year's working or revenue account showed a surplus balance of £6,300, which has been carried to the reserve fund. During the year ending March 31, 1903, it is estimated that £875,799 will be expended on capital account, including £21,000 at Dickinson-street, £55,394 at Bloom-street, £463,705 at Stuart-street, £211,295 upon distributing stations, and £119,400 on mains. The estimated loss on the working of the department is principally caused by the great expenditure of capital during the past year at the Stuart-street works, the 20 odd sub-stations, and the enormous number of cables required. The expenditure of the department on capital account this year has been between £700,000 and £800,000. Provision of electricity for the tramways has, of course, caused the outlay of great sums. It follows that a large sum is required to pay interest and sinking fund, the amount in this respect reaching £70,000. Last week the fire brigade had at least four calls for their services, and many business establishments were left for a time without electric light, while some workmen in a cable manhole in Market-street narrowly escaped suffocation. The cause is stated to have been a short-circuit in a cable in the Market-street area. The workmen who were endangered were caught by the smoke while they were working in a manhole, but were rescued in time. The fusing of the cable was immediately followed by fusing in several places of business, but the fire outbreaks at each place were easily dealt with, and no serious damage was done, but the mishap affected for a couple of hours the whole supply of electricity round Market-street, and it is stated officially that if the area of supply had not recently been split up the whole city would have been affected by the accident. It is proposed to still further subdivide existing districts, and the work of replacing old cables has been in progress for some time.

Bermondsey.—The Council have decided to undertake the wiring of consumers' premises under the following conditions: Any resident or manufacturer desiring an installation of electric light in his house, shop, or factory will obtain from the electrical department a form of application, which must be filled in, signed, and forwarded to the electrical engineer. The premises will then be inspected and an estimate of its cost prepared. For this service the applicant will be charged a fee calculated at the rate of 3 per cent. on the cost of the installation, with a minimum fee of 5s. The Council's installation will only include plain fittings, but the applicant can substitute more expensive fittings at his own expense, or by special arrangement the extra cost can be liquidated by a small increase in the instalments of purchase money. The applicant may decide whether he will purchase upon either of the following methods: (*a*) by one payment, in cash, including the Council's fee for the inspection and estimate, this method avoiding all complication and needing no consent on the part of the owner of the property; (*b*) by deferred payments. The applicant will be required to pay down one-tenth of the cost of the installation on completion, and the Council's fee for the inspection and estimate, and the balance, at the applicant's option, be spread over three, five, or seven years, and be paid by 12, 20, or 28 quarterly instalments, including interest at 4 per cent. on the amount for the time being remaining unpaid. Should the applicant so desire, he may at any time before the expiration of the period agreed upon purchase his installation outright. The installation will remain the property of the Council until all the instalments are made, and the consent of the owner of the premises is essential to this arrangement. If the applicant decides to pay for the installation by deferred payments, the following conditions will apply: The Council to guarantee the efficient working of the installation (except in case of accident, wilful damage or the occurrence of fire, storm, or tempest) for 12 months from the date of completion, but not to be liable to replace any worn-out or defective lamps. The owner of the property must be a party to the arrangement, and sign an agreement. The Council will render to the applicant quarterly a statement of the amount due from him up to the preceding quarter day. The applicant will be required to sign an agreement providing for the observance of the Council's terms. An estimate has been prepared of the approximate cost of an installation of 12 lamps, to be repaid by 20 equal quarterly instalments with interest at 4 per cent. on the balance, showing that the applicant would pay to the Council an annual sum of 1s. 6d. for every lamp installed in his premises. The applicant would, of course, in addition, pay for electricity consumed, and the installation would remain the property of the Council.

London County Council.—The Council on Tuesday agreed to lend the Battersea Borough Council £2,285, repayable on the instalment system within 20 years, for erection of additional buildings at their central electric generating station in connection with the installation of the electric light within the borough; and the Woolwich Council, for the purchase of the Eltham portion of the works (mains, etc.) of the Blackheath and Greenwich District Electric Light Company, Limited, £5,600, repayment being made on the instalment system within 42 years, commencement of repayment being postponed for three years. Notices were agreed to as follows: Blackheath and Greenwich District Electric Lighting Company, under the Blackheath and Greenwich District Order, 1897, of intention to lay low-tension mains along Foyle-road and Humber-road, and high and low tension along Eliot-hill, Lewisham-hill, and High-street, Lewisham. Charing Cross and Strand Electricity Supply Corporation, under the Strand District Order, 1896, to lay mains along Dean-street, Shaftesbury-avenue, Cambridge-circus, Charing Cross-road, New Coventry-street, across Wardour-street, along Leicester square and place, Cranbourn-street, Tavistock-street, Beaufort-buildings, Strand, Bow-street, Hart-street, Wellington-street, Lisle-street, Maiden-lane, Bull-inn-court, Chandos-street, Bedford-street, and Garrick-street, and under the St. Martin's District Order, 1889, to lay mains along Whitcomb-street, James-street, the Haymarket, Pall-mall East, Trafalgar-square, St. Martin's-place, Charing-cross, Northumberland-avenue, Villiers-street, Duke-street, John-street, Adam-street, across the Strand (two places), along Bull-inn-court, James-street, Adelphi, William-street, Durham-street, Bedford-street, Wellington-street, Exeter-street, Endell-street, across Long-acre, along Bow-street, Charing Cross-road, Cranbourn-street, across St. Martin's-lane, and along Garrick-street. County of London and Brush Provincial Electric Lighting Company, under the County of London (North) Order, 1892, to lay power and low-tension mains along North-street, Pentonville-road; under the Camberwell Order, 1896, to lay low-tension mains along and across Talford-road; under the Wandsworth Order, 1892, to lay low tension mains along both sides of Barrow-road. Kensington and Knightsbridge Electric Lighting Company, under the company's order and the Kensington and Knightsbridge Electric Lighting Act, 1893, to lay mains along Keiso-place and Kensington studios. The Charing Cross and Strand Electricity Supply Corporation, under the Holborn and St. Giles (No. 2) Order, 1898, to lay mains along Great Queen-street, Drury-lane, Short's-gardens, Queen-street, Seven Dials, and Little Earl-street to the Shaftesbury-avenue subway. Notice is to be served upon the Charing Cross and Strand Electricity Supply Corporation, requiring it to lay the mains for Shaftesbury-avenue,

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referred to in the company's notice dated April 1, 1902, in the subway of that thoroughfare. The receipt of three notices from the Islington Borough Council, under the Islington Order, 1893, of intention to lay mains (*a*) along a portion of Turle-road; (*b*) along portions of St. Paul's-place and Northampton park and grove; and (*c*) along portions of Grosvenor-road and Highbury New-park was also reported. The Borough Council being the undertaker under the order, the Council has no power of approval or disapproval of the works.

PROVISIONAL PATENTS, 1902.

APRIL 14.

8610. Improved leather glove or hand protector for driving electric cars and the like. George Pescot, 119, Market-street, Manchester.

8616. An improved method of moving electrically the points on an electric tramway or railway. Joseph P. Tierney and John Malone, 44, Booterstown avenue, co. Dublin.

8629. Improvements in or applicable to the trolley heads of electric cars. Henry Craven and Joseph Richardson Garner, 70, Deansgate, Manchester.

8630. Improved insulated lapping for electric wires. Edward Turner Whitelow, 70, Deansgate, Manchester.

8643. Improvements in or connected with means for damping the oscillations of the hands or pointers of electrical measuring instruments or the like. Francis Henry Nalder and Nalder Bros. and Thompson, Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

8645. An improved method of automatically regulating the flow of liquids, gases, electricity, chemicals, and powders. William Player Miles, 62, Greyhound-lane, Streatham, London.

8651. Improvements relating to conduits for electric cables and the like. Leonard Barlow and James Young, 18, Southampton-buildings, Chancery-lane, London.

8653. Electric lamp shade holder. Frank McIntyre, 322, High Holborn, London. (Complete specification.)

8667. An improvement in the method of regulating the pressure of alternating-current dynamo-electric generators. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actien-Gesellschaft, Germany.) (Complete specification.)

8670. Improvements in electric arc lamps Tito Livio Carbone, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

APRIL 15.

8717. Improvements in or relating to electric lamps. William Fairburn-Hart, 50, Wellington-street, Leeds. (The General Electric Company, United States.) (Complete specification.)

8730. Electric valve-controlling gear for fluid-operated lifts. Eugene Chaudoir, 75, Chancery-lane, London.

8746. Improved electric riding track. Walter Darker Pitt, Fife House, Kingston-on-Thames.

8747. Improvements in the locking devices of electrical blocking apparatus for railways. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actien-Gesellschaft, Germany. (Complete specification.)

8748. Improved means for securing and adjusting the active laminated rings of electrical machines and motors in their frames. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actien-Gesellschaft, Germany.) (Complete specification.)

8775. An electric ignition indicator for explosion engines, particularly applicable to motorcars. Thomas William Ellis, 40, Southampton-buildings, Chancery-lane, London.

8784. Improvements relating to rail bonds or connections for electric railways. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Edward G. Thomas, United States.) (Complete specification.)

8788. Improvements in alternate-current measuring and indicating instruments. Leonard Andrews, 46, Lincoln's-inn-fields, London.

8789. Improvements in and relating to electrical distributing systems. Leonard Andrews, 46, Lincoln's-inn-fields, London.

8794. Mechanism for recessing trolley wires. William Andrew McCallum, 322, High Holborn, London. (Complete specification.)

8796. Improvements in or in connection with electric controlling devices. Henry Charles Froelich and Edward Payson Baird, 6, Lord-street, Liverpool.

APRIL 16.

8824. Improved means for suspending overhead wires for electric traction. Thomas Gregson, 4, St. Ann's-square, Manchester.

8858. A process and device for producing effective and reliable electrical ignitions of explosive substances. Heinrich Wilhelm Hellmann, 33, Cannon-street, London.

8843. A new or improved device or apparatus for disinfecting by electric light irradiation. Heinrich Lorenz Wiedemeyer, 1, Broad-street-buildings, Liverpool-street, London. (Complete specification.)

8863. Improved apparatus for the application of the electric light to medical purposes. Annie Brook, 37, Bloomsbury-square, London.

8866. Improvements in wireless electrical communications. Henry Brocker, Walter Herbert Goss, and John Lea, Freezywater, Waltham Cross, Middlesex.

8872. Improvements in switches for electric lighting. Siegfried Bach, 6, Lord-street, Liverpool. (Complete specification.)

8878. Improvements in protecting devices for overhead electric traction systems. Walter Rutherford, 18, Southampton-buildings, Chancery-lane, London. (John Roberts, Natal.)

8884. Improvements in electric arc lamps. George William Johnson, 47, Lincoln's-inn-fields, London. (Voltohm Elektrizitätsgesellschaft, Aktien-Gesellschaft, Germany.)

8892. Improvements in and relating to electrically-wound clocks. Henry Harris Lake, 44, Southampton-buildings, Chancery-lane, London. (Aktiebolaget Svenska Elektriska Urfabriken, Sweden.) (Complete specification.)

APRIL 17.

8947. Improvements in electric arc lamps. Luis Wirtz, 36, Chancery-lane, London.

8969. Improvements in dynamo-electric generators. Herbert John Haddan, 18, Buckingham-street, Strand, London. (Harry Lincoln Peck, United States.) (Complete specification.)

APRIL 18.

9040. Improvements in and relating to the manufacture of electric conductors. Sidney George Brown, 45, Southampton-buildings, Chancery-lane, London.

9044. Improvements in and relating to telephonic apparatus. Sidney George Brown, 45, Southampton-buildings, Chancery-lane London.

9057. An improved method of winding for electric machines and appliances. Raymond Rougé, 45, Southampton-buildings, Chancery-lane, London.

9062. Improvements in connection with electric arc lamps. Frank Gubing and Julius Auerbach, 18, Southampton-buildings, Chancery-lane, London.

9068. Improvements in electric tram and railways on a sectional conductor system. John Leighton and Robert Hacking, 24, Southampton-buildings, Chancery-lane, London.

APRIL 19.

9074. Improvements in series resistances for Nernst lamps. Nernst Electric Light, Limited, and Sydney Gowan, 18, Southampton-buildings, Chancery-lane, London.

9077. An automatic lifeguard for the electric tramcars. William Jackson, 104, Regent-street, Anlaby-road, Hull.

9110. Improvements in speed regulating and steering mechanism for motorcars, launches, and the like. Arthur Paget, Percy Wilbraham Northey, and the Electric Motive Power Company, Limited, 70, Chancery-lane, London.

9111. Improvements in electromagnetic clutches and variable gear. Percy Wilbraham Northey and the Electric Motive Power Company, 74, Caistor-road, Balham, London.

9135. Improvements in coin-freed electric meters. The British Thomson-Houston Company, Limited, and Frank Holden, 83, Cannon-street, London.

9143. Improvements in the production of secondary electric currents. Robert Grisson, 45, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published May 8.

1901.

8015. Direct-acting combined magnetic regulator and brake for electric arc lamps. Lenderyou and Wyatt.

8648. Automatic electric exchange apparatus. Wise. (American Machine Telephone Company, Limited.)

8653. Starters for electric motors. Ridings and Veritys, Limited.

9019. Electric gear for controlling lifts or hoists. Björnstad.

9303. Electric transformers. Berry.

9692. Sectional conductor systems for electric traction, railways, and the like. Haggenmiller.

12088. Method of and means for taking electric current from transformers. Weissmann. (Date applied for under International Convention, Dec. 5, 1900.)

13139. Electric furnaces. Duff and United Alkali Company, Limited.

15366. Safety devices for electrical apparatus. Rudhardt. (Date applied for under International Convention, Jan. 25, 1901.)

16902. Electric typewriter. Wheatley. (Electric Typewriter Company.)

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15818. Storage batteries and insulation thereof. Lloyd.

21935. Incandescent electric lamps. McCullough. (Date applied for under International Convention, April 2, 1901.) 1902.

6184. Section insulators for electric trolley conductors. Hirst and Wood.

6478. Storage batteries. Porter.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	Apr. 19	645	634	+ 11	—	—
Birmingham Tramways	,, 19	4,792	—	+ 536	73,654	65,754
Blackburn Corporation	,, 18	718	575	+ 143	10,036	8,579
Blackpool Corporation	,, 19	278	269	+ 9	3,601	2,242
Blackpool-Fleetwood Tramways	,, 12	254	706	− 452	3,323	2,973
Bolton Corporation	,, 20	1,539	1,526	+ 13	21,172	19,632
Bradford Corporation	,, 13	2,635	1,003	+ 1,632	30,358	11,549
Bristol Tramways Company	,, 18	4,314	4,056	+ 258	—	—
Carlisle Tramways Company	Mar. 15	122	123	− 1	1,282	1,192
Central London Railway	Apr. 19	6,557	6,443	+ 314	105,952	97,984
City and South London Railway	,, 20	2,810	1,936	+ 874	47,543	32,126
Cork E. T. and L. Company	,, 17	433	420	+ 13	5,688	5,479
Darwen Corporation	Mar. 22	169	154	+ 15	1,951	1,844
Darwen-Hoddlesden	,, 14	26	—	—	—	—
Dover Corporation	Apr. 21	194	195	− 1	2,806	2,668
Dublin & Lucan Electric Railway	,, 20	100	104	− 4	1,439	1,296
Dublin U. T., electric cars	,, 18	3,542	3,444	+ 98	—	—
Dublin S. District, Electric	,, 18	978	757	+ 21	—	—
Dundee Tramways Company	,, 16	761	582	+ 179	—	—
Glasgow Corporation	,, 19	11,530	9,294	+ 2,236	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 19	1,626	1,524	+ 102	4,955	4,988
Liverpool Corporation	,, 12	8,893	9,148	− 255	132,806	119,487
Liverpool Overhead Railway	,, 20	1,445	1,644	− 199	22,441	24,382
Newcastle-on-Tyne Corporation	,, 19	2,356	—	—	—	—
Portsmouth Corporation	,, 19	1,415	569	+ 846	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 21	3,762	—	—	—	—
Southampton Corporation	Mar. 27	775	537	+ 238	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £440 decrease.

Barcelona Ensanche y Gracia, £39 decrease. Barcelona, £442 increase.

Brisbane, £181 increase (month of March, £10,934; increase, £1,789).

Buenos Ayres and Belgrano Electric (month of March, receipts £12,184; decrease £647), £49 decrease.

Calcutta, £20 decrease.

Cape Town (month of March), receipts, £17,888; expenditure, £7,343.

Isle of Thanet Electric, £101 increase.

La Capital Traction and Electric, Buenos Ayres (month of Dec.), £1,394 increase.

Mexico Electric (month of March), receipts, £19,000; expenditure, £10,500.

Perth Electric, £229 increase.

Port Elizabeth (month of March), receipts, £3,818; expenditure, £1,947.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Tramways.—	£	£
Anglo-Argentine, 1-260,007	5 ..	3¼-4⅛
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-130
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	3-3½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	103-106
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6¾-7¼
—— Non-Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9¾
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	100-102 p.c xd
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13¼-14½
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12¼-12¾
—— 5 per cent. Perpetual Debenture Stock	100 ..	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1¼-1⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5¼-5½
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2¼-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼ xd
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104 xd
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11½-12½
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	96-99
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	102-104
New General Traction, Ordinary	5 ..	2½-3½
—— 6 per cent. Cum. Pref.	10 ..	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	96-100
Oldham, Ashton, and Hyde Tramway, Ordinary	10 ..	10½-10¾
—— 5 per cent. Cum. Pref.	10 ..	11½-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	99-102
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	9¼-10½
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	10s. ..	¼
—— £250,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	50 p.c. ..	50 p.c.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅛-¼
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅛-¼
—— Ordinary, 1-125,000	1 ..	⅛-¼
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-6
—— 5 per cent. Mortgage Debentures	100 ..	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5¼-6
Brush Electrical Engineering, Ordinary	2 ..	¼-1
—— Nos. 90,001-105,731	2 ..	¼-1
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-2
—— 4½ per cent. Debenture Stock	100 ..	101-104
—— 4½ per cent. 2nd Debenture Stock	100 ..	95-100
Callender's Cable, Debentures	100 ..	111-115
—— Ordinary	5 ..	17-18
—— 5 per cent. Pref.	5 ..	5¼-6
Crompton and Co.	3 ..	3-3¼
—— 5 per cent. Debentures	— ..	100-105 p.c
Edison and Swan United, Ordinary	3 ..	⅛-¼
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	78-83
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	82-87
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-1⅜
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	98-101
W. T. Henley's Telegraph Works, Ordinary	5 ..	17-18
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	99-102
Parker, Thos., Limited, Ordinary	10 ..	15¼-16¼
Telegraph Construction and Maintenance	12 ..	34-37
—— 5 per cent. Bonds	100 ..	102-105
Telegraph Manufacturing, Ordinary	5 ..	10¼-11¼
—— 5 per cent. Cum. Pref.	5 ..	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	8¼-9¼ xd
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6¾ xd
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	¼-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	100-104
Bournemouth and Poole, Ordinary	10 ..	11-12
—— 4½ per cent. Cum. Pref.	10 ..	9¼-10½
—— Debenture Stock, Red.	100 ..	103-106
Brompton and Kensington, Ordinary	5 ..	9-9¼
—— 7 per cent. Preference	5 ..	9-9¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	8¼-9½
—— Nos. 20,001-30,000	5 ..	8-9
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14¼ xd
—— ,, ,, ,, £10 Ord.	6 ..	10¾ xd
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	106-108
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5¼-5⅜
—— 4½ per cent. Debentures	100 ..	110-113
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	103-106
County of London and Brush Provincial, Ordinary	10 ..	8-9
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6¼-6⅜
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	106-109
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4-4¼
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¾-6¼ xd
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10-11
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1⅝
—— 6 per cent. Pref.	5 ..	4¼-4⅝
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	95-100
Metropolitan, Ordinary	10 ..	15-16
——4½ per cent. First Mortgage Debenture Stock	100 ..	111-115
——3½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6⅝
Notting Hill Electric Lighting	10 ..	14-15
Oriental, 1879	1 ..	1¼-1⅝
—— £5 Shares	5 ..	7⅛-8
—— £4½ Shares, New	4½ ..	6¾-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	98-101
River Plate Electric Light and Traction, Deb.	100 ..	65-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1¾-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2¼-2¾
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	98-101
Westminster, Ordinary	5 ..	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	2½ ..	3¼-4
Electric Railways.—		
Central London, Ordinary	100 ..	103-106
—— 4 per cent. Pref.	100 ..	103-106
—— ,, ,, deferred	100 ..	100-103
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-118
City and South London, Consolidated Ordinary	100 ..	65-68
—— Ordinary	10 ..	—
—— 4 per cent. Debenture Stock	100 ..	112-116
—— 5 per cent. Pref. Stock '91	100 ..	128-133
—— ,, ,, ,, '96	100 ..	123-126
—— ,, ,, ,, '01	100 ..	120-124
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Telephones.—		
National Telephone, Preferred	100 ..	95-99
—— Deferred Stock	100 ..	57-61
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— Preferred, 590,001-790,000	3½ ..	3¼-3⅜
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-5⅛
—— 4 per cent. Deb. Stock, Red.	100 ..	93-96
—— 3½ per cent. Deb. Stock, Red.	100 ..	101-105
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

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NOTES.

Lord Kelvin.—A Laffan message from Washington states that Lord and Lady Kelvin were entertained at dinner by Mr. and Mrs. George Westinghouse one day last week. A distinguished company were asked to meet the celebrated scientist and his wife.

Wireless Telegraphy Competition. — It is announced that the United States Government have invited the Allgemeine Elektricitäts-Gesellschaft, as the holders of the patent of the Slaby-Arco system of wireless telegraphy, to compete with Mr. Marconi in the establishment of a wireless telegraph service in Alaska.

Electrical Engineers Volunteers. — We are informed that the Electrical Engineers (R.E.) Volunteers Cycling Club will give a Bohemian concert at headquarters, Westminster, on May 10. The chair will be taken at 7.30 p.m. by the Officer Commanding. Those attending this concert are requested to be in uniform or evening dress.

Electrical Conference on the 1901 Factory Act.—We are informed that the Council of the Institution of Electrical Engineers has decided to call together representatives of branches of the electrical industry which are affected by the last Factory Act, which includes in its definition of a factory electrical stations: (20) "Electrical stations—that is to say, any premises or that part of any premises in which electrical energy is generated or transformed for the purpose of supply by way of trade, or for the lighting of any street, public place, or public building, or of any hotel, or of any railway, mine, or other industrial undertaking." The meeting of the conference will be on Monday, May 12, at 3.30 p.m. The place of meeting will be notified later on.

International Tramway Exhibition.—The second International Tramways and Light Railways Exhibition will open to the public at the Agricultural Hall, Islington, on July 1, and on the same day the Union Internationale Permanente de Tramways, at the invitation of the Tramways and Light Railway Association, will hold the first meeting of their annual congress in the Berners Hall, adjoining the Agricultural Hall. In addition to this society it is expected that a number of other associations will hold one or more meetings at the hall, notably the Municipal Tramway Managers' Association, the Municipal Electrical Association, and the Association of Municipal and County Engineers, so that while attending the meetings the members will have ample opportunity to inspect the exhibits. The exhibition will remain open till July 12.

Dutch-German Cable Scheme.—The telegraphic convention between the Dutch and German Governments providing for a joint subsidy for telegraph cables to the Dutch colonies and East Asia is, we note, having a mixed reception on the Continent. A Reuter's message from the Hague says that the convention was under discussion in the Bureau of the Second Chamber of the States-General on the 23rd ult., when, on the one hand, the project was welcomed as a means of diminishing the dependence of Holland on British companies, but, on the other, it met with opposition owing to the fear that the convention might unduly subordinate Dutch interests to those of Germany. As was explained in these columns a few weeks ago, it is sought by the scheme to establish a direct telegraphic communication with the Far East which shall be under the sole control of the Dutch and German authorities.

Institution of Civil Engineers.—The council of the institution have made the following awards for papers read and discussed before the institution during the past session: A Telford medal (in standard gold) to Mr. W. M. Mordey, and a George Stephenson medal (in standard gold) to Mr. B. M. Jenkin, M.I.C.E.; a Watt medal (in standard gold) to Mr. J. A. F. Aspinall, M.I.C.E.; and Telford premiums to Messrs. W. C. Copperthwaite, A. H. Haigh, B.Sc., and J. Davis, MM.I.C.E. The council have also awarded the Howard quinquennial prize of the institution to Mr. R. A. Hadfield, M.I.C.E., of Sheffield, for his scientific work in investigating methods of treatment and new alloys of steel, and on account of the importance, in industry, of some of the new products introduced by him. The presentation of these awards, together with those for papers which have not been subject to discussion and will be announced later, will take place at the inaugural meeting of next session.

Osmium Lamps.—Mr. Gabriel, the chief engineer of the company which has to do with the Welsbach patents, recently issued some statements as to the results obtained by lamps with osmium filaments. He gave on the occasion in question a curve which showed the variation in watts per candle-power with an osmium lamp for 1,200 hours. It commenced with an efficiency of 1·5 watts, and then fell to about 1·32 watts per candle-power, and kept practically at this value for the rest of its life. The candle-power curve for this lamp showed that it commenced to give about 14½ c.p. and rose in the course of 300 hours to about 16·8 c.p.; the curve then falls in practically a straight line to 15 c.p. at 1,100 hours. So far the drawback to these lamps is that they can only be successfully made for low voltages. We gather that the lamp in question was used in a 50-volt circuit. It is suggested that until the process of manufacture has enabled the delicate filaments required for higher voltages to be successfully made, lamps might be burned in series.

Municipal Electrical Association.—A preliminary notice has just reached us of the seventh annual convention of the Incorporated Municipal Electrical Association, which will be held in London from July 2 to July 5 next. It is expected that the following papers will be read and discussed, in addition to Mr. J. H. Rider's presidential address: "Double-Current Generators and their Application," by Mr. E. T. Ruthven Murray; "High-Tension Continuous-Current Systems," by Mr. A. S. Barnard; "Steam-Turbines," by Mr. S. E. Fedden; "The Correct Type of Engine for Large Generating Stations," by Mr. A. A. Day; "Some Notes *re* Earthing," by Mr. H. Faraday Proctor; and "Two *v.* Three Wire Distribution," by Mr. J. F. C. Snell. Arrangements have also been made to hold either the usual annual dinner or to substitute a smoking concert, as the majority of the members may decide. Those members desiring to attend the convention should communicate with the secretary, Mr. C. McArthur Butler, at St. James's Hall, Piccadilly, W., not later than Monday, the 5th inst., and in due course further details and full programme will be issued.

Composite Filaments.—A large number of experimenters have been investigating the best means of combining other materials with carbon for the improvement of filaments for incandescent lamps. The success or otherwise of these inventions can only be determined by years of trial, but in a good number of instances results have been obtained which point to considerable improvement being possible from admixtures. We understand that Mr. F. de Mare, of Brussels, proceeds on somewhat the following lines in the manufacture of the new filaments which he is turning out. He first prepares a core of magnesia, tar, and carbon. Through this filament a current is passed while it is exposed to the air. The consequence is that all the carbon is burnt off, leaving a hard surface of magnesia.

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The next process is to flash this filament in a hydrocarbon vapour, which results in the deposition of a layer of carbon on the outside of the magnesia. This is said to furnish an exceedingly strong filament, and one which gives a good efficiency. We have not, however, yet heard what average watts per candle are obtainable with lamps equipped with this new composite filament.

Meter Testing in Russia.—After Jan. 1 next year only such types of electric meters will have official recognition in Russia as have been tested and approved by the Department for Measures and Weights of the Ministry of Finance. A decree to this effect has been issued by the Russian Government, but it is also provided that types of meters which have been known and used in Russia previous to Jan. 1, 1903, and which later on may be rejected by the Department for Measures and Weights, will, nevertheless, be acknowledged by the Russian authorities as standard and permissible till Jan. 1, 1908. The testing of the meters by the Department will be of a practical nature, having reference to the behaviour of the instrument under the varying conditions to which it might be subjected in practice. Material and workmanship will also be examined. Manufacturers who wish the use of their instruments to be sanctioned in Russia are required to send to the Department for Measures and Weights for the test at least five instruments, with a description and drawings of the mechanism. The test must be made by the Department for Measures and Weights within six months, and in case of approval the owner will receive an official certificate admitting his device for use in Russia.

Electricity in Mines.—Mr. J. H. Whittaker read a paper before the South Staffordshire Institute of Mining Engineers last week, in which he drew attention to the fact that the use of electricity in mines has not extended in a measure at all commensurate with the development of science in other directions. The reason he gave for the lack of progress in this direction will not perhaps find favour with all classes of engineers, but it is, nevertheless, one which offers the most probable solution of the question. It is that colliery proprietors and their engineers know comparatively little of electrical science, and are accordingly nervous of bringing electricity into everyday use in places where explosive gases are more or less prevalent. There is, however, a good number of electric light and power plants doing excellent work in collieries and mines for surface lighting and underground work, but on the whole it is being taken up somewhat slowly. The author also emphasised the point that what is wanted to-day for mining purposes is electrical power machinery which will run entirely without sparking or wear of brushes, and without accumulators, and which will carry an overload for a considerable time without risk. To meet these requirements he advocated the use of three-phase machinery, the one type of motor being equally suitable for hauling, pumping, rock and coal drilling, and general shafting work. The efficiency of such motors, he asserted, is as high as the best continuous-current motors, and seeing that as a rule it is so difficult to keep the latter motors in good condition, the three-phase type generally proves of much higher efficiency, whilst its life is more than double. The only disadvantages of three-phase machinery he knew of is the difficulty of speed regulating, and the fact that at the present time so little is known among engineers of polyphase work.

Raoult Memorial Lecture.—The Raoult memorial lecture was delivered before the Chemical Society recently by Prof. J. H. van't Hoff, F.R.S., who gave a brief sketch of the life and achievements of Raoult. Born in 1830 his first paper, published in 1853, contained observations on the transport of electrolytes by the galvanic current and on electrical endosmosis. In the year 1862 Raoult proceeded to Lens, where, amidst adverse material surroundings, he prepared his thesis on E.M.F., for which a year later he obtained in Paris the degree of docteur ès-sciences physiques. His work may be divided into three distinct parts: the physical, the chemical, and the physico-chemical. His career as a physicist begins with the thesis above referred to, by which he was marked out as an accurate and independent investigator already in advance of his time by the conclusions he based on a careful examination of facts. In the first part of this research he measured and compared in the cells of the Daniell type the amount of heat due to the chemical action with that corresponding to the electrical work produced, and showed that they were by no means identical. The second part was devoted to the decompositions in the voltameter by the galvanic current, the thermal phenomena being especially studied. It was whilst carrying out his electro and thermo chemical investigations that Raoult entered the Faculté des Sciences de Grenoble in 1867 as "chargé du cours de chimie," being promoted in 1870 to the chair of chemistry, which he occupied until his death last year. Raoult's character as a man may be read in his papers, in which he showed activity, patience, tenacity in pursuing an aim, as much eye for detail as for the vaster horizon, absolute independence of mind, criticising or admitting without bias views of others as well as his own, and testing both with the same calm conviction that the last word must rest with experiment.

Imperial Cables.—Under this title the issue of the *Times* for Tuesday presents a long article from the pen of Mr. Chas. Bright, who was one of the witnesses before Lord Balfour's Cable Communications Committee, whose final report was recently issued. On the subject of rates Mr. Bright says that now that the pioneer stage in cable communication is now long past, the Government is not only perfectly entitled morally, but it is also its duty, to protect the interests of the public by putting a limit on the rates to be charged by the telegraph companies when they seek concessions from the Government. A sliding-scale tariff dependent on a standard revenue might be found possible, or the rates could be fixed in future somewhat on the average earnings for a given period. Another useful reform, as Lord Balfour's Committee recommended, would be the adoption of a class of "deferred messages" at special and reduced rates. The Government should also guard against subsequent financial amalgamations, absorptions, or joint purses; besides providing for taking over any given cable—at an expert's valuation—at any time, if found desirable. Further, exclusive landing rights should be capable of being terminated if necessary in the public interest, and should never be made permanent. Turning to the question of all-British cables, Mr. Bright argues in favour of direct all-British lines in addition to others on trade routes, if only to ensure speedy and uninterrupted cabling facilities with the whole of the Empire in times both of peace and war. The class of cables whose object is mainly strategic have seldom been laid, because they are liable to be unremunerative, but the writer advocates that we should recognise them as a necessity at all hazards. It is just the laying of such lines that the State should consider, the companies having already provided a fair network of cables on trade routes. Apart from strategic grounds, however, Mr. Bright contends that we require all-British cables in addition to international ones from the point of view of consolidating the Empire—politically and socially—as well as for the assistance of Imperial trade. If we could render the entire British Empire practically as one country by means of telegraphy, a great result would be achieved.

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Power Transmission in California.—California, as is generally known, is exceedingly rich in natural water power, and it is, therefore, not surprising to find that the transmission of electrical energy to long distances has been taken up with so much activity in the last few years. Owing to the nature of the country it was necessary to solve the problem of long-distance transmission before the harnessing of the waterfalls could be seriously undertaken, and now within the space of a few years there are several large companies owning enormous networks of lines, and some of them transmitting power to distances of between 150 and 200 miles. During the present month a supply of electricity was commenced into San Francisco from Colgate, 212 miles away, and this, we believe, is the longest line yet brought into operation in California, or in any other part of America. This new line is owned by the Standard Electric Company, whose huge network, extending for miles in the neighbourhood of San Francisco, has now been joined up with that of the Bay Counties Power Company. According to our contemporary, the *Journal of Electricity, Power, and Gas* of San Francisco, the network around that city includes as many as 23 sections of lines for transmitting the power from Colgate, their aggregate length being 1,580, and the average length of each line 69 miles. Some of these lines, however, cover very long distances. Thus, the section from Colgate to Stockton is 208 miles; from Electra to San Francisco, 153 miles; from Colgate to Oakland, 132 miles; from Electra to Oakland, 122 miles, and so on. Of the total 23 lines, no less than 15 are aluminium cables, while the remainder are either copper or partly copper and partly aluminium. As to the poles themselves, those used on the Bay Counties lines are uniformly of the round cedar variety throughout the whole system, while those of the Standard Company are all of the sawed redwood description. The height of the pole above the surface of the ground ranges from 25ft. to 60ft., and the depth in the ground from 5ft. to 8ft. Further extensions are now being made by the Standard Company in southerly and south-westerly directions from San José, and through the Suburban Electric Light Company, of Oakland, secondary distribution at 4,000 volts is being made through all the thickly-settled fruit-growing and suburban residential districts.

Electrodes.—Among the many interesting papers read at the inaugural meeting of the American Electro-Chemical Society at Philadelphia last month was one by Mr. C. L. Collins on the subject of electrodes. Practically, the paper was limited to a discussion of the use of artificial graphite electrodes in furnace work. The author showed that different forms of carbon have different temperatures of oxidation, and that of graphite is higher than of amorphous carbon by several hundred degrees. When reduction of an oxide takes place in the presence of two forms of carbon of different temperatures of oxidation, the one with the lower temperature of oxidation is consumed in preference to the other. One can therefore make the electrodes of graphite, while in the mixture to be reduced an easily consumed form of carbon may be used, like charcoal. Another characteristic feature which distinguishes graphite from other forms of carbon is that graphite can easily be cut by machines. This makes it possible to cut easily artificial graphite electrodes of any form wanted for the practice. The author showed diagrams of different forms of electrodes for furnace work, some involving considerable machine work, and discussed the best and cheapest construction of the electrodes for large furnaces and for large currents. He also gave some very interesting results of comparative tests with atmorphous carbon electrodes and of graphite electrodes in practical furnace work in industrial processes on a large scale. These results, as stated, show the much greater resistivity to oxidation of the graphite electrodes; their efficiency was found four to eight times as great as that of amorphous carbon, while their price is only three times that of the latter. Several speakers took part in the discussion which followed, reference being made to the use of graphite electrodes in the electrolysis of solutions. Graphite anodes were very highly recommended for the electrolysis of chlorides, for which purpose they were stated to be practically indestructible. In the electrolysis of sulphates graphite anodes are destroyed by oxidation, and for this purpose, therefore, they were not recommended. In his reply the author described how the creeping of solutions upwards in the porous electrodes, with resulting corrosion of the joints, can easily be avoided by destroying the porosity by means of paraffin, the graphite electrodes being partly suspended in a kettle of melted paraffin, so that the pores may be filled with the oil.

Parallel Operation of Alternators.—The current number of the Franklin Institute *Journal* prints a paper under this title by Lincoln, in which he gives a mechanical analogy of the operation of alternators in parallel. At the outset he states that for successful operation in parallel the load should be properly divided; for this, the prime movers are to be provided with governors of such a type that the speed falls as the load increases. Proportional division of load, while desirable, is not an absolute essential to the successful operation of many plants. Freedom from hunting is, however, an essential. Hunting in synchronous machines is the oscillation of the armature masses accelerated and retarded above and below normal average speed. Hunting can be prevented, therefore, either by removing the synchronous force tending to keep alive the oscillating motion, or by providing "electric friction," tending to destroy such motion if once started. Probably the most potent factor in keeping alive hunting is found in the steam-engine governor as usually installed. Hunting induces or tends to induce in certain governors a synchronous force to keep itself alive. The remedy to this action is to make the time between a movement of the governor balls and its application of the corrective force, greater than the time of a half cycle in a period of oscillation. The remedy involves the prolongation of the time of response to motion of governor balls. This object may be accomplished by the aid of properly designed dash-pots. The uneven torque at different points in an engine cycle may give rise to hunting if the natural period of oscillation is synchronous with the engine impulses. One remedy for this difficulty is to synchronise engines as well as alternators, so that at any instant each engine is in a similar part of its cycle. Another remedy lies in the addition of flywheel weight. The second prevention for hunting lies in so designing the alternating machines, that as soon as hunting occurs a resisting force of a frictional nature is set up tending to destroy the oscillation. This electric friction is produced by surrounding the field poles, especially near the tips, with a band of copper. The author has found cases in practice in which the hunting could be ascribed neither to the irregularity of torque in the prime mover, nor to the action of the governor. In all of these cases some part of the electric system—not necessarily that in which hunting was most noticeable—contained synchronous machines with laminated poles and no damping devices.

Platinum.—Some interesting details have recently been published in the daily Press with regard to the finding of platinum in Australia. It is pretty generally known that the metal is more or less plentiful in New South Wales, but up to the present the output has been

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comparatively insignificant. Thus the output in the year 1900 was only 530oz., valued at £1,007, while the total quantity raised since the beginning of 1894 is put at 8,295oz., and valued at £12,432. "In prospecting for the rare metal in Australia, the chief obstacle met with, it seems, is the scarcity of water in the districts where it is found, and consequently operations on a very extensive scale are not yet practicable. Platinum itself is usually met in its native state alloyed with iron, iridium, osmium, and other rare metals. It usually occurs in grains or scales, sometimes in the irregular lumps or nuggets, and rarely in crystals. There is, however, on view in the Sydney Geological Museum a cubical crystal of platinum, found at Fifield, which measures $\frac{3}{16}$in. The only other form in which platinum is found is that of an arsenide or the mineral sperrylite, which occurs in minute cubes or cubo-octahedral crystals, which have a tin-white colour and black streak. The New South Wales platinum is obtained chiefly from the Fifield district, about 322 miles west of Sydney, where it is found associated with gold. The principal workings are at a small township called Platina, from which extends for over a mile in length a deep alluvial lead, containing platinum and gold, and varying from 60ft. to 150ft. in width. The platinum and gold occur in fairly coarse waterworn grains, and as a rule are confined to the cavities in the bed-rock and to the wash-dirt for a few inches above it. Occasional nuggets of platinum have been obtained; the largest hitherto found weighs 27dwt., and was purchased for the Sydney Geological Museum. The wash-dirt contains from 5dwt. to 12dwt. of platinum, and from 1dwt. to 3dwt. of gold per ton. The yield from 269 loads taken from a number of claims along the lead in question was at the rate of 6dwt. 21gr. of platinum and 1dwt. 23gr. of gold per ton. Platinum has also been found in the Broken Hill district and in many other localities; also on the beaches of the northern coast, where it is obtained from the auriferous sands. In this case the metal is brought down by the action of the sea waves from an ancient beach deposit. Of the many uses of platinum it is unnecessary to speak here, as its great value is well known, especially to electrical engineers.

South African Water Power.—Some time ago we briefly mentioned in these columns that a scheme was on foot to harness the Victoria Falls on the Zambesi, the great South African river, and to utilise their enormous resources in the generation of electrical energy. Further particulars are now to hand, which show that the proposal is now taking definite shape, and it is hoped to begin the survey and planning out of the giant installation in the autumn of next year. So long ago as 1895 the scheme was originated and a syndicate formed, which obtained a concession for the sole right to develop electric power from the Victoria Falls for a period of 75 years. The nominal capital of the company, known as the African Concessions Syndicate, Limited, was fixed at £30,000, but only last month this was increased to £50,000, the British South Africa Company taking up 25,000 working capital shares at par. One of the latest steps taken by the promoters has been to retain Sir Douglas Fox and Sir Chas. Metcalfe, the consulting engineers to the Rhodesia Railways, as consulting engineers to this scheme. The possibilities of transmitting electrical energy from the falls to a sufficient distance to allow of its being employed for industrial purposes have been well considered, and it is proposed at first to erect transmission lines over a radius of 150 miles. That the transmission of power over this distance is quite within the limits of possibility may be gathered from the fact that in California, where the longest power transmission line is now in operation, there are several lines of 150 miles in length, and one, we believe, covering a distance of no less than 212 miles. The distance embraced by the 150-mile radius from the Victoria Falls is one in which electric power would find many uses. For instance, there are the famous Wankie coalfields and some rich copper deposits a little to the north of the falls, close to which also are to be found all the materials necessary for the manufaeture of acetelyne. The first and most probable customer for the electric power, however, is the railway which crosses the falls themselves, and it may easily be conceived that the owners of this line, which extends for nearly 300 miles, would not be long in doing away with their present steam power in favour of its more successful rival. It is to be noted that there are no goldfields within the 150-mile radius mentioned, but taking a radius of 300 miles we find that several large gold-mining centres are included. One of the hopes cherished by the promoters is that some day, with improved methods of transmission, they will be able to convey their power a distance of 600 miles, in which case the Rand, with its enormous industrial resources, would be reached. In conclusion, it may be mentioned that the Victoria Falls are nearly a mile wide and 420ft. in height. Practically speaking, there is no limit to the power that could be developed, for even in dry seasons the river is 2ft. or 3ft. deep above the falls.

Opto-Technics.—Prof. Silvanus Thompson discussed the subject of opto-technics before the Society of Arts on the 23rd ult., the keynote of his paper being a complaint that the optical industries have not received that attention which their importance in the national life calls for. The magnitude of these industries is scarcely appreciated as it should be, and the professor shows that within the postal area of London, excluding most of the suburbs, there are no less than 216 firms described as "opticians." But in addition to these there are numerous other trades, amongst which are glass manufacturers, glass grinders, glass polishers, looking-glass makers, microscope makers, optical turners, opera-glass makers, etc. The author's explanation of the comparatively small progress which has been made in these industries is the lack of sound technical knowledge of optics, and the question which arises is how the education of the optician is to be carried out in order that he shall acquire a varied experimental and mathematical training? For a parallel the author is forced to another branch of applied science—that of electric engineering—where a very similar problem was presented. For the young electrician of to-day there are classes, schools, and technical colleges all over the country to which he can resort for instruction on the physical phenomena, for teaching in the theory, and for exercise in the application of theory to practice. In a word, the subject of electro-technics is a recognised branch of education for the trade of electrician or electrical engineer. But there is nothing to correspond for the education of the optician or optical engineer. This is not so much the fault of the students apparently as of the teachers, and Prof. Thompson contends that until the classes in optics are taught by men who have had optical experience, and who teach from a technical instead of an academic standpoint, the present decrease in the number of students is bound to continue. This decrease is shown to be very striking. From figures given by the author for the United Kingdom it seems that the number of classes on sound, light, and heat (exclusive of training colleges) was in the session 1891-1892 as high as 251, and about 7,430 students were taking instruction in those subjects. At the end of 1899 these figures had decreased to 173 to 4,596 respectively, a falling off which he attributes to the fact that the

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classes do not meet the wants of real students of optics. He makes a special appeal to the managers, principals, and committees of the local technical schools and colleges on this point, and further appeals for the creation of proper optical laboratories in the science schools, that the teacher may have a fair chance of training his students. The vital suggestion of Prof. Thompson's paper, however, is the creation—whether at the Northampton Institute or elsewhere—of a real opto-technical institute, the curriculum of which he thinks ought to be somewhat as follows: (*a*) Entrance examinations — computations (including logarithms, slide-rule, and use of trigonometric tables), geometrical drawing, and German. (*b*) First year—physics, mechanics, algebra and trigonometry, projective geometry, drawing, laboratory work in simple optics, with lens grinding and prism grinding. (*c*) Second year—calculus, higher optics (including aberrations), mechanical drawing of optical instruments, machine design as applied to instruments, laboratory measurements. (*d*) Advanced course — applications of calculus, higher geometry, theoretical optics, computation of lenses, optical design, higher optical measurements, and optical research. The staff ought to be picked men who have liberty to practice as consulting opticians—that is to say, as consulting optical engineers. Further, an institute such as that proposed by Prof. Thompson ought to make a speciality of having a perfect optical library, and the members of the staff ought to be encouraged to write optical monographs on some consistent plan to replace the academic text-books of the past? Last, but not least, the aim should be to attract a few really good students rather than a crowd of mediocre ones.

General Conditions for Electrical Contracts.—At the meeting of the Institution of Electrical Engineers last week the Council brought up for discussion a model set of general conditions to be used in connection with contracts for electrical plant, as drafted by a committee appointed for the purpose. The document, which was printed in the form of a paper occupying some 29 pages, was introduced by Mr. Robert Hammond, who, it may be stated, was chiefly instrumental in drafting the present model conditions. As he explained in his speech, at an early date of his career as a consulting engineer he formulated a set of general conditions to be attached to contracts for electrical plant, and he had been rewarded by observing how extensively they had been adopted by members of the profession. He noticed, however, that the tendency of consulting electrical engineers was towards originality, with the result that when manufacturers of plant were called upon to tender, it became necessary for them to peruse, with great care, the set of general conditions attached to the specification, and in some cases to go to the expense of appealing to their solicitors in order to safeguard their legal responsibility. This would not be the case if standard general conditions were adopted. As an example, he referred to the standard conditions which the Royal Institute of British Architects had now adopted for many years. Obviously it was of general benefit to the electrical industry that tendering should be made as easy and as cheap as possible, and with this view Mr. Hammond submitted to the Council of their Institution the idea that a set of general conditions should be considered by the Institution, and adopted by it as the standard general conditions which they recommended to be attached to contracts. The Council of the Institution was good enough to approve of the suggestion, and referred the matter to a committee, consisting of Mr. W. Langdon (president), Prof. John Perry, F.R.S. (ex-president), Prof. W. E. Ayrton, F.R.S., Colonel R. E. Crompton, C.B., Mr. R. Hammond, Mr. H. Hirst, Mr. A. J. Lawson, Sir H. Mance, C.I.E., Mr. W. M. Mordey, Sir W. H. Preece, K.C.B., F.R.S., Mr. J. H. Rider, Mr. M. Robinson, Mr. A. Siemens, Prof. S. P. Thompson, F.R.S., Mr. H. R. J. Burstall, Mr. E. T. R. Murray, Mr. Tom Callender, Mr. W. E. Gray, Mr. A. H. Howard, Mr. G. Sutton, and Mr. Antill. The conditions as finally settled, continued Mr. Hammond, had been submitted to counsel, and it was now felt that they were in a form for submission to the full body of the members of the Institution. The Council did not expect for one moment that the Institution would be able to issue a fiat that no contract for electrical plant should be entered into in the United Kingdom except under their general conditions, nor did they expect that in every case the general conditions would be used *en bloc*, without the slightest alteration, but they did urge that the path of both consulting engineers and tenderers would be made clearer by the adoption of definite general conditions as a standard. These conditions would be on sale, and, instead of it being necessary to print them in every contract, they might be incorporated by reference. In cases where the purchaser desired to vary the conditions, Mr. Hammond concluded, they would only be put to the necessity of stating the variations instead of reprinting the whole of the conditions. With this short introduction the general discussion was opened by Major-General Webber, who expressed the Institution's indebtedness to Mr. Hammond for having originated the suggestion of these model conditions. Having ventured a few criticisms on one or two matters of detail, the General expressed the opinion that the document was a very valuable one, and one which would prove very useful when carefully studied, especially by junior engineers. Mr. J. S. Raworth, on the other hand, condemned the document as useless, and only fit to be consigned to the waste-paper basket forthwith. He pointed out that it was a specification for machinery, and machinery could be bought without the aid of any such conditions. Incidentally, he thought there ought to be some definition of the word "plant" in order to avoid disputes. He also complained that there was no differentiation between what he called the high-toned engineer—like Mr. Hammond—and the engineer who happened to be a servant of a corporation or a company, and contended that it ought to be clearly stated in the conditions that the engineer under the contract was the engineer of the seller as well as the engineer of the purchaser. He also advocated that a specification of this character ought to have a clause to be signed by the engineer that he would carry out the work to the satisfaction of the purchaser, and that when it was properly done he would give a certificate. With a few more like criticisms Mr. Raworth remarked that the present document was nothing but an old set of conditions used by building contractors with the substitution of the word "plant" for "building." Mr. Jeckell next took up the discussion, his point being that the conditions would be of greater value to local authorities, who often got some most undesirable contractors, than to individuals or to companies, who dealt with people whom they could thoroughly trust, and did not want any general conditions whatever. Mr. Nisbett expressed the opinion that the drafting of these conditions was the best bit of work the Institution had done, and he was sure engineers and manufacturers would welcome them. He offered one or two criticisms most of which, however, referred to matters of detail. By the time Mr. Nisbett had concluded his remarks it was close on 10 o'clock, and the President announced that the discussion would be adjourned till the meeting on May 8.

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MIDDLETON ELECTRICITY WORKS AND LIGHT RAILWAYS.

Formal Opening.

The formal opening of the Middleton electricity works and light railways took place on Monday, the 14th April, beautiful weather favouring the occasion. The guests assembled at the electricity works at 11 a.m., when Mr.

COUNCILLOR J. J. SCHOFIELD, J.P., MAYOR OF MIDDLETON.

Clirehugh (of Messrs. Lacey, Clirehugh, and Sillar, the Corporation's consulting electrical engineers) presented Mr. Alderman Walker, chairman of the Electricity Committee, with a gold key, with which he (Mr. Walker) unlocked the door, at the same time declaring the station open.

The guests then proceeded into the station to witness the ceremony of naming and starting the three engines. The Mayor (Councillor J. J. Schofield, J.P.) started the first engine and dynamo, Mr. Alderman Walker the second, and

MR. F. ENTWISTLE, TOWN CLERK, MIDDLETON.

the Deputy Mayor (Mr. Councillor Hilton) the third. After these proceedings two special cars conveyed the company over a portion of the Middleton light railways. The first car was skilfully driven by Miss Walker (daughter of Mr. Alderman Walker). No hitch occurred from start to finish, the run proving a most enjoyable one. From the Manchester boundary, at which the out-run had perforce to terminate, the cars returned to the town, the company thereupon adjourning to the town hall, where light refreshments were provided in the committee-room for the ladies, and luncheon in the Council-chamber for the gentlemen. The Middleton Electric Traction Company, Limited—otherwise the latest offspring of the British Electric Traction Company, Limited—were the hosts on this occasion. The toast list included "The Mayor and Corporation of Middleton," proposed by Mr. J. S. Raworth, M.I.C.E., director of the British Electric Traction Company, Limited, and responded to by the Mayor and Alderman Walker; also "The Middleton Electric Traction Company, Limited," proposed by Councillor J. Aspell, chairman of the Rail-

ALDERMAN WALKER, CHAIRMAN OF THE GAS AND ELECTRIC LIGHTING COMMITTEE, MIDDLETON.

ways and Tramways Committee, and responded to by Mr. J. S. Raworth and Mr. Price.

Description of the Undertaking.

The Corporation obtained their provisional order in 1896. In the following year they appointed Messrs. Lacey, Clirehugh, and Sillar as their consulting electrical engineers to prepare a scheme. About the same time the British Electric Traction Company, Limited, intimated

MR. S. PAULS, M.I.E.E., BOROUGH ELECTRICAL ENGINEER, MIDDLETON.

their intention to apply under the Light Railways Act for an order to enable them to construct a system of tramways in the district, and the Corporation then entered into negotiations with this company with regard to the supply of current to work the tramways. The negotiations, however, fell through, and the engineers were instructed to make their report, leaving out of consideration the question of supplying the system with electricity. That was in 1898, and their report was adopted in 1899, when the Corporation decided to apply for powers to borrow £21,952 in order to carry out the proposed works. This application

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was granted in 1900, but in the same year the British Electric Traction Company again approached the Corporation, and an arrangement was ultimately arrived at whereby the Corporation agreed to supply the energy necessary to work the tramways. The engineers were accordingly instructed to prepare an enlarged scheme. In 1901 their amended scheme was adopted, and it was decided to apply for powers to borrow an additional £12,440, which powers were duly granted. In addition to supplying the tramways system of the above company, which has a total length of about nine miles of single track, the Corporation's new station will be called upon to supply energy for working between two and three miles of tramways which the Manchester Corporation are about to construct on the Manchester New-road, and three miles of tramways which the Middleton Corporation propose to work themselves. The arrangement with the British Electric Traction Company provides for the supply of energy for working the company's lines at the rate of 1½d. per unit for the first 300,000 units—this being the guaranteed minimum consumption—the next 100,000 units to be charged at the rate of 1·4d. per unit, and so on until the minimum rate of 1d. per unit is reached. The Manchester Corporation will be charged at the same rate as the Manchester Tramways Committee pay to the Lighting Committee for their main supply. In each case the energy is delivered on the line by cables laid and maintained by the Middleton Corporation. As regards the demand for current for lighting purposes, about 2,000 8-c.p. lamps, or their equivalent, have been connected to the mains, while the further demand continues satisfactory. At the present rate the equivalent of about 5,000 8-c.p. lamps should be connected by the end of the year, in addition to the traction load. The lighting supply is on the three-wire system, with a pressure at the consumers' lamps of 220 volts. The position of the station with regard to the area of supply is fairly central (see Fig. 1). The buildings are of red-brick construction with stone dressings. They are of a very substantial character, neat, and compact. The engine-room has a boarded ceiling, which gives it an unusually finished appearance, the room being lofty and sufficiently light without roof windows. Mr. S. Pauls, M.I.E.E., the borough electrical engineer, who was formerly with Messrs. Lacey, Clirehugh and Siliar, has superintended the erection of the works. The block plan (Fig. 2) and the section (Fig. 3) give an idea of their general arrangement. The following is a detailed description of the plant installed. The principal contractors for the plant and the amounts of their respective tenders were as follows:

Boilers and fittings—Messrs. Tetlow Bros., Hollinwood, Oldham, £1,180.

Superheaters, economiser, feed pumps and pipes, tanks, steam and exhaust pipes, valves, and accessories—Messrs. W. B. Haigh and Co., Limited, Oldham, £3,080.

Steam dynamos, balancer, and boosters—Messrs. Siemens Bros. and Co., Limited, Woolwich, £10,566.

Motor-generator—Messrs. Siemens Bros. and Co., Limited, Woolwich, £720.

Lighting switchboard—Mr. Bertram Thomas, Cornbrook Telegraph Works, Manchester, £730.

Travelling crane—Messrs. Carrick and Ritchie, Edinburgh, £228.

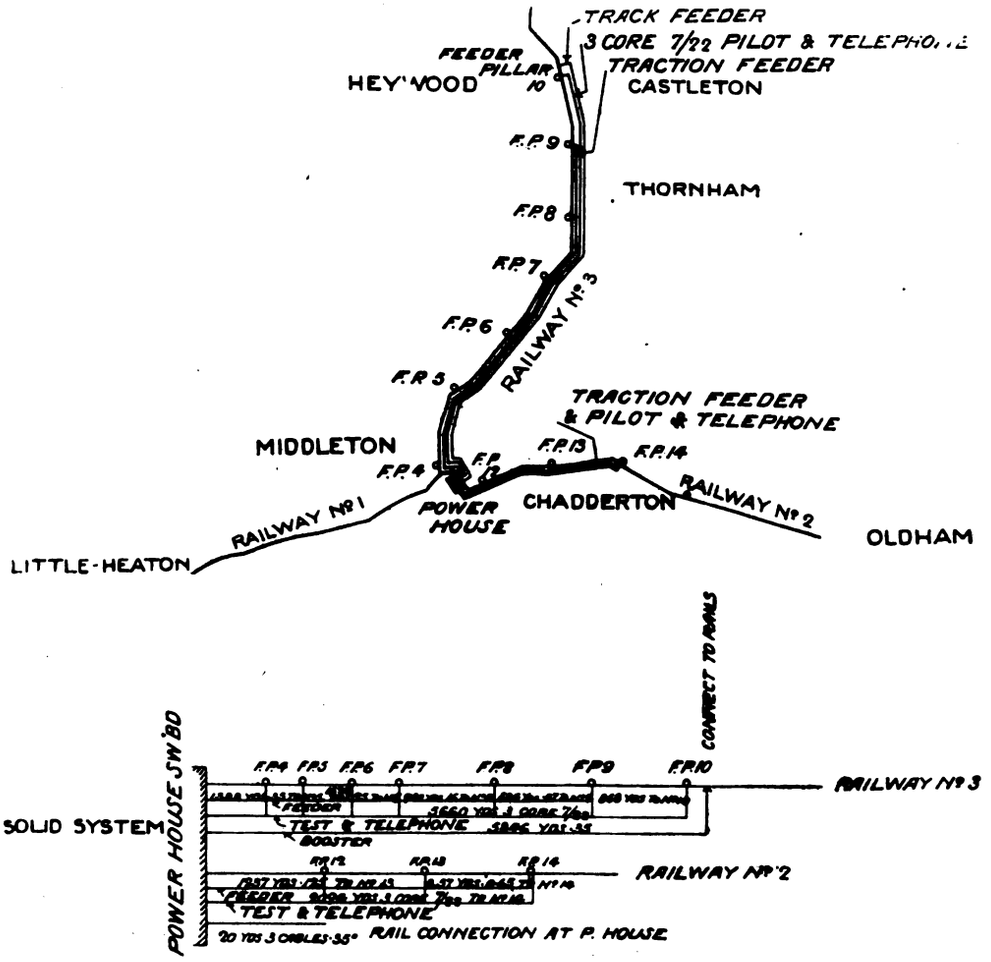

FIG. 1.—Area of Power Supply, showing Cable Routes and positions of Feeder Pillars, Middleton.

Traction switchboard—The Brush Electrical Engineering Company, Limited, Loughborough, £910.

Accumulators—The Tudor Accumulator Company, Dukinfield, near Manchester, £1,232.

Cables—Messrs. W. T. Glover and Co., Salford, Manchester, original tender £3,064, first extension £1,358, second extension £366.

Boiler-House Equipment.

In the boiler-house there are installed three boilers, as shown in Fig. 2. These are of the Lancashire two-flue type, 30ft. in length and 8ft. in diameter, designed for a working pressure of 170lb. per square inch. They were supplied by Messrs. Tetlow Bros., Hollinwood, Oldham. Each boiler has a grate surface of 39 square feet, a heating surface of 1,080 square feet, and a normal evaporating capacity of 6,500lb. of water per hour. The usual fittings are provided, these being by Messrs. J. Hopkinson and Co., Limited, Huddersfield. In the back end of each of the three boiler seatings there is erected a superheater, which can be readily raised and withdrawn from the flue after being disconnected from the steam

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pipes. The duty of these superheaters is to raise the temperature of the steam generated in the boilers. They are of the 35-tube type, made by Messrs. John Musgrave and Sons, Limited. The steam plant further includes an economiser of 256 tubes, divided into two sections, in rows of eight tubes wide, and fitted with deflectors at the back. A motor of 1 b.h.p., working at 800 revolutions per minute, serves to run the scrapers and gear. This motor is of the Lundell enclosed type, shunt wound, and was supplied by Messrs. Veritys, Limited. Its efficiency at full load is 81 per cent. The economiser is by Messrs. E. Green and Son, Limited, Manchester, and is placed in the main flue of the boilers, according to the usual practice.

As regards the supply of water to the boilers, there are two sources available—one the town's mains, and the other the river flowing at the back of the station buildings. The latter supply is drawn upon also for the condenser, which

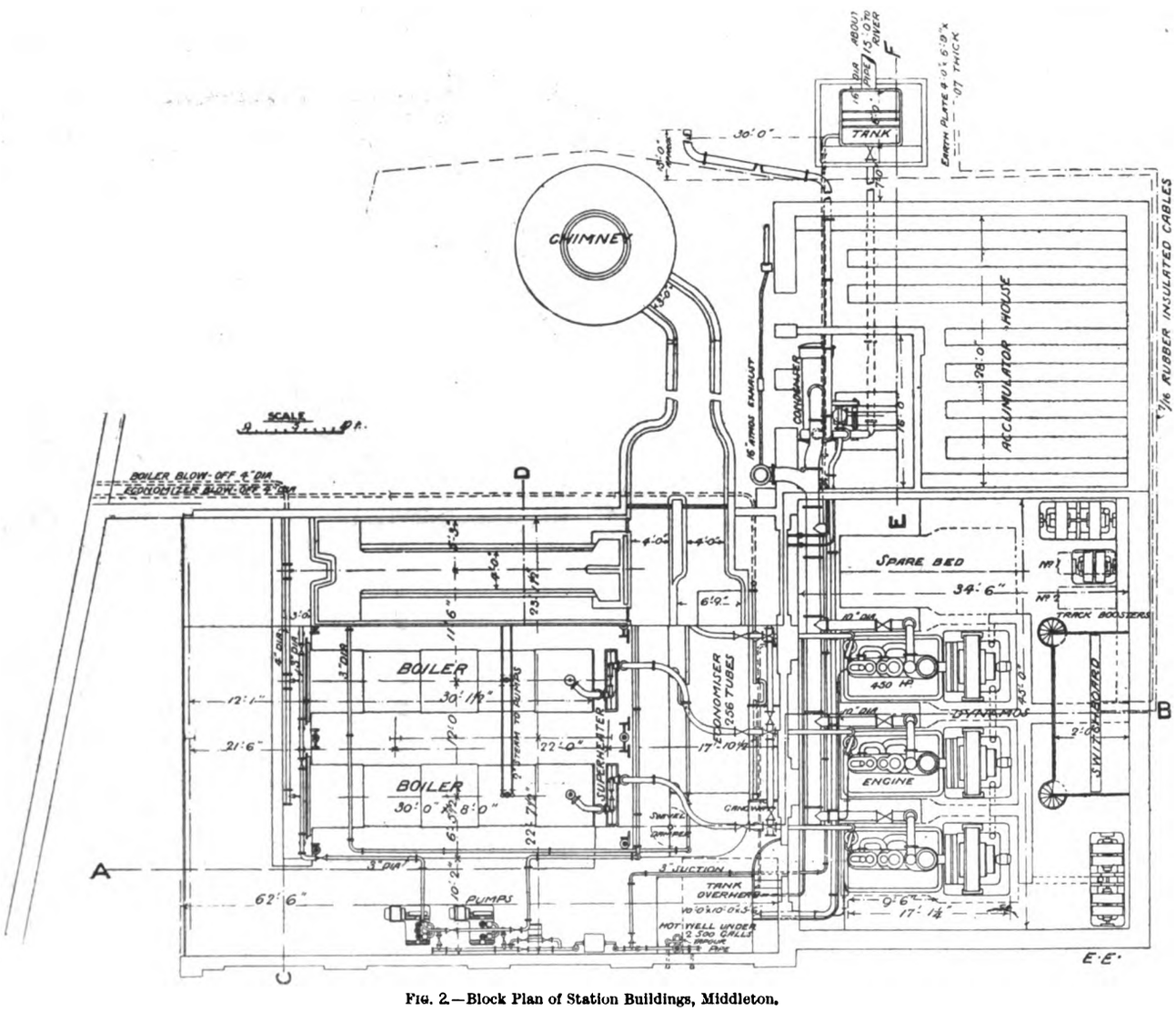

Fig. 2.—Block Plan of Station Buildings, Middleton.

of delivering 1,500 gallons of water per hour against the full pressure of the boilers. The pumps are of the three-throw single-acting type, geared to the electric motors by worm gearing. The motors, it may be mentioned, are of the enclosed type, series-wound, and provided with two commutators for series-parallel running. The full load speed of these motors is 800 revolutions per minute, but each is provided with a series-parallel controller, by means of which the speed may be reduced to 80 revolutions. A resistance is provided for each controller, divided into two parts. The running combinations allow (1) both armature windings to be run in series, and one-half of the resistance in series with them; (2) the resistance to be cut out in four steps; (3) both armature windings to be connected in parallel, and both halves of the resistance (in parallel) in series with them; and (4) the combined resistance to be cut out in three steps. Current is supplied to the controllers, which are attached the wall of the boiler-house, at 220 to 240 volts. A feed-water filter is placed on the suction side of the feed pumps. An injector is also provided as a stand-by to the latter.

will be hereafter described. A water-meter, made by Messrs. Glenfield and Kennedy, Limited, and capable of registering up to 5,000 gallons per hour, is connected to the town's water supply. A second meter, registering up to 3,000 gallons per hour, is fixed in the suction of the feed pumps. This meter is capable of working with hot water. Each meter is provided with a by-pass, to enable it to be cut off without interfering with the supply. The suction pipes to the feed pumps are so arranged that the feed may be taken from the hot-well, from the town's water-tank, or from the river, as desired. The feed ring is arranged so that the feed may be delivered to the boilers either direct or through the economiser. The town's water-tank has a capacity of 3,000 gallons, its bottom being about 11ft. above the level of the boiler-house floor. Both this tank and the hot-well are of cast iron, the latter being capable of holding 2,500 gallons. There are two feed pumps provided. These are electrically driven, and each is capable

Steam-Piping and Condenser.

As regards the steam-pipes, the arrangement of these is shown in Figs. 2 and 3. From the outlet of each superheater a 6in. curved steel pipe is taken to a valve and a tee-piece. On the opposite side of the tee a 4½in. valve is fixed, and from this a 4½in. copper tube is taken direct to the steam separator on the corresponding engine. The other branch of the tee is fitted with a valve, from which a steel bend is taken, and connected through a tee to a by-pass pipe, supported on the wall of the boiler-house. The exhaust from each engine is conveyed through a 10in. cast-iron pipe (having two inlets) to a 16in. main exhaust pipe. The latter is carried in a trench behind the engines

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to the condenser room, where it is fitted with a tee piece, one branch of which is taken through the outer wall of the condenser room and continued up outside the wall to a height of about 38ft. This forms the atmospheric up-take pipe. From the other branch of the tee in the condenser room a cast-iron pipe, tapering from 16in. to 14in., is taken to the steam inlet of the condenser. The circulating water for the condenser is conveyed through a pipe laid between the river and a suction tank. A grating is provided at the river end of this pipe. From the suction tank a pipe is taken to the centrifugal pump in the condenser room, which is connected to the water inlet of the condenser. The arrangement of this condenser is shown in Figs. 4, 5, and 6. Messrs. John Spencer and Son, Limited, made the steel pipes, Messrs. Isaac Storey and Sons the copper pipes, and Messrs. Templer and Ranoe the steam-valves.

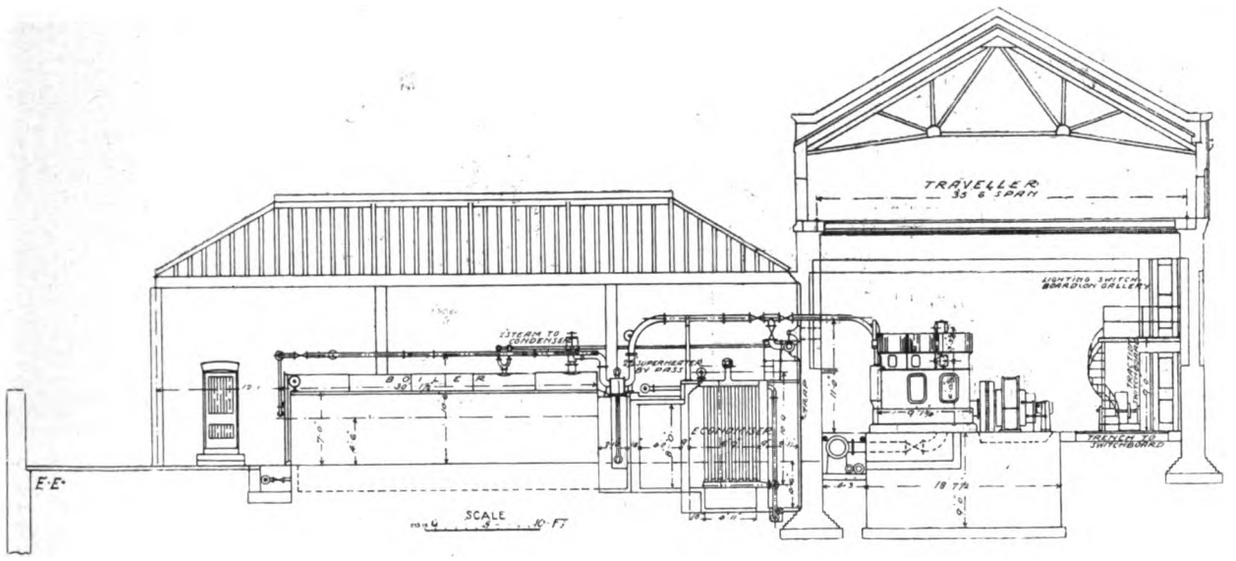

FIG. 3.—Section through Station Buildings, Middleton.

Generating Plant.

The present equipment of the engine-room (see Fig. 2) includes three steam dynamos, balancer and booster, and a motor-generator. There is room for another steam dynamo. The engines are of the triple-expansion type, by Messrs. Belliss and Morcom, direct coupled to dynamos of Messrs. Siemens Bros.' six-pole type. Each engine is capable of giving 369 b.h.p. to 461 b.h.p., with a steam pressure of 165lb. per square inch at the engine stop valve when exhausting into the condenser, and at a speed of 380 revolutions per minute. Expansion gear is fitted to deal with the overload. The dynamos each have an output of 256 kw., the current output being 533 amperes at a voltage variable between 440 and 480 by means of a shunt resistance. The armatures are of the drum type slot wound, a compound winding being put on the fields to render the machines suitable for traction work. The fields are excited from the 'bus bars of the station switchboard at a difference of potential of 445 to 480 volts. Continuous lubrication of the disc type is provided. A switch is fitted to each dynamo for cutting out or inserting the series field winding, according to the machine is required for the lighting or the traction load The steam consumption at these sets per kilowatt-hour when supplied with dry steam of 165lb. per square inch at the engine stop-valve and non-condensing is as follows: full load, 28·8lb.; half load, 37·2lb.; and under similar circumstances, by condensing: full load, 24·5lb.; half load, 26·8lb; with a vacuum of not less than 25in. in the exhaust pipe.

The balancer and charging boosters consist of four separate armatures, mounted on two coupled shafts supported on four bearings from a base-plate carrying four independent sets of field magnets. The function of the balancer is to work with one armature on each side of the three-wire lighting network, each armature running as either motor or generator, at a difference of potential of 220 to 250 volts and a current of 50 amperes. The middle wire connection is carried as a compounding coil on the fields to give better regulation under varying loads. Each booster armature is capable of raising the voltage of the charging circuit by 100 volts at a current of 120 amperes Two track boosters are also provided, these serving to raise the potential on the trolley line beyond the line feeders, which terminate half mile short of the ends of the track.

The motor-generator consists of two similar dynamos with their shafts directly coupled together and provided with a heavy fly wheel between. One of these dynamos is intended to run as a motor, taking current from the traction system, and the other as a generator, delivering current to the lighting system. The dynamos are of the Siemens multipolar type. The generator half of the com-

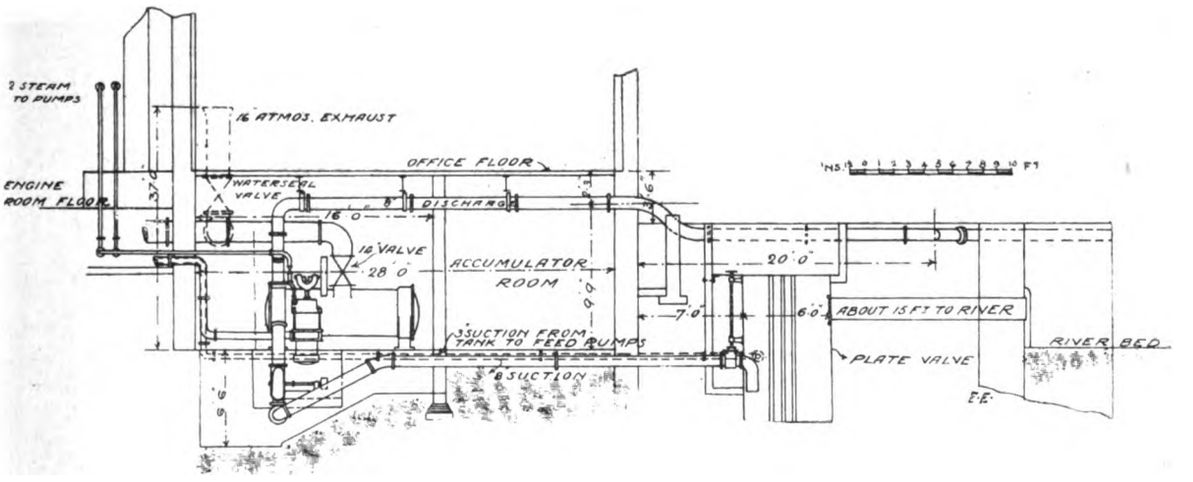

FIG. 4.—Arrangement of Condenser, Middleton.

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bination has an output of 50 kw., the fields being shunt-wound, a shunt resistance providing for the necessary variation in voltage. It may be mentioned here that the engine-room is served by a 10-ton travelling crane, hand worked from the floor level, having a span of 34ft. 6in.

Switchboards.

The lighting switchboard is erected on a gallery skirting that side of the engine-room which faces the main generating sets, as shown in Fig. 2. This board is built in three sections, the centre section comprising two divisions on lead and return. Each side section is divided into three feeder panels, one accumulator panel, two dynamo panels, and one balancer panel. Above these panels the ammeters are independently fixed to the frame, and above the ammeters the voltmeters are fixed. Below the panels are the resistance and balancer starting switches, independently fixed to a separate framework, and removable to allow of access to the framework. A clear space of 3ft. is provided at the back of the board. Except for the centre panels, all fittings and instruments are of the edgewise pattern. The panels themselves, it should be mentioned, are of black marble, mounted on a strong angle-iron frame. All the switchgear and connections are on the face of the board with the exception of the voltmeter wires. Each of the four dynamo panels is provided with a switch designed to automatically break circuit at any current less than 40 amperes, and three plug fittings for the omnibus bars. Each of the two balancer panels is provided with a maximum cut-out. Three horizontal omnibus plug bars are carried across the whole length of the above-mentioned panels and continued on to the centre panels to carry the dynamo returns. Each of the centre panels carries four vertical plug bars for dynamo returns, a two-way booster switch and the two-way booster plug bars, also a handwheel controlling one of the two battery regulators, which latter are mounted on the wall behind the switchboard, being geared from the hand-wheels mounted on the face of the board. This board was supplied by Mr. Bertram Thomas.

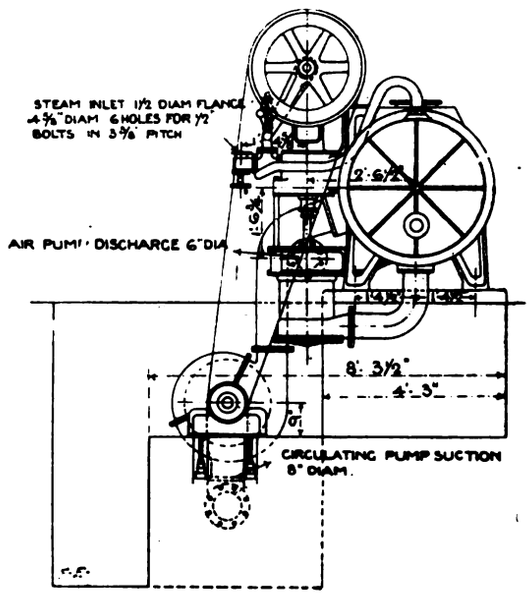

FIG. 5.—Details of Condenser, Middleton.

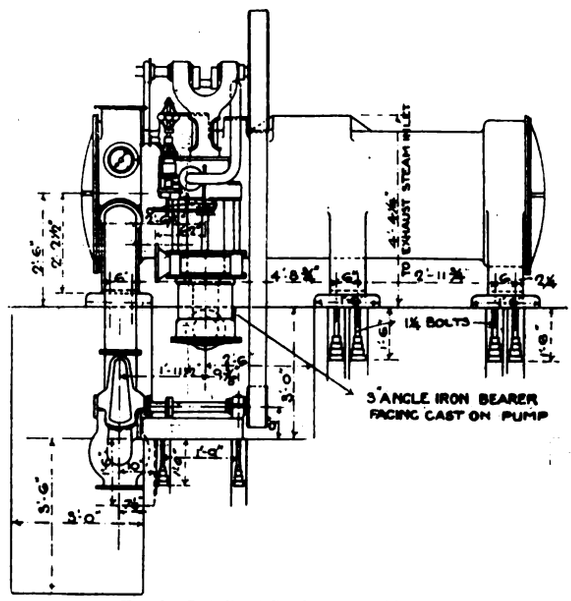

FIG. 6.—Details of Condenser, Middleton.

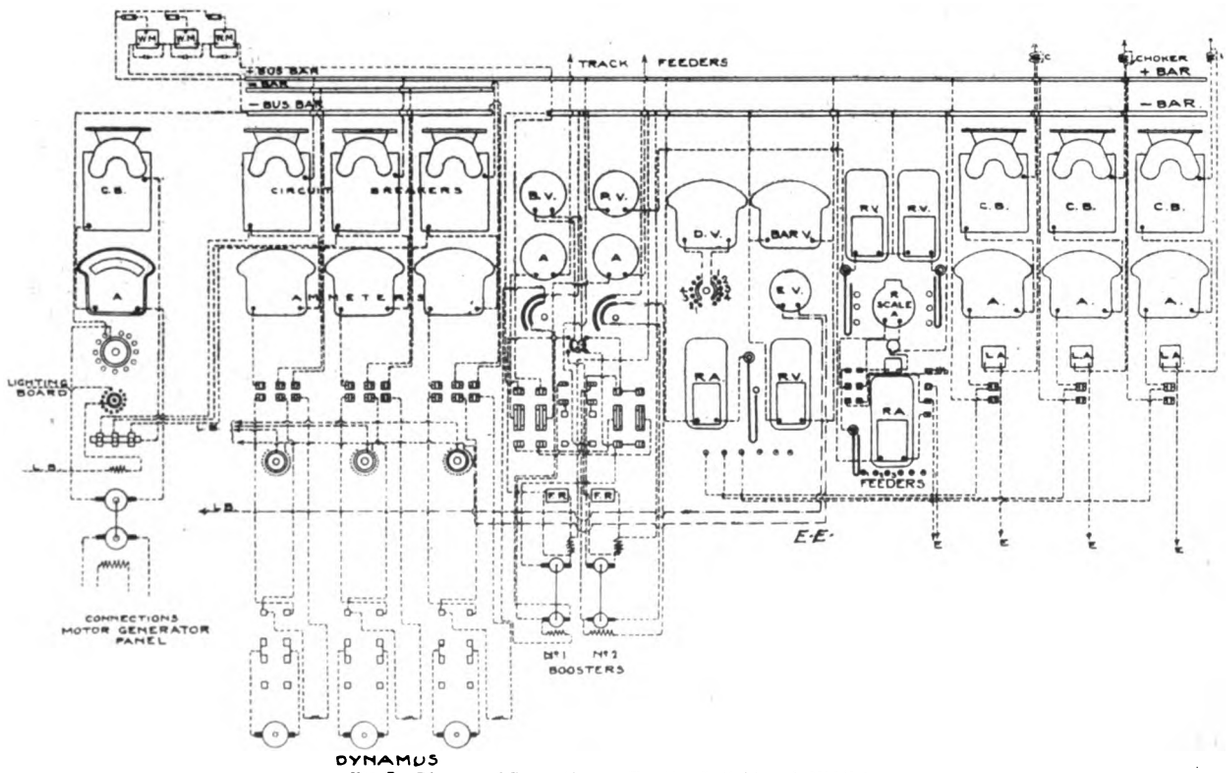

FIG. 7.—Diagram of Connections to Traction Switchboard, Middleton.

The traction switchboard, on the other hand, was supplied by the Brush Electrical Engineering Company, Limited, Loughborough. It is erected immediately below the gallery supporting the lighting switchboard, and is arranged to control three dynamos, two boosters, and three feeders. It consists of three dynamo panels, one booster panel, one Board of Trade panel, one main panel, and three

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feeder panels. When connected to this board the generators are run as compound machines with a maximum output of 605 amperes at 525 volts each. The shunt field circuits are excited from the 'bus bars of the lighting switchboard. The board is built up of enamelled slate panels placed at a distance of about 3ft. 6in. from the

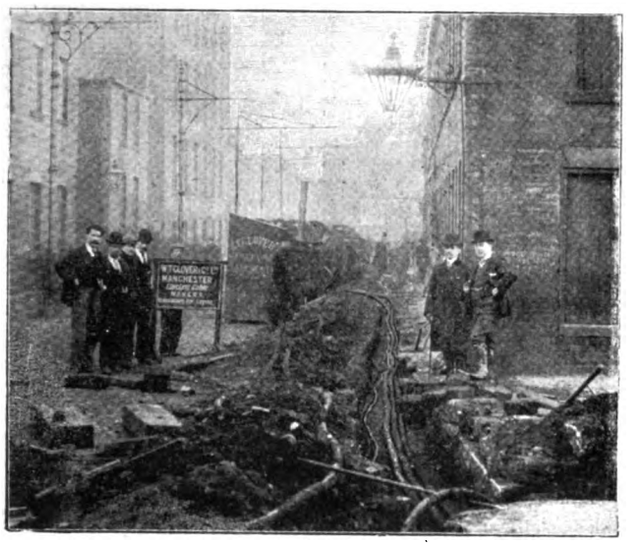

FIG. 8.—Laying Armoured Cables in Townley-street, Middleton.

wall. Three wattmeters are fixed to the wall behind the board. These are connected up in series with the negative 'bus bar between the dynamo panels and the rest of the board, and serve to measure the energy supplied to the track. The 'bus bars are carried at the back of the board from end to end. The equalising bar is carried behind the dynamo panels. All the ammeters and voltmeters fitted to the board are of the "Eversbed" round-dial 5in. radius type, except on the main panel, on

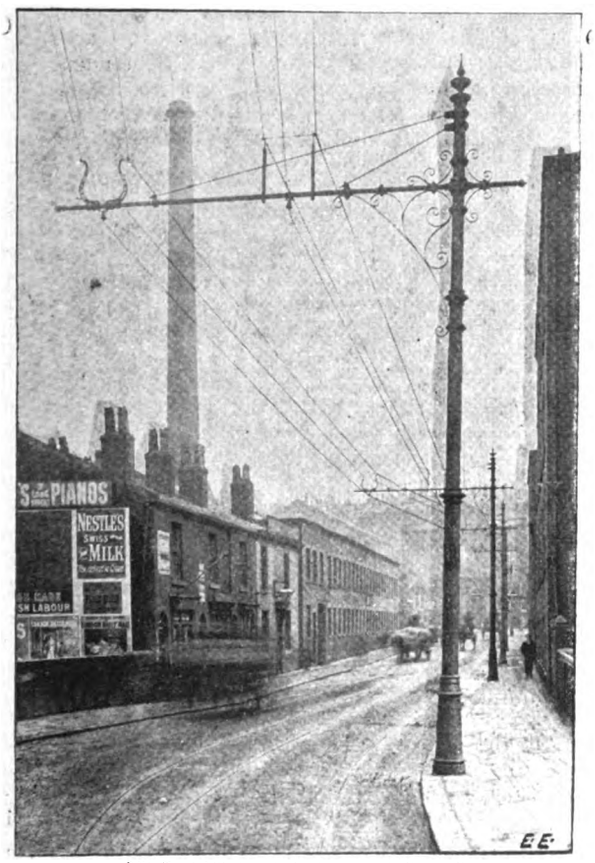

FIG. 9.—Overhead Construction, Middleton.

which illuminated voltmeters of the "Weston" type are mounted. The recording and Board of Trade panel instruments and switches are of the "Elliott" pattern, while the automatic circuit breakers provided on the dynamo and feeder panels, as also the lightning arresters, are of the British Thomson-Houston pattern. The total length of the traction switchboard is 16ft. and its height 7ft. The connections to this board are shown in Fig 7. The starting gear for the motor-generator is mounted on a separate panel placed close to the machine.

Accumulators.

In the accumulator-room there are installed two sets of 124 cells. These cells were supplied by the Tudor Accumulator Company, and are capable of giving a discharge of 50 amperes over a period of 10 hours, or 200 amperes for a period of one hour. The containing boxes are of lead. The accumulators are run on the lighting load only.

Cables.

The lighting cables are of the three-core armoured type. There are three feeding points. A single middle wire is tapped off a distributor passing the station for balancing purposes. These armoured cables are laid direct in the ground at a depth of about 2ft., with a tarred board laid over them for protection. The soil being of a dry, sandy nature, the life of the cables

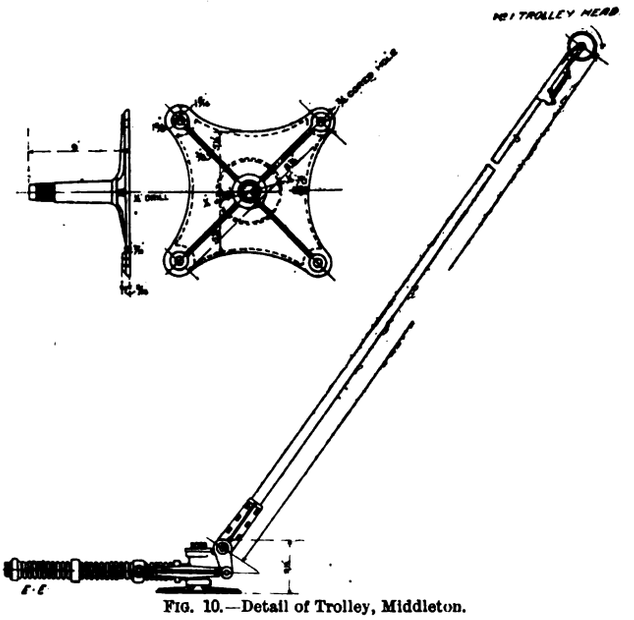

FIG. 10.—Detail of Trolley, Middleton.

should be long. The traction feeders (the routes of which are shown in Fig. 1) are lead covered, laid solid in wood troughing, the sections on the Castleton route being ·35, ·25, and ·16 square inch respectively, and on the Chadderton route ·125 and ·065 square inch. Both the lighting and traction cables were manufactured by Messrs. W. T. Glover and Co., Limited, Trafford Park, Manchester, and laid by them under the supervision of their Mr. A. T. Stewart. Extensions to the lighting network, amounting in all to about three miles, are now in hand by the same firm. In Fig. 8 the laying of the armoured cables is shown in progress.

Public Lighting.

Only a very small scheme of public arc lighting has at present been adopted. This consists of nine lamps arranged to burn in series across the outers of the three-wire system, between which there is a difference of potential of 440 volts. The lamps were supplied by the Brockie-Pell Arc Lamp Company, Limited, 60, Worship-street, London, E.C., and are of their 10-ampere open type. They are arranged to be switched out at midnight from the generating station, and two 16-c.p. incandescent lamps on each pole switched on instead of them.

Tramways.

Referring back to the area of supply (Fig. 1), it will be seen that the system of the Middleton Electric Traction Company extends to Castleton and Rochdale on the north, through Chadderton to the Oldham boundary on the east, and to Rhodes, on the borders of Prestwich, on the west. These three routes radiate from Middleton as shown, and at their termini connect with systems either completed or to be completed. The Prestwich section runs nearly to

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Heaton Park, where eventually the Manchester trams will meet the company's system. This will provide a connection from Manchester to Rochdale, and eventually there will be also a direct connection from Manchester to Middleton, *vid* Blackley, when the extension now being constructed by the Manchester Corporation for the Middleton Corporation is completed. The total length of the Middleton Electric

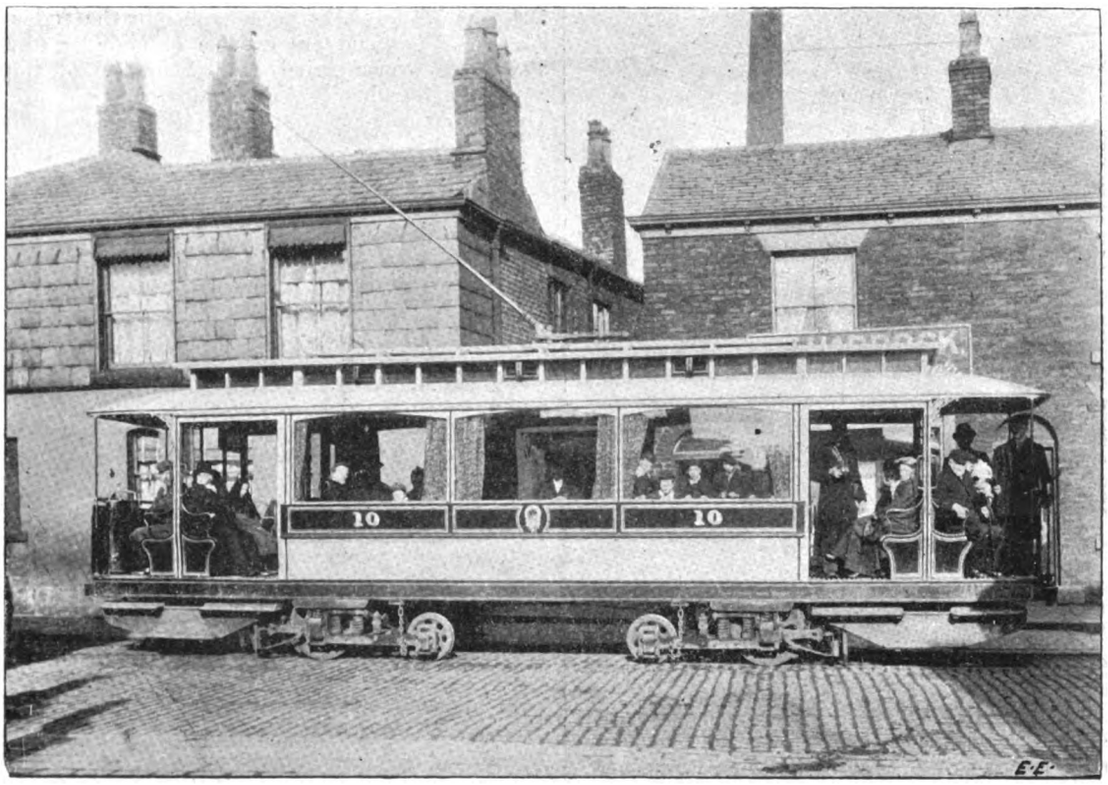

FIG. 11.—Exterior of Car, Middleton.

Traction Company's tramways amounts to 8¾ miles of single track. The permanent way has been constructed by Messrs. Geo. Freeman and Son, of Hollinwood, Oldham. Grooved rails are employed, weighing 90lb. per yard, laid on 6in. of concrete. Neptune rail bonds are used at the joints, cross bonds being also provided at intervals of 200ft. Both the span-wire and bracket-arm systems of overhead equipment are used,

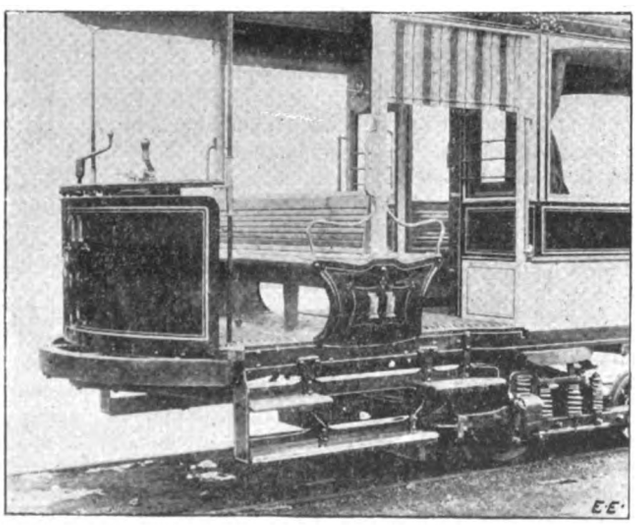

FIG. 12.—Open End of Car Middleton.

the total number of poles fixed being approximately 550, and bracket arms 300. The poles are of steel, and weigh about 8cwt. each. They are constructed in three sections, and fitted with ornamental bases, rings, and finials. The bracket arms are of wrought iron, and vary in length from 7ft. to 22ft. To these arms the trolley wire is fixed by means of solid suspension. There is a double trolley wire throughout the whole length of the route, the size of wire used being ·324 square inch, and its weight about 1lb. yer yard. The ornamental appearance of these bracket arms, fitted complete with wrought-iron scrolls, is seen in Fig. 9. In this illustration the manner of supporting the guard wires is also shown. Special anchorages, the invention of Mr. E. A. Browning, resident electrical engineer for the tramways, have been provided at all the section insulators. In these anchorages the anchor wires are in the same vertical plane as the trolley wire, thereby avoiding the tendency of de-wired trolleys to foul the anchor wires. It should be mentioned that Messrs. Geo. Hill and Co., Trafford Electric Works, Cornbrook, Manchester, were the contractors for the whole of the overhead work.

Rolling-Stock.

As regards rolling-stock, this consists at present of 20 cars. The bodies of 10 of these were constructed by the Brush Electrical Engineering Company, Limited, while those for the remaining cars, together with the electrical equipments for the whole were supplied by Messrs. Dick, Kerr, and Co., Limited, 110, Cannon-street, London, E.C. The cars supplied by the latter firm are of the single-deck combination bogie type, manufactured to the special design introduced by the Electric Railway and Tramway Carriage Works at Preston, and embody improvements in construction introduced as the result of the considerable experience which this company have had in the building of combination cars. Each car has an over-all length of 36ft., and provides seating accommodation for 42 passengers—26 inside and 16 outside. The bottom framing of the car is of sectional steel and teak combined, the result being an exceedingly strong and durable combination. The car bodies are mounted on Brill maximum traction trucks of standard design. The electrical equipment of each car consists of two 25-h.p. motors operated by two rheostat brake controllers. All equipments were manufactured by the English Electric Manufacturing Company at Preston, and are of their standard design. The same firm also manufactured the trolleys, which are of a type recently introduced for use in connection with single-deck cars. Fig. 10 shows the general arrangement of the trolley, the head of which is kept in line with the trolley mast by means of a spring acting in conjunction with a hinge attachment. It will be seen that two springs are provided at the base of

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the mast. One of these serves to maintain the requisite contact pressure between the trolley and trolley wire, while the other preserves the mast from violent concussion should the trolley leave the wire. An exterior view of a complete car is given in Fig. 11, while Fig. 12 shows one of the open ends of the car in better detail. In conclusion, we have to thank Messrs. Lacey, Clirehugh, and Sillar, the consulting electrical engineers, for most of the above information and drawings relating to the generating station, and the various contractors concerned for the particulars given of the outside work at Middleton.

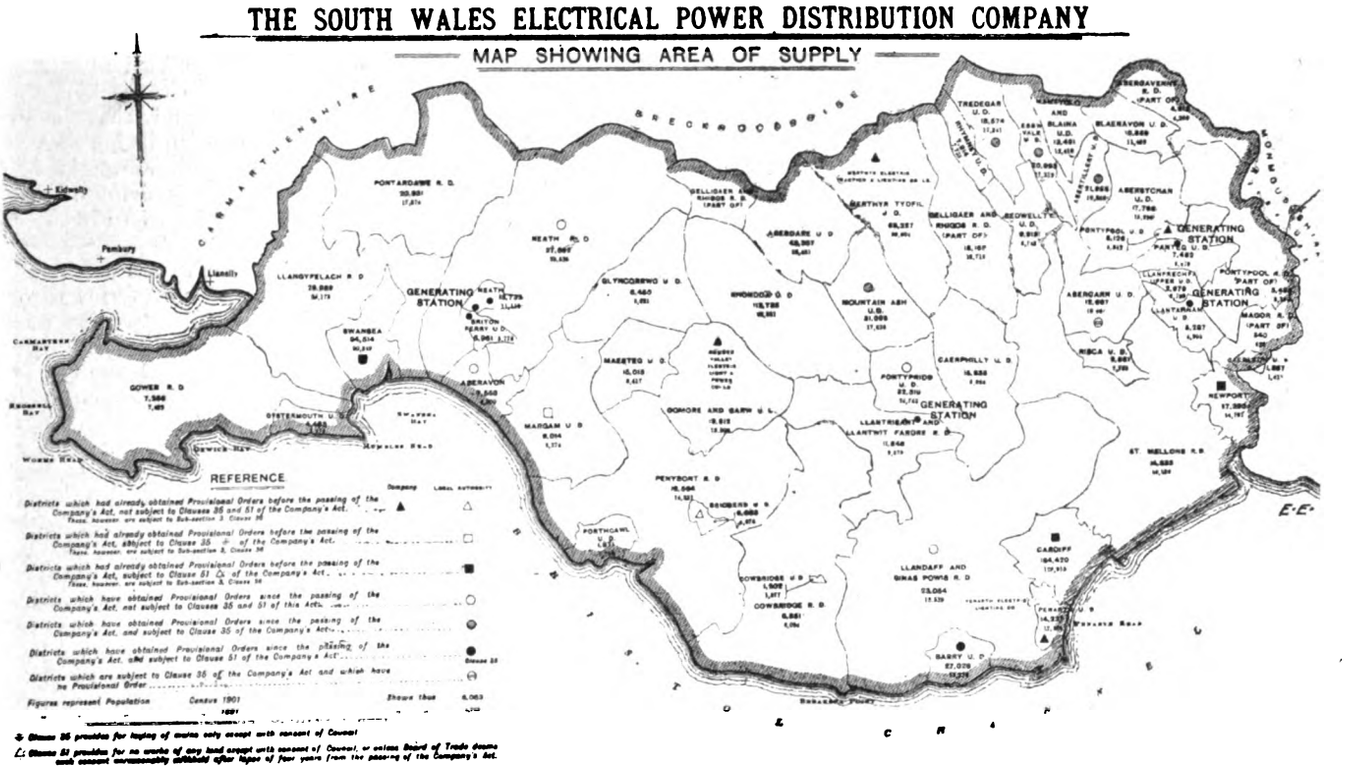
SOUTH WALES ELECTRICAL POWER DISTRIBUTION COMPANY.

This company, which will come before the public for subscriptions next week, has been formed to take over the powers granted two years ago for the distribution of electrical energy over the large area in South Wales which is shown in the accompanying map. The district in question has an area of 1,034 square miles, and contains several of the most important industrial and manufacturing areas in the United Kingdom. It also contains the noted coalfield of South Wales, which will enable the company to obtain excellent fuel at cheap rates. On Wednesday last the foundation stone of the first power station of the company was laid at Pontypridd by Sir Frederick Bramwell. A report of the function will be found below. The following is a brief description of the equipment of the station in question, which will be carried out by the following contractors: Messrs. Willans and Robinson, Limited, will be responsible for the engines, boilers, and the general equipment. They will supply 24 Niclausse boilers, each capable of evaporating 14,000lb. of water per hour at a steam pressure of 200lb. We understand that the draught will be obtained by mechanical means, and not by the erection of a high chimney. There will be six main engines, each of 3,000 i.h.p., and of the well-known Willans central-valve type. They will run at 120 revolutions per minute, and will work condensing. To these engines will be coupled three-phase Ganz alternators generating at 12,000 volts. Messrs. Ganz and Co., of Budapest, will supply all the electrical plant in the generating station and also in the sub-stations. The cables distributing current at this high voltage are to be supplied by the Callender Cable and Construction Company, and will be manufactured at their Erith works. The buildings will be erected by Messrs. Holloway Bros. Reverting to the prospectus, of which an advance copy has been sent to us, we find that the company has already entered into agreements with three local authorities for supplying them with electrical energy at prices ranging from 1½d. to 3d. per Board of Trade unit. The estimate of revenue in the prospectus is made up as follows: It is assumed that 8,000 kw. will be used for 3,000 hours per annum, and that the average price obtained is 1·375d. The cost of production and distribution is estimated at ·75d. per unit. To reach these figures the load factor on the station would have to be a very good one—*i.e.*, the bulk of the supply must be for power purposes, as is expected to be the case. The capital of the company will be three-quarters of a million, of which 45,000 £10 shares are about to be issued.

The ceremony of laying the foundation stone of the new generating station at Treforest, near Pontypridd, of the South Wales Electrical Power Distribution Company, was performed by Sir Frederick Bramwell, D.C.L., LL.D., F.R.S., on Wednesday, the 30th ult. The weather was fine, and there was a very large and influential gathering of county notabilities and others from a distance, including

THE SOUTH WALES ELECTRICAL POWER DISTRIBUTION COMPANY

MAP SHOWING AREA OF SUPPLY



Mr. Forrest, agent for Lord Windsor; Mr. Blandey Jenkins, J.P., chairman of the Glamorganshire County Council; representatives of the various local authorities in the county; Lieutenant-General Sir Richard H. Sankey, K.C.B., R.E.; Mr. Archibald Hood, managing director of the Llwynpia Collieries; Sir Henry Wood; Mr. Walter Hunter; Captain Sankey, R.E.; Colonel J. Wild Thackery; Mr. Mark H. Robinson; Mr., Mrs., and Miss Graham Harris, etc. This is the first generating station out of four which will be eventually erected to complete the scheme, but is looked upon as the central station. The work on it is proceeding apace under the skilled management of Mr. Hill and his deputy, who had made perfect arrangements for the convenience of the guests, a luncheon being subsequently served in a very able manner in a marquee erected in the company's grounds. Soon after noon Sir Frederick Bramwell, accompanied by several of the more notable visitors, proceeded to lay the foundation stone.

Mr. ARCHIBALD HOOD, the chairman of the company, presided, and in his opening speech remarked that they were going to lay the foundation stone of works which were new to that district, but which were common on the Continent of Europe and in America, and the proceedings

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that day were graced by a most distinguished company. He was sure he expressed the feelings of that influential assembly when he said that they were all delighted to have the ceremony performed by Sir Frederick Bramwell. The construction of the works was an engineering subject, and in Sir Frederick Bramwell they had one of the most celebrated engineers in the kingdom—if not in the world. Sir Frederick had witnessed almost the dawn of steam power, because it was since then that steam had become a power much in evidence in connection with engineering. Now he was present with them at the dawn of electric power distribution, because he (Mr. Hood) looked upon electricity as only in its infancy. There was not a more fitting person, therefore, than Sir Frederick who could be got to perform the ceremony of laying the foundation stone. He had now great pleasure in calling upon Sir Frederick to offer some further remarks and lay the foundation stone.

Mr. HENRY HOLLOWAY then presented Sir Frederick Bramwell with a magnificent trowel for the purpose of performing the ceremony. It bore the inscription to the effect that it was presented to Sir Frederick Bramwell, Bart., D.C.L., LL.D., F.R.S., upon the occasion of laying the foundation stone at Pontypridd on April 30, 1902. Mr. Holloway said that Sir Frederick had been asked if he would give them a motto proper for the occasion, and had complied by suggesting that they should use the words of Matthew Bolton to George III., "That James Watts gave the nation what most kings loved—power," or words to that effect. The promoters of that enterprise, too, would in due course offer power which could be utilised in that large and important industrial centre. He then went on to say that the services rendered to commercial industry by Sir Frederick were well known, and he (Mr. Holloway) would simply say that he fervently hoped Sir Frederick would live to see the company's completed work and the company itself thriving, and that that memento would bring back to Sir Frederick pleasant and interesting memories of the part he had taken in those proceedings.

Sir FREDERICK BRAMWELL, on coming forward, received an ovation. He remarked that he would not make much of a speech, as he intended reserving himself for the after proceedings, but played with much humour on the qualifying phrase made by Mr. Holloway in making a citation, "words to that effect," which he traversed to the intense amusement of the vast throng around him, and then proceeded to lay the foundation stone, which he declared to be well and truly laid.

The Rev. PRECENTOR LEWIS then offered prayers and pronounced the benediction, after which Mr. FORREST (agent to Lord Windsor) proposed a vote of thanks to Sir Frederick Bramwell for his services that day. It was the foundation stone of a great work that Sir Frederick had laid—a work which would probably revolutionise that great and enormous coalfield that sent its coal to all the world. Sir Frederick was at the inauguration of steam, and he was also at the inauguration of electricity, and they valued the compliment of his presence very much indeed. He was the Grand Old Man of science and of engineering.

Mr. MARK ROBINSON, as chairman of the body which had done the pioneer work in this matter—the body which had obtained the passing of the Act and fought the fight and smoothed rough places which had enabled them to traverse the road they were travelling that day—said he esteemed it a privilege to second the motion, and they could not but admire Sir Frederick's extraordinary energy—he was to them the personification of the greatest engineering achievements of the nineteenth century—and it was most fitting that he should be with them to start them on the way to what was going to be the great engineering movement of the twentieth century. They would look back on that day with profoundest interest in years to come—those of them who would "remain"—and one of the gracious memories to which they would be able to revert was the kindly presence of Sir Frederick Bramwell.

The vote was carried with enthusiasm, and

Sir FREDERICK BRAMWELL replied briefly, reserving his lengthy remarks, he said, till the luncheon. He said that one lost many faculties in old age, and on that occasion, as on previous occasions, he was thankful to say he had lost the faculty of blushing; were this not so, his face would be incarnadine. He thanked them for the vote, and could assure them that as long as he was able to take an interest in engineering matters he would do so, and the interest was as warm as ever in it, and it afforded him the greatest possible pleasure when he was able to say or do anything for its development. Although he was in his eighty-fifth year, he could not, however, claim to have been at the birth of steam, but he was entitled to say that he had lived through the use of oil lamps and gas at the Lyceum. He again thanked the assembly.

The assembly then passed on to the luncheon.

Mr. ARCHIBALD HOOD presided at the luncheon, and the loyal toast having been duly honoured, Mr. Hood proposed the toast of "Prosperity to the Trade of South Wales and Success to the New Electrical Power Undertaking," and remarked that the success of the undertaking and the prosperity of South Wales were very closely allied. The prosperity of the undertaking would conduce to the prosperity of the district. Electrical power was now fast becoming to be used for nearly all purposes. It could be utilised more conveniently and more economically than steam. If time permitted he would give a description of what was now in progress there, but he could only say that the appliances were all of the most modern type, and if these hereafter became obsolete, they would do all in their power to adopt the newest contrivances. It was not for him, in the presence of so many distinguished scientists, to expatiate upon the advantages of electrical power for almost all kinds of purposes, and that more economically than the present methods of utilising steam. They could not prophesy what the possibilities might be. He would, therefore, ask them to cordially drink to the toast, which would be responded to by Sir Frederick Bramwell.

Sir FREDERICK BRAMWELL responded to the toast, and said that he thanked Mr. Hood and the company for their great kindness. He wondered very much why he was there to return thanks to the toast which had just been submitted. Those of them who could carry their memory back to about 1855 or 1860 would remember that the late Lord Brougham was in a similar difficulty on another occasion. He was invited to propose at the wedding breakfast the health of the bridesmaid. His age was between 70 and 80, and he was not an Apollo in appearance, as those of them who remembered the sketches in *Punch* in those days might recall, and his lordship was, moreover, as crafty in the proper sense as a man who had been Lord Chancellor and Councillor might well be, and Lord Brougham gave as his reason for being called upon to discharge the function, his youth, his innocence, and his beauty. Well, he (Sir Frederick) could not give that as his reason for being there. But there was some sort of propriety in his being there on an occasion which related to the distribution of power from a central point. The man to whom he was apprenticed (John Haig) was one of the first who devised and carried out the distribution of power from a central point. That power was by exhaustion of the air, to 10lb. pressure to the square inch, and it would have needed a 6in. main for 20 h.p. But, however, it was very effective. One of the apprentices to the same man was Samuda, to whom so much was due for the early development of the atmospheric railway. In this connection might be found the reason why it might be considered that he was appropriately there, where an attempt was being made to distribute power from a central point. He had there the trowel which he used with great care, for fear of spoiling it, in laying the first stone. That trowel he intended making his text—the words inscribed on it in a citation from the words of Mathew Bolton to George III.: "I offer to your Majesty that which most kings love—power.' That, he repeated, would be his text, but he was sorry that his sermon might not be that which they would expect, or what it ought to be—logical and in sequence, and relating to the text. But they had chosen to have a man there who was in his eighty-fifth year, and they must suffer the consequences of having taken that step, and the consequences were remarks which would be illogical, irrelevant, and egotistical—he repeated egotistical, and in his anec

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dotage. Well, there had been a tendency for many years to do things in a wholesale manner rather than in the retail—to obtain the end in the first, instead of going through the necessary stages. He had already referred to his old master Haig, and the knowledge he had and the success which had attended his efforts to some extent. Sir Frederick then went on to give an illustration of the point which he desired to put before the assembly by reference to the matter of lighting, for he remembered the days of tallow candles for the kitchen, mould candles for the parlour, and paraffin-wax candles for his lordship; and a very nice illuminant wax candles were, for in those days they were lighted with ordinary primitive matches. These articles were very picturesque things, and he went on amid much laughter to describe how the candles were lighted in old days—the intricate manœuvrings and the consternations which attended the accomplishment of the marvellous feat. Too often the result was to take the skin off one's fingers, and not to produce sparks, but gore and bad language. Then came gas. They had then the potentiality of light, but not light; but the people wanted light, and said, "This won't do." Then came electricity. Now they did not want to light with the match; they simply turned on a handle and they had the light itself. He had told them that he should be discursive, and what he had said was said in view of what they were attempting to do in the production of electrical power in that undertaking. Their object was to produce the power itself. If they gave a man a ton of coal they gave him means to produce power, but they had not given him the power. What they proposed to do was to abolish the chimney and the man to look after it, and all that sort of thing. They proposed to give their customers the power to turn the tap on. That power would be supplied in the way most convenient for the general manufacturer in rotary form, not in reciprocating, but always easily converted into reciprocating when wanted. He was going to make a reference to a letter as to the Niagara Falls. It was written by a dear friend of his in the United States, and he would give them a summary of that part of the letter which they would care about hearing. This gentleman wrote that the distributing power at the first station was 50,000 h.p., and this was fully taken up. Sir Frederick went on: "They have so many engagements coming that they were now putting up 25,000 h.p. more in a second station, and are ordering 30,000 more—making 105,000. They are going across to the Canadian side of the fall there to establish a power-house containing three 10,000-h.p. sets." Well, that had been done, continued Sir Frederick. There was not much to begin with in the neighbourhood. The great customers of these people was Buffalo, and that was 18 miles away. But they had had that enormous success to which he had referred. There had been this great demand for the power notwithstanding these difficulties. Well, there in the neighbourhood of that—the South Wales electrical power neighbourhood—it was proposed to give the public electrical power in its best form. They knew what that meant. It would give them electric energy, motive power for the factory, motive power on the tramway, motive power on the railway. Electro-chemical energy was now largely coming into use, and electro-thermal energy was also coming into use. All these things were distributive, and they had all this without any of the usual accompaniments of boilers, engines, and the other elements which caused smoke to defile that lovely Welsh valley. They had the thing perfect and complete, and conveyed to them by cables so small that they might be looked upon as webs. They had begun to-day's function with a religious ceremony. He thought, although they were a trading company looking for profits, this was quite in place. Besides, they would save fuel, and there was to his (Sir Frederick's) mind a most important work to be done in the kingdom to save fuel. If time had permitted, he should like to have given them his own experience of the amount of fuel wasted by petty non-condensing engines. To him fuel was sacred; it was the life-blood of the nation. And that in two ways. Without it he could not contemplate the existence of a nation except as a desert island. And there was another way of viewing the matter, and it was this—they could not raise 100,000 tons of coal without one death. That was the life-blood in the other way. They should have the same reverence for life as David had, and any undertaking which had for its object and result the saving of most valuable lives—the life-blood of the nation—well deserved the blessings of the Church at the beginning, and he hoped he might be allowed to say at the close of his address, "God bless the undertaking of the South Wales Company."

Lieut.-General Sir RICHARD H. SANKEY, K.C.B., R.E., proposed the toast "The Engineers," which was briefly responded to by Mr. H. GRAHAM HARRIS.

This ended the proceedings.

TUBE BILLS IN PARLIAMENT.

PROCEEDINGS IN COMMITTEE.

FRIDAY, APRIL 25.

The Select Committee of the House of Lords enquiring into the various schemes for the construction of tube railways in London resumed their examination into the amalgamated proposals of the London United Electric Railways, Piccadilly and City Railway, North-East London, and the City and North-East Suburban Railway.

Mr. C. Rawlings, chairman of the Parliamentary Committee of the Hammersmith Borough Council, who confirmed the statement on Wednesday that the Council had agreed to support the promoters in endeavouring to have transferred the licenses of the two public-houses which were to be purchased for the widening of the Broadway, now stated that it was not true that the support of the Council of the present scheme turned upon the purchase of these two public-houses. He had not heard that, if the licenses were lost, the promoters would be involved in a cost of £80,000. The Council were mainly influenced by the amalgamation which had been effected between these four companies and by the concessions in the way of road widenings made by the London United.

Sir E. Clarke, in his address on the general case of the combined scheme, repudiated the suggestion that there had been a sort of bribe offered to the Hammersmith Borough Council in order to secure their support to one of two competing lines. Everybody must hope that this costly and elaborate investigation would result in the sanctioning of some scheme which would be practical, and would satisfy the requirements laid down by committees of Parliament in past times. The first consideration in any scheme which proposed to deal with the traffic along the great highway from Hammersmith to the City was that it should be a through line, and not in a circle. The problem in this case was, having got the people from the large districts outside London to Hammersmith and Shepherd's Bush by the tramways, how to get them into, and over every part of, London. He submitted that an examination of these competing schemes would show that his proposal was the only one which took them immediately and easily to any part. As to the financial stability and sufficiency of the promoters, he thought the committee would be quite satisfied by the evidence of Mr. Clinton Dawkins and Mr. George White. There would be one board of directors, representing the interest and experience of the persons concerned in the different parts of the line, and unity of administration. The scheme, he submitted, ought to be adopted in the public interest.

In reply to the chairman, **Sir E. Clarke** said he understood that an agreement with regard to administration was being prepared, and would be put before the committee.

Mr. Littler, K.C. (for the Brompton and Piccadilly-circus lines) expressed the hope that they might be allowed to see the agreement as early as possible.

Mr. Page, K.C., on behalf of the City and North-East Suburban Railway Company, then called a number of members of Parliament representing divisions served by the proposed line in support of the scheme.

The **Chairman** said it seemed to him that the question was whether or not the Great Eastern Railway Company could deal with this traffic.

Mr. Freeman, K.C., said he thought he should be able to satisfy the committee that they could, and that there was no justification for the construction of the additional line from the Mansion House to Waltham Abbey.

Mr. Claude Hay, M.P. for the Hoxton division, said that, as far as his personal observation and experience enabled him to judge, he should say the Great Eastern Railway Company was quite incapable of dealing with the traffic.

Mr. Freeman said the Great Eastern Company had already done something to relieve the congestion, and were contemplating still further action.

Mr. Warner, M.P., lord of the manor of Higham Hill and a land-owner at Walthamstow, supported the scheme.

Evidence was next called on behalf of the North-East London to Southgate tube.

Sir Douglas Fox, engineer for the North-East London Railway and joint engineer for the City and North-East Suburban Railway, said it was intended to have a fireproof footway, 3ft. wide, between the rails. After further consideration, and in view of the opinions expressed at the opening of the committee by Colonel Yorke, they had decided to suggest a second emergency footway for passengers if it met with the approval of the Board of Trade. There would be no

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difficulty in having such a footway throughout the whole of their railway if they adopted, as he thought they would, a 13ft. 6in. tunnel. He had made it an absolute condition that the conductor should be carried at the side of the train under the emergency platform and not between the rails, so that there should be no liability to shock on the part of the passengers. The sleepers would be of wood, but, in accordance with the recommendation of Colonel Yorke, they would not be creosoted. Working arrangements had been made with the Metropolitan electric tramways and the Middlesex County Council tramways. He had examined the City and North-East suburban route with the view of opposing it in the interests of the Walthamstow branch of the North-East London Company, but he was so convinced of its importance as serving Bethnal Green, Victoria Park, Leyton, and Epping Forest that he recommended its being joined into the combination and the Walthamstow branch being withdrawn. This course had now been adopted. At the Monument it was proposed to have a joint station between both their lines and the City and South London Railway. They also provided stations at Ludgate-circus, Cannon-street, Liverpool-street, and, on the City and North-East Suburban line, at Mark-lane and Moorgate-street. There were no engineering difficulties in placing the tubes under the Metropolitan District Railway.

The committee adjourned.

MONDAY, APRIL 28.

The committee resumed the enquiry into the competing Piccadilly schemes.

The **Chairman**, at the opening of the proceedings, said the committee desired to have a more complete statement of the estimates of the proposal now before them for a line from Hammersmith to Charing Cross, and from the Mansion House to Waltham Abbey. They wished to have a statement showing the estimates of the separate lines before the amalgamation of the Piccadilly and City, London United Electric Railways, North-East London, and City and North-East Suburban Companies.

Mr. Page, K.C., promised to have the estimates ready by Wednesday morning.

Sir Douglas Fox, recalled, said that the original Walthamstow branch of the North-East London Company had now been finally abandoned. In the construction of their North-East line they were prepared to lower the level of their deviation to avoid St. Paul's Cathedral, so as to secure that there should be a depth of 20ft. of clay, and, in fact, that the line should be in the clay throughout. The extension of the Central London line to Liverpool-street was, in his opinion, a right thing, and should be done. His view was that the air of the tunnel must be changed by the introduction of a fresh current. The present arrangement of allowing the trains to churn the impure air was not satisfactory. He agreed that the North London and the Great Eastern Companies had done as much as any suburban railway companies to cope with the traffic on the North-East lines, but that traffic had grown far beyond them.

Mr. Buckland, land valuer, estimated the value of the land and easements required for the North-East London line at £1,140,000.

This closed the case for the North-East London Railway.

Mr. Edwin Fox, surveyor and valuer, placed the cost of the land and easements required for the City and North-East Suburban Railway at £803,071.

Alderman Bude, a member of the Housing Committee of the London County Council and secretary of the National Association for the Extension of Workmen's Trains, said the City and North-East Suburban line was the only tube railway which passed through the most crowded parts of London. The line would afford great relief to the districts of Bow, Whitechapel, and Bethnal Green.

Mr. S. G. Fraser, joint engineer of the line, described the route it was proposed to follow. The tube portion of the line was just over four miles in length, and extended from the Mansion House Station to a little east of Victoria Park, and for the remaining 11¼ miles it was in the open. The total estimated cost of the works and land was £2,532,998, and of the electrical equipment, including the power station, £900,000. Interest during construction was estimated at £206,000, and compensation to District Railway Company, additional works, and cost of finance at £361,000, giving a gross total of £4,000,000. In cross-examination by Mr. Clode for the District Railway Company, the witness stated that the promoters of this line were in friendly relations with Mr. Perks until the last moment, when Mr. Pierpont Morgan took the matter up, Mr. Perks having refused it.

The witness, in re-examination by Mr. Bushe, K.C., said he and his colleagues were associated with the engineers of the District Railway Company in planning the work which was to go underneath the District Railway, and the plans were actually signed by them.

Mr. Francis Fox, partner with Sir Douglas Fox, having given confirmatory evidence, the case for the City and North-East Suburban line was concluded.

Mr. Littler, K.C., then explained the proposals embodied in the Bill of the Brompton and Piccadilly-circus Railway (New Lines) Bill, describing the arrangement which had been come to between the promoters and Mr. Yerkes for the merging of their interests in those of the District Railway Company and the other lines which have been taken over by the newly-formed Underground Electric Railway Company. (Details of this combination appeared in our issue of the 18th ult.) Counsel said that the District Railway, with its proposed conversion into an electrical undertaking, had now become for all practical purposes a part of the tube railways group. The advantage of such a course was that at Earl's Court the District branched off into two directions, and they would be able to establish a complete network of electric railways before these tubes were constructed, offering access with the river end district and the south-west of London. As soon as electric traction was introduced there would be two absolutely good routes from Hammersmith to the City over the existing lines of the Metropolitan and the District. An arrangement had been made with the Metropolitan, under which there had been transferred to the Brompton and Piccadilly-circus Company all the deep-level portion of the line between Earl's Court and South Kensington. They joined the enormous district from Uxbridge and Harrow on the north down to Wimbledon on the south, and, by a change from one train to another at Earl's Court, access was given to Knightsbridge, Hyde Park-corner, or Piccadilly. At Piccadilly-circus they put in a junction line which ran down to and formed a connection with the District Railway at Charing Cross. They also availed themselves of the deep-level line of the District Railway, and ran on to the Mansion House. From Piccadilly they ran another line onwards to Holborn, and having secured a preponderating influence in the Great Northern and Strand Railway, they ran up to King's Cross and right up to Finsbury Park. The total estimated expenditure was £3,827,500, and the total capital and borrowing powers sought were £4,133,000. Mr. Yerkes had obtained a controlling hand in the Brompton and Piccadilly-circus Company, and had let the tenders. At one place the work was actually begun, and, whatever happened, the Brompton and Piccadilly-circus Railway would be made. The size of the Brompton and Piccadilly-circus tunnel was 12ft. If, however, the committee came to the conclusion that the tunnel should be of a larger diameter, Mr. Yerkes would bear the loss and rearrange the contracts for its construction of a larger size.

The committee adjourned.

TUESDAY, APRIL 29.

The committee resumed consideration of the Brompton and Piccadilly-circus Railway (New Lines) Bill.

Mr. Littler, K.C., for the promoters, said his clients were prepared to submit to the Board of Trade the question of the arrangements at the stations, as to the method by which their trains should be worked, and to submit themselves absolutely to the Board of Trade in regard to all the provisions that were considered necessary for the protection of the public.

Mr. Perks, M.P., chairman of the Metropolitan District Railway Company, explained the connection of the District and Metropolitan Railway Companies with Harrow and also with Bow by the new Whitechapel and Bow Railway, which would be open in June. They had an arrangement with the Tilbury and Southend Railway whereby this line would be run by electric traction as far as Barking. He also explained the existing connections of the District Railway with Wimbledon, Richmond, Ealing, and other suburban districts, and detailed the negotiations by which the District Company acquired a large interest in the Brompton and Piccadilly Railway. In his opinion all that was reasonably required by the London public could be done by the Brompton and Piccadilly line and the changing of the District into an electric line. This would be accomplished in 18 months, or at the outside in two years. To carry out the complete scheme additional capital was required, and this was arranged for by Mr. Yerkes in conjunction with the financial firm of Speyer Bros., and five millions guaranteed. They had purchased the Great Northern and Strand Railway, and proposed to make a short line from Piccadilly to join this at Holborn. This junction line would run under Leicester-square and up Long-acre, accommodating Covent Garden Market, and would join the Great Northern and Strand underneath the new County Council street. The cost of it would be £409,000. There would be a shuttle service backwards and forwards from the junction at Holborn to the new Strand crescent. They also proposed to build a line from Piccadilly-circus to Charing Cross at a cost of £392,400, thus providing a continuous deep-level route from Earl's Court through Piccadilly to the Mansion House. For that expenditure of £392,000 he maintained that they effected all the objects proposed to be effected by the Morgan combination (the City and Piccadilly group) at a cost of £3,709,000. It was proposed to use the same station building at Piccadilly-circus as the Baker-street and Waterloo Company. Thus there would be direct communication with the populous districts of South London. By coupling with the Great Northern and Strand line at Holborn there would be direct connection with Finsbury Park, Wood Green, Enfield, etc. By the combination of lines and new lines they proposed to open 30 new stations in busy parts of London. When electric traction was applied to the District Railway they proposed to run trains from Hammersmith to the Mansion House at 2½ minute intervals. There would also, of course, be the Metropolitan Company's trains. They proposed to have an all-night service of trains from Piccadilly-circus through Holborn to Finsbury Park. The City and North-East Suburban promoters were in treaty with the District Company, and carrying on friendly negotiations with them relating to the running of their proposed line under the District line along the Whitechapel-road, and it was not till he came into the committee-room and heard counsel's statement that he knew that the North-East Suburban Company had suddenly changed their minds and had gone to other quarters.

In cross-examination, Mr. Perks stated that there were about 46 miles included in the lines embraced in the Yerkes combination, and the total capital involved, including the electrification of the District Railway, was between £15,000,000 and £16,000,000. It was not true to suggest that there had been any negotiations between Mr. Yerkes and himself and Mr. Clinton Dawkins with a view to joint financing or joint working of the present schemes.

Replying to Viscount Knutsford, the witness said he thought there would be a great deal to be said for a time-limit clause—say two or three years—in regard to compensation for injury through the working of the railway.

Mr. C. T. Yerkes, chairman of the Metropolitan District Electric Traction Company, next gave evidence with regard to the financial aspects of the case, stating that the capital of the Underground Electric Railways of London Company, Limited, had been secured by a combination, of which Messrs. Speyer Bros., London, Messrs. Speyer and Co., New York, and the Old Colony Trust, of Boston, were

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the principals. It was proposed to have trains of seven carriages, each 50ft. over all, and each seating 48 persons. There would be a motor-carriage at each end and one in the centre of the train, and the others would be trailers. Everything would be of a non-inflammable material. Personally, he thought that an 11ft. 6in. tube would be perfectly safe, and offer no disadvantages in the working, but if the committee or the Board of Trade decided in favour of a tube of the diameter of 13ft. 6in. they would be perfectly willing to conform to their decision. As to ventilation, they had arranged a system under which the air would be changed in every mile of tunnel every 45 minutes. The trains would run about 15 miles an hour in the tube, but on the lines of the District the speed would be 16 miles an hour. It was not a fact that they did not propose to contract for machinery or rolling-stock in this country It was his duty, as well as his wish, to throw everything he could among English manufacturers. They had made about £400,000 of contracts, and 98 per cent. of them were with firms in England. He did not think it was wise to construct tube railways in close proximity to each other or to lay several under one street. If they honeycombed the streets of London in that way, they would run the risk of considerable subsidences.

The committee adjourned.

WEDNESDAY, APRIL 30.

The enquiry into the Brompton and Piccadilly-circus scheme was resumed.

Mr. Balfour Browne, K.C., on behalf of the Piccadilly and City Railway and combined companies, informed the committee that the filled-up Bill showing the present position and powers of the amalgamated schemes would be ready for presentation on Friday morning.

Mr. C. T. Yerkes was further cross-examined by Mr. Balfour Browne. The Fulham line, he said, would be worked as a shuttle service, and so would the deep-level line from South Kensington to Charing Cross, unless they could have permission from the committee or the Board of Trade to make a confluent junction. He would take it that the total capital commitment of the District Railway Company in respect of the lines owned, jointly owned, and leased by them was £12,000,000, and that the cost of the line from Finsbury Park to Earl's Court, and also the junctions in the present Bill, was between £15,500,000 and £16,000,000. He was also prepared to accept counsel's calculation that to pay 4 per cent. on the total of £28,000,000 they would require £1,120,000 a year, and that, if they only worked at 50 per cent., they would require a gross receipt of £2,240,000. He did not know that they would have to carry 270,000,000 passengers at 2d. over the whole of the District undertaking, but was convinced that there would be a sufficient traffic to make the railways remunerative.

Examined by Mr. Coward, K.C. (for the London County Council), as to a through line from Hammersmith to Piccadilly and on to the City, the witness said that there would be three shuttle services on their lines, two of these being from Holborn to the Strand and from Parson's Green to South Kensington. A passenger on the Holborn and Strand Railway would have to change if he wished to reach the District Railway, but it would take him only a minute to get to the Temple Station.

Mr. Brereton, partner with Sir John Wolfe-Barry and the engineer for the Fulham line, explained that this particular length commenced by a junction with the Brompton and Piccadilly-circus authorised railway at South Kensington, and proceeded under the Fulham-road to the Parson's Green Station of the District Railway. The length of the line was two miles three furlongs, and there were eight stations on the route. The estimate for lands and works was £826,875.

In cross-examination the witness said the Fulham line had a considerable value as a local line and also as a relief line to the traffic from Earl's Court. The King's-road line was also proposed over practically the same route, but he did not think there would be sufficient traffic for the two railways. He estimated the cost of an 11ft. 6in. tube at £40 a yard, and that of a 13ft. 6in. tube at £48 per yard.

Sir Hugh Owen, chairman of the Commissioners under the London Government Act, and formerly secretary to the Local Government Board, said that the proposed communication between the authorised Brompton and Piccadilly-circus and the Great Northern and Strand Railways would connect the North of London with the West-end and the South-West of London, and would enormously increase the usefulness of the Strand Railway.

Sir James Salumper, engineer, said that by the Brompton Act of 1897 the time for the compulsory purchase of land was fixed at Aug. 1, 1900, and for the completion of works at Aug. 1, 1902. This limit was further extended to 1902 and 1904 respectively, and the present Bill asked for a still further extension to 1904 for lands and 1906 for works.

By **Mr. Moon, K.C.** (for the Piccadilly and City line): The 3½-chain curve was no obstacle to the conduct of the traffic, and it was not a source of danger. It might be if it was to be taken by a locomotive, but the motor-carriages would easily go round such a curve. He adopted it not from choice, but because the geographical necessity of the place required it. There were several four-chain curves on the line, but it was not correct to say that the line from beginning to end was a series of reverse curves.

In answer to Mr. Talbot (for the Duke of Devonshire, the Duke of Wellington, and St. George's Hospital), the witness stated that he did not think that frequent stoppages would increase the vibration, unless, perhaps, the trains were running at a high speed. He was willing to undertake to keep the line running under Piccadilly as far from the houses there as their limits of deviation would allow, and to have it in the London clay.

The committee adjourned till to-day (Friday).

ANOTHER COMMITTEE FORMED.

It was announced on Saturday that a second group of Metropolitan "Tube" Railway Bills had been formed for consideration by a select committee of the House of Lords. The Bills which are included in the group are the Charing Cross, Euston, and Hampstead (Nos. 1, 2, and 3), the Islington and Euston, City and Crystal Palace, Edgware and Hampstead, Great Northern and City, North-West-London, Great Northern and Strand, and Baker-street and Waterloo. Lord Ribblesdale is chairman of the committee, and the other members are Earl Donoughmore, Lord Saltoun, Lord Castletown, and Lord Aberdare.

THE DISTRICT RAILWAY BILL.

A special report was issued on Wednesday by Mr. Henry Hobhouse, chairman of the House of Commons Committee on Group 3 of Railway Bills, to the effect that in the case of the Metropolitan District Railway Bill they had agreed to the following special report: "That the committee have had their attention drawn to the fact that it is not the duty of any Government department to examine into and to report upon proposals for electrical undertakings however extensive and important. In view of the rapid development of such undertakings, and the novel and possibly dangerous character of some of the proposals, the committee consider it desirable that in future every Bill containing such proposals should be reported upon by the Board of Trade."

FORTHCOMING EVENTS.

FRIDAY, MAY 2.

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. Paper: "Some Factors in Colonial Railway Construction," by Mr. Lewis H. Rugg.

Royal Institution.—At 9 p.m., Mr. A. E. Tulton on "Experimental Researches on the Constitution of Crystals."

SATURDAY, MAY 3.

Institution of Electrical Engineers (Students' Section).—At 2 p.m., visit to the Deptford generating station of the London Electric Supply, Limited.

MONDAY, MAY 5.

Society of Engineers.—At 7.30 p.m., ordinary meeting. Paper: "Recent Blast-Furnace Practice," by Mr. Brierley D. Healey.

Society of Arts.—At 8 p.m., Prof. R. T. Glazebrook on "Glass for Optical Instruments" (Lecture IV.).

WEDNESDAY, MAY 7.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., ordinary meeting. Paper: "Electric Light and Power Cables," by Mr. Langford.

THURSDAY, MAY 8

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting at the Society of Arts, Adelphi. Conclusion of discussion on "Form of Model General Conditions."

FRIDAY, MAY 9.

North-East Coast Institution of Engineers.—General meeting at Newcastle-upon-Tyne.

SATURDAY, MAY 10.

Institution of Junior Engineers.—At 10 a.m., visit to the Great Eastern Railway Works, Stratford.

APPOINTMENTS VACANT.

Clerk, York Corporation, £120 per annum, May 12. Full particulars in our advertisement columns.

Junior Assistant Engineer, York Corporation, £78 per annum, May 12. Full particulars in our advertisement columns.

Chief Assistant Engineers, Croydon Corporation, £200 per annum, May 8. Wycombe (Borough) Electric Light and Power Company, Limited, experience in the working of a central station—low-tension, three-wire system, with accumulators, £2 per week, May 8. Full particulars in our advertisement columns last week.

Shift Engineers, Manchester electricity department, £150, May 3. Full particulars from Chairman, Electricity Committee, Town Hall, Manchester. Shipley Urban District Council, 35s. per week, May 5. Full particulars in our advertisement columns last week.

Professor of Physics and Electrical Engineering, Victoria Jubilee Technical Institute, 500 rupees per month, rising in five years to 800 rupees. Full particulars in our advertisement columns.

Electrical Engineer and General Manager, Ilkeston Corporation tramways department, May 8. Full particulars in our advertisement columns.

Switch and Switchboard Hands, only those used to this class of work need apply, Ediswan, Ponder's End, Middlesex. Full particulars in our advertisement columns.

Engineer, to take charge of 400-light country house installation, about 30 miles from London, 30s. per week. Full particulars in our advertisement columns.

Jointer, used to high and low pressure cables. Full particulars from Mr. R. W. L. Phillips, Corporation Electricity Works, Bedford.

Dublin Local Section.—At the meeting on the 17th ult. the chairman, Prof. W. F. Barrett, F.R.S., announced the following nominations as officers for the ensuing session: chairman, Mr. J. W. Towle; vice-chairman, Mr. F. Gill; council: Prof. W. F. Barrett, F.R.S., Messrs. W. Brew, W. Brown, A. T. Kinsey, H. Luttrel-Elward, G. F. Pilditch, A. E. Porte, P. S. Sheardown, and W. Tatlow, and Prof. W. E. Thrift.

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THE
ELECTRICAL ENGINEER.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140, Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

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POWER STATIONS.

The ceremony of laying the foundation stone of the South Wales power station, fully described in another column, although in one way not inaugurating a new era in electrical development, is perhaps one of the most important actions which have occurred in electrical work during the past few years. Power stations are in actual work all over the world, and in one or two places in this country, but so far as we know the previous works opened in this country have been installed under different conditions. In the case we refer to the proposal is to erect a generating station and distribute electrical energy under what may be termed purely commercial conditions It is not to provide power in a new district to be developed, as at Manchester, or to extend operations, as on the Tyne side. South Wales is an industrial hive. The district over which the operations of this station are to extend uses for power purposes many thousands, if it does not reach to millions, of horse-power. Now, we always have objected, and we strongly object, to the comparisons generally made with regard to the utilisation of electrical energy in this and in other countries, especially in America. The old adage says comparisons are odious, and in this case they are worse—they are misleading. At the commencement of what may be called the electrical era, say 25 years ago, America had no roads—they had tracks, a few and deplorably bad at that. They had also towns and many nuclei of towns, but without any artificial light. Everything and everybody there looked upon the motto "Go ahead" as their birthright; and go ahead it was. Plants for lighting were put down everywhere, traction schemes went ahead like wildfire; and because this was so we have been told that we were a benighted nation, never ready to take advantage of the progress of applied science, and wishful to follow in the rear instead of the front of progress. All such criticism was simply a sign of the emotional gush of the daily paper, which neither considered nor cared about different conditions, which neither considered nor troubled about practicability, but concluded without investigation that what was sauce for the newly pitched town in Texas was equally sauce for the thousand-year-old town in this country. Almost, or quite, in the early stage of electrical development we pointed out that the world would see a greater development in electrical work for power purposes than for lighting purposes—indeed, we insisted again and again that the latter might almost be looked upon as a by-product of the former. To return, however, to our immediate text—the power station of South Wales and its prospects. As we have said, an enormous horse-power is required within the area of its operations. The people who require this horse-power are already provided with it, and their question is quite different from that of one who proposes to erect a new factory or sink a new shaft. Replacing what exists is a very different matter to installing in a new concern, but England has to face this question of replacing. Assume a factory erected and equipped twenty-five years ago. Assume, further, a factory erected contiguous to the former and equipped to-day, and then ask the question, Which factory will have the pull in the competition which is to ensue between them? Assume that both are intended to produce the same class of goods. There can be only one answer to this question—that the modern factory is in a better position than the older one, and, all things equal, will be more likely to obtain a greater patronage than its older rival. The factories of America are new and newly equipped. We are told that their competition is keen, and that we are losing orders because we cannot compete with them in

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their production. The moral of this seems to be quite clear, and it is that our own factories must be equipped with the most modern appliances, and must be placed in a position of equality with those with which they have to compete. Last week we referred in a note to an excellent article which appeared in the *South Wales Daily News*, wherein t was stated that the older-equipped works employed a number of comparatively small engines over the large area from which to obtain the power they required for the works. According to our present lights, this is a most uneconomical method of procedure, and a considerable gain would accrue by replacing small steam-engines by electric motors. The same argument holds good wherever applied, and we are prepared to assert that in almost every case where the actual conditions existing are considered, the replacement of steam by electricity will show a saving in the annual balance-sheet. That is the point, and the only point that business men have to consider. Of course, in considering the advantages, you have to consider such things as space occupied, cleanliness, the cost of getting rid of waste material, the saving by only using energy when it is actually required, and many other items which are usually unthought of. The replacing of machinery means an expenditure of capital, hence the result has to be carefully considered, and that is why we insist upon the economy of this expenditure. The promoters of this scheme estimate their returns for what we should say is a comparatively small supply of energy, but if—as we think will be the case—users after examination find that they benefit both directly and indirectly from the use of electrical energy, we should imagine that the estimates both for production and sale may be considerably reduced, and that the results will even be better than those shown in the estimates.

ELECTRICAL LEGISLATION.

The report of the Committee of the Institution of Electrical Engineers on Electrical Legislation will be found elsewhere. The nine resolutions which this committee have passed after hearing evidence will be endorsed by practically all English engineers. The only exception that we can see to this general approval will be the engineer who advises small and obstructive municipalities on the best way to erect small works, which serve no useful object, and which can only show a balance on the right side of their accounts by charging high rates for electrical energy. The resolutions suggesting active measures for the improvement of affairs may be divided into two heads. The first is to the effect that local authorities should not have their present powers of veto over electric tramway, lighting, and power distribution schemes. The other is that the regulations of Government departments dealing with the industry should be drawn up to accord with the future state of the industries, and not, as is now the case, from past experience on limited lines. It is advocated that the Government should employ in these departments a much larger staff, and should educate them by trips abroad to enable them to help forward the industry by the experience so gained. We trust that the proposed memorial to Lord Salisbury will result in changes being made in the right direction, but in view of the great power which municipal authorities can exert in Parliament, we have not much hope of reform as far as local veto is concerned. Still, if this veto can be dispensed with on recommendation of the Board of Trade much will have been accomplished, and the above committee will not have laboured in vain.

ASSISTANT ENGINEER-IN-CHIEF TO THE POST OFFICE.

It is with much pleasure that we announce the appointment of Major Walter Alfred John O'Meara, R.E., C.M.G., to be assistant engineer-in-chief to the Post Office. It will be remembered that the post fell vacant a few weeks ago on the promotion of Mr. J. Gavey to the position of engineer-in-chief in the room of Mr. J. Hookey, retired. The new assistant engineer, although only 39 years of age, has established for himself an exceptionally brilliant record both as a soldier and an engineer. Entering the Royal Engineers in 1884, he took part in the Burmese War of 1885-86, where he was wounded 36 times, and on one occasion was left by the Dacoits for dead, but was afterwards recovered by the British troops. For his distinguished services in this campaign he was several times mentioned in dispatches, and also received the wound pension and the medal with clasp. After this Lieutenant O'Meara, as he then was, found employment for several years on the construction of the London-Paris telephone trunk line, and on its completion he received the thanks of the Postmaster-General of that time. He has also taken a prominent part in the present war in South Africa and was in Kimberley during the siege as chief staff officer, his name being mentioned in dispatches on some few occasions. In the earlier days of the war Major O'Meara was engaged in the battles of Paardeberg, Poplar Grove, and Driefontein, and was also present at the occupation of Bloemfontein, where he was made chief intelligence officer. He was subsequently appointed assistant to the military governor, Johannesburg, as acting major until May of last year, being afterwards confirmed in this rank.

INSTITUTION OF ELECTRICAL ENGINEERS

REPORT OF THE COMMITTEE ON ELECTRICAL LEGISLATION.

The following is the report of the above committee as adopted at the Council meeting on Thursday, April 10, 1902 :

At the meeting of Council on March 14, 1901, the following were appointed members of the Committee on Electrical Legislation to determine whether they can recommend the Council to take any action, and if so, what action that would assist the industry in connection with the matters dealt with in Mr. Madgen's paper, "The Electrical Power Bills of 1900 : Before and After" : Prof. W. E. Ayrton, F.R.S. ; Major P. Cardew, R.E. ; Lieut.-Colonel R. E. Crompton, C.B. ; Mr. S. Z. de Ferranti ; Mr. Robert Hammond ; Mr. H. Hirst ; Mr. J. E. Kingsbury ; Mr. W. L. Madgen ; Mr. W. M. Mordey ; Prof. J. Perry, F.R.S. (president) ; Mr. R. P. Sellon ; Mr. A. Siemens ; Mr. C. P. Sparks ; Mr. J. Swinburne ; Mr. A. A. Campbell Swinton ; Prof. Silvanus P. Thompson, F.R.S. Mr. W. Langdon became an *ex-officio* member of the committee in May, 1901.

In the course of its enquiry the committee has met on 11 occasions. A number of gentlemen representing various shades of opinion upon the subject under consideration were invited to express their views. The evidence of those who responded accompanies this report.*

The evidence shows that, while taking divers views of subsidiary questions, the witnesses were practically unanimous in their conviction that electrical enterprise has not attained that stage of industrial development in this country which might fairly have been expected having regard to the many favourable natural conditions, and having regard also to the achievements of British capital, labour, and inventive genius in so many other branches of the mechanical arts. In considering the comparative development which might have been reached in this country, the committee has had in view not only the extent of the plant employed, but also the source of its design and manufacture. As leading indicative cases, the committee draw attention to the foreign equipment of the Central London Railway, the undisputed competition of American and Continental firms for the electrification of the Metropolitan District Railway, and the large orders executed abroad for the Dublin, Glasgow, Manchester, and numerous other Corporations. The committee finds that the essential difference between the electrical industry as it exists in the United Kingdom and as it exists abroad is largely due to the exceptional legislative enactments, official regulations, and powers of local authorities existing in this country. Thus British electrical engineers, capitalists, and others concerned have been hampered by enactments and rules which other Governments have regarded as either unnecessary or opposed to public interests.

Under these conditions it has been possible for numerous local authorities to prevent any electrical supply whatever being provided within the area of their jurisdiction, and comprehensive traction

* This evidence can doubtless be seen at the Institution offices.

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schemes have been blocked, or only carried out at great unnecessary expense, owing to the opposition of one or two of the local authorities concerned.

A Joint Select Committee of the two Houses of Parliament, appointed so long ago as in 1898, reported that the law should be amended in so far as it gives local authorities the power of veto; but no steps have been taken to give effect to this recommendation. The committee considers that the Acts restricting the electrical industry should be revised in order that there may be that development which is necessary to the commercial progress of the nation.

Besides the legislative enactments governing the projection, duration, expropriation, etc., of electrical undertakings, the committee considers that the Government departments should be put into such a position financially as would enable them to keep more in touch with the progress of science so as to prevent them from continuing to enforce regulations which unduly impede engineering development.

The following resolutions embody the views and recommendations of the committee in respect to the matters covered by the reference of the Council:

1 That notwithstanding that our countrymen have been among the first in inventive genius in electrical science, its development in the United Kingdom is in a backward condition, as compared with other countries, in respect of practical application to the industrial and social requirements of the nation.

2. That the cause of such backwardness is largely due to the conditions under which the electrical industry has been carried on in this country, and especially to the restrictive character of the legislation governing the initiation and development of electric power and traction undertakings, and the powers of obstruction granted to local authorities.

3. That local boundaries have usually no reference whatever to the needs of the community in regard to electric supply and traction; that the selection of suitable areas should be dealt with on the basis of economic principles and industrial demands; and that this has been found to apply also to gas, water, and sanitary engineering.

4 That the development of electric power and traction undertakings offers the most favourable means of relieving congested centres, and of thus contributing towards the settlement of the housing question.

5. That it is expedient in the national interests that the Electric Lighting Acts, 1882-8, the Tramways Act, 1870, and the Standing Orders relating to special Acts for tramways should be amended in so far as they enable local authorities to veto or delay the carrying out of electric supply and traction projects of which the utility can be shown; and that effect should be given to the recommendations of the Joint Select Committee of Parliament, 1898, on "Electrical Energy—Generating Stations and Supply."

6. That excessive time is occupied and expense incurred in obtaining authority to carry out electrical undertakings, and that important and growing industries are thereby checked.

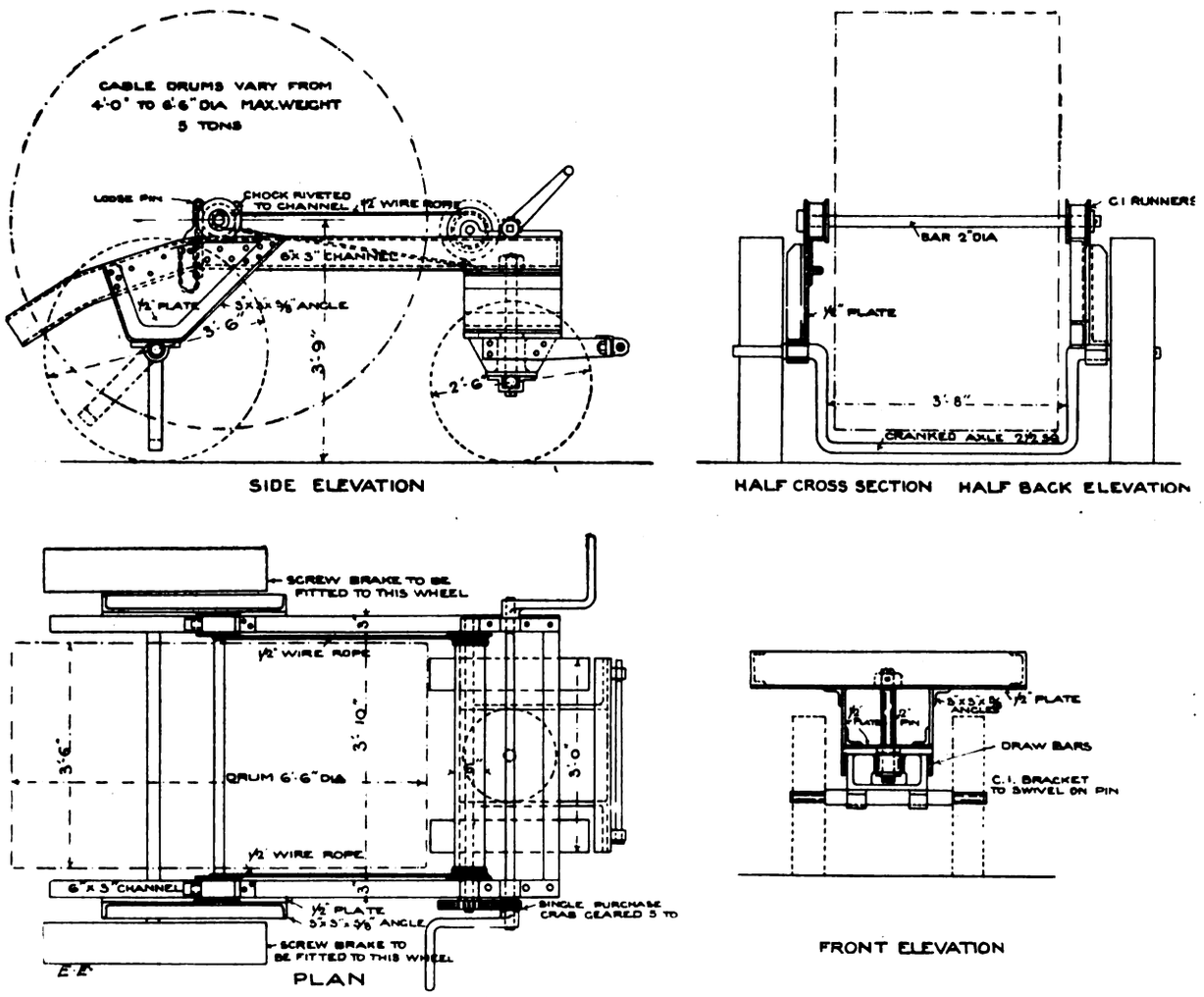
7. That while this committee fully recognises the ability of the technical officials of the Government departments concerned, it is of opinion that the staffs of those departments as at present existing are wholly inadequate, having regard to the great industrial interests involved; that it is essential that these departments should be put into a position enabling them to keep in touch with all developments in engineering matters, both in this country and abroad, and that a sufficient sum should be provided annually by Government to enable them to employ and pay a proper staff for such purposes.

8. That the adjustment of departmental regulations to engineering development should not be delayed until the industrial interests concerned are seriously hampered, and that, with a view to preventing any such delay, the Institution of Electrical Engineers should be willing to take part in revising such regulations from time to time.

9. That this committee recommends that the Institution should memorialise the Prime Minister to receive a deputation for the purpose of urging the removal of the present disabilities and restrictions which prevent electrical engineering from making the progress that the national interests demand, and attaining at least the same level as in America, Germany, and other industrial countries.

IMPROVED CABLE CART.

The illustrations which we give below are of an improved cart for transporting cables for electrical distribution work and for paying out the cables in any way that may be required in laying the same. The cart is designed by Mr. Alex. H. Robinson, of 190, Queen Insurance-buildings, Dale-street, Liverpool, and we believe that certain features in it are patented by him. The details of construction are clearly shown on the drawings. The object of the new design is to save labour. The cable drums are heavy and cumbrous to handle when full of cable, with a result that many men (from six to eight) are usually required when loading them or when unloading. As a consequence, for small distances it often pays to roll the drum, and this sometimes damages the cable and always strains the drum itself. With this new type of float, two men can easily handle a five-ton drum, thus saving the time of from



Plan and Elevations of the New Cable Cart designed by Mr. A. H. Robinson.

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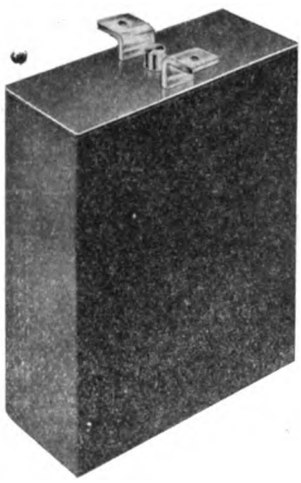
four to six men. Also, the damage to the drum and chance of injuring the cable are avoided. To operate the cart the loose axle is taken out and put through the hole in the drum, the cart is then pushed up till the bottom of the inclined ramps engage with the flanged wheels on the loose axle, the parbuckle ropes are then attached and the cable drum wound up the ramp by means of the single or double purchase crab. When the drum axle is against the stop on the ramps, the chocks are dropped in on the other side to prevent the drum falling back again. The cable drum can then be either rotated to pay out the cable or carried away on the cart as required. The mechanical advantage gained by this arrangement is as follows: gain due to ramps of 1 in 3, 3 : 1; gain due to parbuckle rope, 2 : 1; gain due to gearing on cart, 5 : 1; gain due to ratio of lever to drum (lever 15in. long, radius of drum 3in.), 5 : 1; two men, 2 : 1; $3 \times 2 \times 5 \times 5 \times 2 = 300 \div 1$. So that in lifting a three-ton drum each man would have to exceed a pressure of 22·4lb., or in lifting a five-ton drum a pressure of 38lb. each, or adding 20 per cent. for friction, would, say, 27lb. and 46lb. respectively. The design of the cart is such that the cost of upkeep should be very small.

TRADE NOTICES AND NOVELTIES.

Traction Type Cell.

The accompanying illustration shows a cell introduced by the Hart Accumulator Company, Limited, Marshgate-lane, Stratford, London, E., and which is designed especially for traction work. It is claimed that this cell combines mechanical strength with electrical efficiency, and has very high capacity, low weight, and great durability. The



cells are made up in three standard sizes, having each an over-all height of 11in. Further particulars, supplied by the makers, relating to the cells are given in the following table:

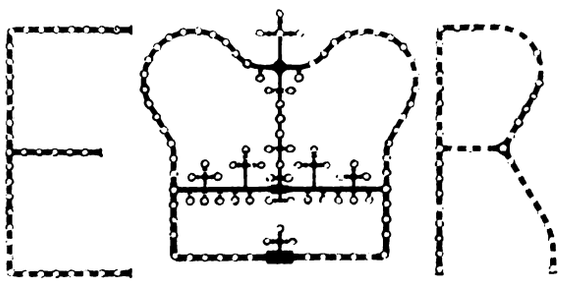
Letter.	Capacity.	Charge rate. Amperes.		Discharge rate. Amperes. Hours				External dimensions.		Acid per cell, part of carboy.	Weight.
		Normal.	Maximum.	10	5	3	2	Length. Inches.	Width. Inches.		Lbs.
A	80	12	16	8	13	18	22	2	8	·03	17
B	120	18	24	12	20	27	33	2⅜	8	·05	24
C	160	24	32	16	26	36	44	3⅝	8	·06	33

Car Trucks, etc.

From the European McGuire Manufacturing Company, Limited, we have received a copy of their 1902 catalogue. We are informed that the above company, whose works are situated at Elton Fold, Bury, Lancs., have purchased the rights, designs, and patents of the McGuire Manufacturing Company, of Chicago, and are now manufacturing car trucks in this country, believing it to be particularly advantageous to engineers to have them built where they may be seen in course of construction. The company, we are further informed, employ British capital and British labour, the latter being under the supervision of trained men from the Chicago works. The specialities in electric railway equipment dealt with in the catalogue before us include trucks, snow sweepers, track sprinklers, stoves, fenders, life-guards, elastic brake hangers, brake handles, etc. The firm' sNo. 35 motor truck has a solid steel frame, cushioned by spiral springs over each journal box, and is equipped with swing bolster on elliptic and spiral springs, mechanically proportioned. The motors are hung inside. It is claimed that this truck has fewer parts than any other of its kind, and being machine fitted throughout possesses great strength and durability. In another truck—No. 39A double type—the motors are hung outside, giving a very short wheel base, and enabling the car body to be carried as low as on a single truck, adapting it especially to interurban and surface roads, where high speed and heavy service are required. Numerous other trucks are illustrated, including one of the maximum traction type designed for fast city service. A perusal of this catalogue would repay the trouble.

"Simplex" Coronation Fittings.

The illustration herewith shows how the Simplex Steel Conduit Company, Limited, Mansion House-chambers, 20, Bucklersbury, London, E.C., also of Birmingham, Manchester, and Liverpool, adapt their conduit for Coronation devices. The device shown consists of a crown with a 7ft. base and 8ft. in height, while the initial letters "E. and R." are approximately 8ft. high by 4ft. wide.



A star fitting suitable for erection along with the "crown" is also made a speciality of by the Simplex Company, together with other devices. Further particulars and prices are contained in a circular just issued by the firm.

Coronation Specialities.

We have been asked by Mr. G. Braulik, manufacturer and exporter of electric supplies, Upper Thames-street, E.C., to state that in the view of the probable large demand for searchlights during the Coronation illuminations, he is stocking a large number of varieties of these appliances, as well as of the new flame arc lamp, and that he is prepared to supply our readers with any information they may require on the subject.

CORONATION ILLUMINATIONS.

The following regulations for wiring and charges for supply for additional temporary lighting in connection with Coronation illuminations, have been issued by the electricity and public lighting department of the St. Pancras Borough Council:

1. Applications for temporary lighting for illuminations should be made as early as possible, stating the equivalent number of 8-c.p. lamps required or the amount of current.

2. Applications will be considered in the order received. The Council reserve the right to refuse applications after a safe limit to the station, sub-station, or house lead capacity has been reached.

3. For a special connection the charge will be the actual cost of same, this charge to be refunded if the supply becomes permanent within three months.

4. For the supply of current there will be a charge of 1d. per 8-c.p. lamp or its equivalent per night.

5. Connection can only be made subject to the above and the following wiring regulations for temporary work:—(*a*) Current density: the maximum current allowed by the I.E.E. rules will be approved—viz., 18 S.W.G., 4·2 amperes; 17 S.W.G., 4·4 amperes; 16 S.W.G., 6·8 amperes, etc. (*b*) Insulation to earth: if tested in wet weather to be such that not more than one ten-thousandth of the whole current required can leak, assuming one pole to be earthed; if tested in dry weather to be such that not more than one twenty-thousandth of the whole current required can leak, assuming one pole to be earthed. (*c*) Joints need not be soldered, provided that the wires are well cleaned, that the joint is mechanically strong, that the joint is well insulated with both pure rubber and black tape. (The "Britannia" form of joint is preferable.) (*d* Not more than 50 8-c.p. lamps are to be connected with one circuit, and each circuit is to brought direct to the temporary switchboard and there controlled by a single-pole switch and fuse in each conductor. No other fuses are to be used. (*e*) Temporary leads are to be secured at points not exceeding one yard apart, either by wood cleats or binding to insulators. (*f*) A temporary switchboard is to be fixed close to the supply service. The board should be of hard wood or soft wood covered with sheet asbestos, and to be fixed in a horizontal position on brackets like a shelf. The wires to be brought up from underneath through holes in the board to various switches, etc. It is important that there should be at least 3ft. headway above the board. (*g*) Sufficient lead must be provided to connect the supply service. (*h*) If any temporary wires are connected in any other manner than provided by these rules, the ordinary wiring rules will hold good.

6. In general, it may be pointed out that the whole decoration should be regarded from the fire point of view. The amount of inflammable material, including electric light wires, should be kept as low as possible. They should be as far removed as possible from the facia board or other woodwork.

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QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

477. Explain the use and object of the fourth wire when used in connection with the distribution of three-phase current.—F. E. H.

478. With a condenser to be capable of dealing with 12,000lb. of steam per hour, with cooling water at 60deg. F. to 75deg. F., and to sustain a vacuum of 26in., what is the best method of arriving at the diameter, stroke, and bucket speed of both single-acting and double-acting vertical air-pumps, also speed of water through the foot and head valves for single-acting bucket pump (Fig. 1)? Also speed of water through suction and delivery valves for double-acting piston pump (Fig. 2)? Also capacity of jet condenser and cooling surface required for surface condenser?—VACUUM.

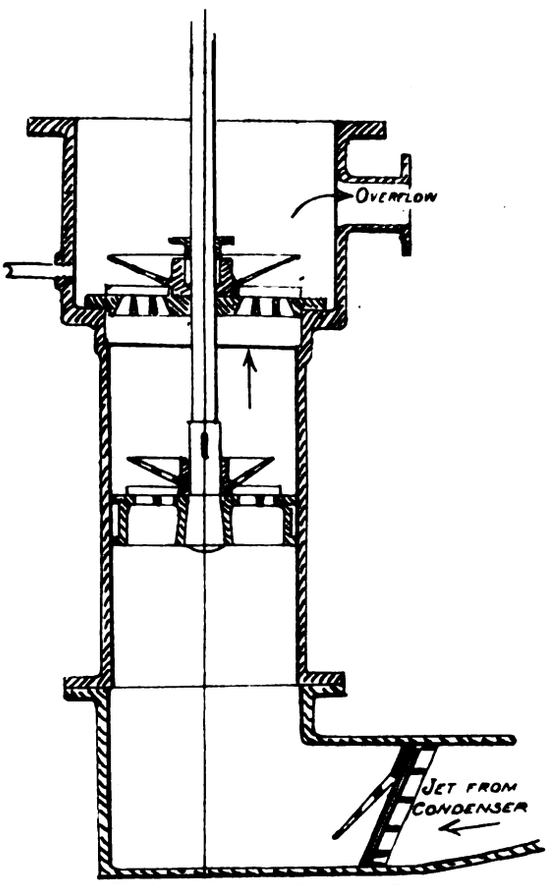

FIG. 1.—Single-Acting Vertical Air Pump.

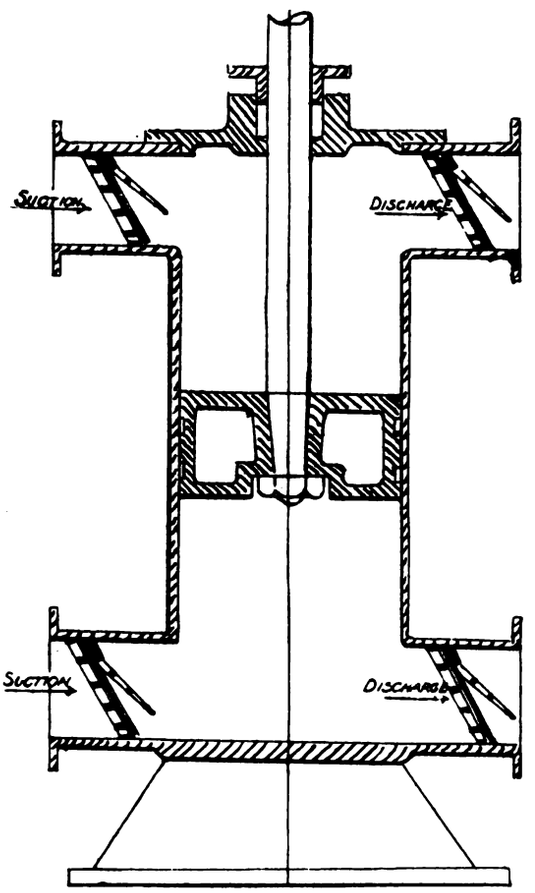

FIG. 2.—Double-Acting Vertical Air Pump.

ANSWERS.

Question No. 471.—Describe the construction of and method of using a photometer for giving mean horizontal candle-power of incandescent lamps?

Best Answer to No. 471 (*awarded* 10*s.*).

I. *Construction and Use of Apparatus.*—The apparatus used for finding the mean horizontal candle-power of incandescent lamps, described herewith, is at once simple in construction and working, and accurate in results. Fig. 1 shows the general arrangement of the whole apparatus. The inside of the wooden box in which the photometer is used is painted a dead black to avoid any reflection errors. A is the lamp to be tested, the holder of which can be revolved on its vertical axis. B is a standard candle. By means of a spring in its holder the flame is always kept in one position—a similar arrangement to that used in carriage and cycle lamps. C is the photometer, consisting of two slabs of wax of equal thickness placed side by side, and separated by a piece of black paper or tinfoil. One slab faces the lamp under test, and the other the standard candle. The slabs are mounted together on a carrier which can be slided along the scale, D (Fig. 2). The observer looks at these slabs end on. He slides the photometer along the scale until he sees the slabs equally illuminated. They are then receiving equal quantities of light from both lamp and candle. From the scale, D, he reads the distances of the carrier from both lamp and candle.

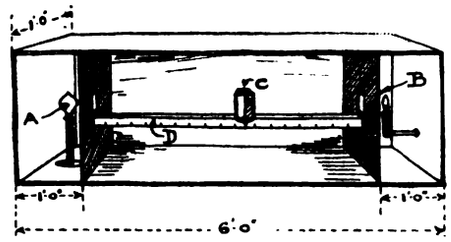

FIG. 1.

If D_1 = distance of carrier from lamp;
„ D_2 = „ „ „ candle;

then $$\frac{D_1^2}{D_2^2} = \text{candle-power of lamp}$$

II. *Method of Carrying out the Test* (Fig. 3).—(1) The test should be carried out in a dark or dimly-lighted room, arrangements being made to illuminate the voltmeter and ammeter without interfering with the rest of the apparatus. The compartments containing the lamp and candle are closed up so that the light only shines through the slits (Fig. 1) and illuminates the photometer. It is better to cover the front of the long compartment containing the scale and photometer with a black cloth. The operator when adjusting the photometer, of course, gets behind this cloth (*à la* camera man). (2) The candle being lighted, readings should not be taken until the hollow cup of

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melted wax in the base of the wick is well formed. (The candle is then burning 120 grains of spermaceti per hour.) (3) The voltage should be kept constant throughout the test. The photometer is adjusted until both slabs are

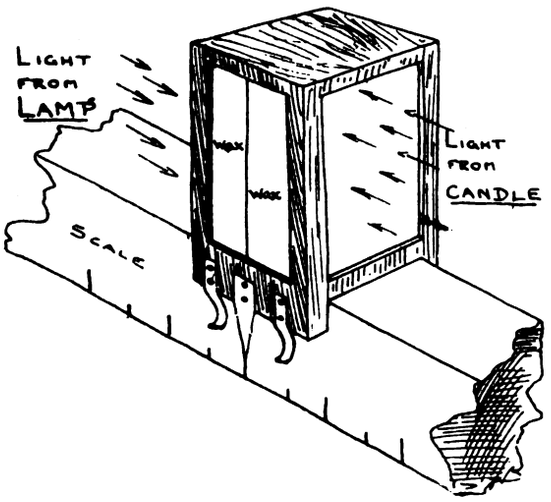

FIG. 2.—Sketch of Photometer, showing Carrier and Slabs of Wax.

equally illuminated, at the same time voltmeter and ammeter readings should be taken by an assistant. The distances of the carrier from the lamp (D_1) and the candle (D_2) are read off from the scale. (4) Keeping the voltage constant, the experiment must be repeated for a number of angular positions of the filament when the lamp is turned

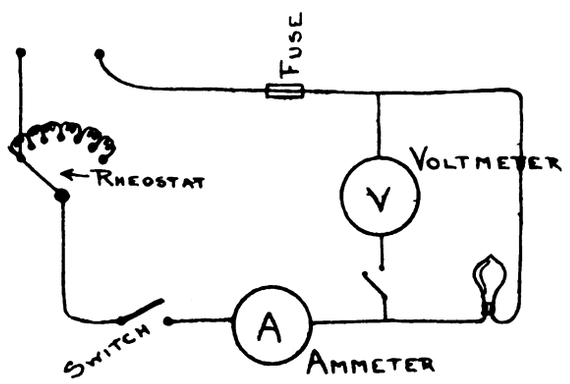

FIG. 3.—Diagram of Connections.

on its vertical axis from 0deg. to 90deg. (5) To obtain the mean horizontal candle-power of the lamp tabulate as below, and find the mean of column 4 :

1	2	3	4
Angle of filament.	Distance of lamp from carrier. D_1.	Distance of candle from carrier. D_2.	Candle-power. C.P. $= \frac{D_1^2}{D_2^2}$.
0deg.			
15deg.			
30deg.			
etc.			

(6) Knowing the amperes and volts, which are constant throughout the test, the efficiency of the lamp—*i.e.*, the watts per candle—is $\frac{V \times A}{\text{mean candle-power}}$.

3. *Conclusion.*—For incandescent lamps of high candle-power such as the Sunbeam and Nernst, a concave lens whose focal length is known must be placed between the lamp and the photometer. The formula for obtaining the candle-power is as follows :

f = focal length of lens ;
c = distance of standard candle from the photometer ;
l = distance of lens from photometer ;
e = distance of lamp from photometer.

$$\text{Candle-power} = \left(\frac{l\ (e-l)+f\ e}{c\ f}\right)^2.$$

—R. W. G.

Answer to No. 471 (*awarded* 7*s.* 6*d.*).—The intensity of illumination from any source of light varies as the square of the distance from it. This is proved at once from the following consideration. Suppose we have a luminous point giving out light equally in all directions. Then the light intensity per square centimetre of any point on an imaginary sphere with the point as centre will be the same. Now the surface of a sphere $= \pi$ (diam.)^2. Therefore, as the light is divided up equally over the whole surface its intensity for successive spheres must vary as $\frac{1}{(\text{diam.})^2}$. In practice we can only apply this rule if we are comparing the light intensity of two or more points

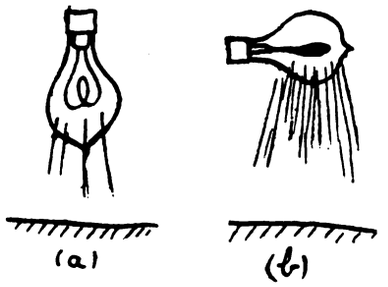

FIG. 1.

which can be joined by a straight radial line from the source of light, since the rays of light given out in one direction very often are much more powerful than those given out in another. Thus suppose we wish to light up a table from an incandescent lamp immediately above it, we shall get the best illumination if we place the lamp so that the "plane" of the filament is horizontal as in Fig. 1 (*b*). I have found cases where the light given from a lamp in this position was twice as powerful as when held in its ordinary vertical position. This is evidently due to the fact that we have turned the lamp into such a position that the maximum area of filament is

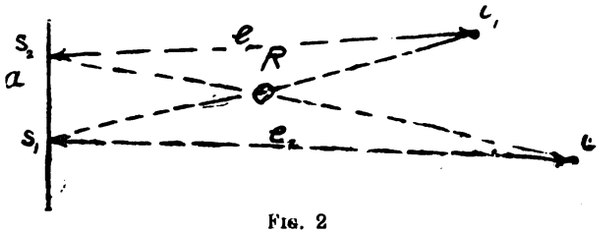

FIG. 2

facing the spot we wish to illuminate. The candle-power of the rays which are striking the table in (*b*) we might call the horizontal candle-power of the lamp.

The earliest form of photometer used was Count Rumford's. This is a very simple and reliable instrument. This is known as the "shadow" method. R is an opaque rod ; A is a *white* opaque screen ; i_1 and i_2 are the sources of light which we wish to compare. Now from both i_1 and i_2 there will be a few rays which are stopped by the rod R, so that we have the spot, S_2, is illuminated only by i_1 and S_1 by i_2. We then shift about i_1 or i_2 until the illumination of the spots is, as near as we can judge, the same. We then have

$$\frac{\text{Intensity or candle-power of } i_1}{\text{Intensity or candle-power of } i_2} = \frac{l_1^2}{l_2^2}. \quad . \quad (1)$$

The next photometer in order of invention is Bunsen's grease spot. This is shown in Fig. 3. B is a long narrow

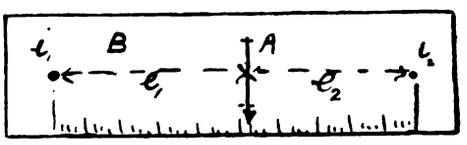

FIG. 3.

bench ; i_1 and i_2 are the sources of light which we wish to compare—*i.e.*, our "standard" candle on an incandescent lamp. Between i_1 and i_2 we have a graduated scale. A is a white opaque screen with a semi-transparent grease spot

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in the centre, and it can be moved to or fro along the board, so that the grease spot is always passed through by the line joining i_1 i_2. If the light intensity on the one of A caused by i_1 is stronger than the light intensity on the other side due to i_2, then part of the light will pass through the grease spot, and we shall see it lit up from either side as we look at it. If, however, the light intensities are equal, no light will pass through, and the grease spot will appear just like the rest of the screen. We therefore shift A about till this happens, and then read off l_1 and l_2, then substitute them in equation (1).

The next modification to come along was Joby's paraffin wax blocks. Here we have the same arrangement as in Fig. 3, only that the screen, A, is quite opaque. It has, however, a block of paraffin wax fastened on each side instead of the grease spot. The screen is then adjusted till the paraffin blocks, when looked into edge-wise—*i.e.*, at right angles to the i_1 i_2 line—are seen to be equally illuminated.

The best photometer is undoubtedly that of Lummer-Brodhum. The great advantage of this type is that the two light intensities which we wish to compare appear on the same spot as concentric circles of light, so enabling us to compare them exactly. The rays of light are first reflected from the screen, A (which is perfectly opaque), on to the mirrors, CC, and from there on to the glass rectangular prisms, P_1 and P_2. A perspective view of these prisms is

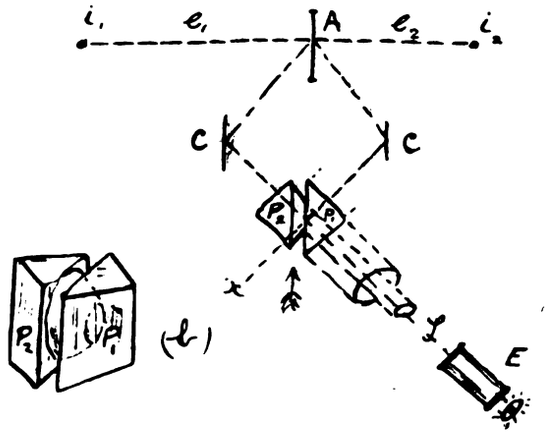


FIG. 4

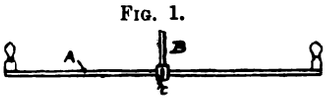
given in Fig. 4 (*b*), looking in the direction of the arrow. They consist of two rectangular prisms placed back-to-back, joined together by a piece of glass shaped like a frustrum of a cone. The light from i_1 falling on P_2 is all reflected in the direction x, except some rays in the centre, which pass through the top of the frustrum, and so are not reflected, but pass straight on in the direction y to the eye-piece, E, thus forming the inner circle of light. The rays from i_2, on the other hand, are all reflected in the direction y, except those in the centre, which pass through the circular contact made by the top of the frustrum of the cone and P_1, and so straight on in the direction x, so that all the rays in the inner circle come from i_1 and all the rays in the outer concentric ring from i_2. We therefore adjust A until the light intensity is the same in each; read off l_1 and l_2 and proceed as before.—T. SQUARE.

Answer to No. 471 (*awarded* 5*s.*).—Comparison of the candle-power of incandescent lamps does not require any elaborate form of apparatus. A very simple arrangement for comparative tests of lamps is shown in Diagram I. A is a scale about 4ft. long divided into equal parts, a centimetre scale being ordinarily used. B is a Bunsen's photometer, which consists of a square wooden frame across which is stretched a sheet of white paper having a grease spot in the centre. This frame is fixed vertically to the block, C, which is free to slide along the scale, there being a slot cut in this block through which its position on the scale can be read. At one end of the scale is mounted the standard lamp, say 16 c.p., and at the other the lamp which is to be tested. Regulating resistances are placed in series with both lamps, the supply being drawn preferably from accumulators, as giving a steadier pressure than is obtainable from a machine circuit. Wattmeters should also be inserted to determine the efficiency of the lamps. The voltage on the lamps is brought exactly the same by means of the regulating resistances and a voltmeter with a two-way switch. The photometer is then moved along the scale until the point is found where, viewing the grease spot from either side, it is practically invisible, for should the light on one side be the stronger, looking from that side the spot will appear dark while from the other it look quite bright. Having thus balanced the lamps, the distances from the lamps to the photometer are measured. Let the distance from the standard lamp to the photometer be x, and from the experimental lamp, y. Then the candle-powers of the lamps are in direct proportion to the squares of these distances, and c being the unknown candle-power, we have

$$16 : c :: x_2 : y_2.$$

It is usual to place the lamps so that the axis through the filament coil is parallel to the scale, the filament being at right angles to it. This exposes the greatest luminosity of the lamps to the photometer. It is interesting to study the variation when tilting the experimental lamp at various angles. The lamp can be readily mounted on a spindle between between pivots, as in Diagram 2, and if backed by a segment of a circle divided up into angles, say of 15deg., with a pointer fixed to the spindle on which the lamp turns, it can be set to any angle desired. As much as 30 per cent. decrease in candle-power is noticeable when the axis through the centre of filament coil stands at right angles to the scale. This applies to lamps with clear globes, for in the case of reflector lamps this latter position is obviously the one giving the highest candle-power.

FIG. 1.



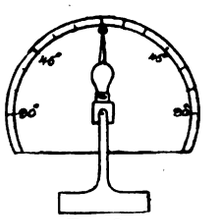


FIG. 2.

FIG. 3.

Another form of photometer is shown in plan in Diagram 3. It consists of a square woooden box, with sides only, which are painted a dull black. Fixed vertically in this box are two sheets of white cardboard, with a hole in one piece at *h*, set at such an angle that, looking through the sighthole, *s*, both pieces are seen, the lower one through the hole *h*. The light from the lamps is allowed to shine on the cardboard slips from either side, and by careful manipulation a good comparison may be made by adjusting the position of the photometer so that the light reflected from both pieces of cardboard is the same—*i.e.*, the hole becomes practically invisible. All experiments in connection with photometry must be conducted in a darkened room.—G. L. J.

NEW COMPANIES REGISTERED.

General Motorcar Company, Limited.—Capital, £1,000. Objects: to carry on the business of manufacturers of and dealers in motorcars, automobiles, cycles, vehicles, locomotives, and rolling-stock, electricians, suppliers of electricity, electrical and mechanical engineers, etc.

Rosario Electric Company, Limited.—Capital, £120,000. Objects: to carry on the business in the Argentine Republic or elsewhere the business of producers and suppliers of electricity; as electricians and electrical engineers; to construct and maintain rail and tram roads, telegraph and telephone systems, etc.

Haskew, Walton, and Co., Limited.—Capital, £10,000. Objects: to acquire from Messrs. Haskew and Walton and Ash certain patents relating to the manufacture of welded tubes, breaking-down rolls, and furnace machinery, and generally to carry on business as electrical and mechanical engineers, etc.

Electric Carriage and Storage Company, Limited.—Capital, £100. The primary objects are sufficiently indicated by the title.

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LEGAL INTELLIGENCE.

CAPE TOWN TRAMWAYS AND TELEGRAPH DISTURBANCES.

On the 21st ult. the Judicial Committee of the Privy Council (consisting of Lords Macnaghten, Davey, Robertson, and Lindley, Sir Ford North and Sir Andrew Scoble) gave their reserved judgment in the case of the Eastern and South African Telegraph Company *v.* the Cape Town Tramway Companies on the appeal of the Telegraph Company from a judgment of the Supreme Court of the Cape of Good Hope.

Lord Robertson, in delivering the judgment of the committee, said the question raised by the appeal was whether the respondents were liable in damages for certain disturbances in the working of the appellants' submarine telegraph cable at Cape Town. That such disturbances did take place, that they were caused by electricity which had been stored by the respondents and used in propelling their tramcars in Cape Town and its suburbs, but from time to time had left the tramway system and found its way to the appellants' cable in the sea near Cape Town, and that pecuniary losses resulted, were matters beyond dispute. In order to complete the description of the nature of the injury it was necessary to add that the difficulty had now been completely got over by laying a twin-core cable for several miles out, the two wires rectifying one another's action. Now that that had been done, the electricity from the tramways could pass along the sheathing without any harm being done. The cost of that remedial measure formed a large part of the claim in the suit, much of the rest representing experimental and tentative measures. His lordship then went on to consider the points raised by either side, and for reasons which he gave held that so far as the respondents' liability was governed by common law, the appellants' claim was not maintainable. He next considered the liability of the respondents for the escape of electricity on those sections of their line which had been constructed under statutes. The company under those statutes had right to maintain and work all necessary power stations, subject to the approval and in accordance with any resolution or standing order of the Council of the city of Cape Town, "provided that . . . the company specially undertakes that, in the event of any electric leak taking place and damage being thereby caused at any time by electrolysis or otherwise, it will reimburse and make good to the Council or other body or person all costs, damages, and expenses to which the Council or other body or person may be put by reason thereof; and provided further that nothing in this Act contained shall entitle the company to use the rails of any of the said lines of tramway as a part of its system of conductors for the return electrical current without the consent of the Council first had and obtained." The consent of the Council to the use of the rails for the return current, continued his lordship, was obtained under certain conditions, one of which was that "if at any time and at any place a test be made by connecting a galvanometer or other current indicator to the insulated return and to any pipes in the vicinity, it shall always be possible to reverse the direction of any current indicated by interposing a battery of three Leclanché cells connected in series if the direction of the current is from the return to the pipe and by interposing one Leclanché cell if the direction of the current is from the pipe to the return. If at any time a greater leakage is discovered than would render it possible for the current to be reversed in the manner above indicated, the same shall be localised and removed as soon as practicable, and the running of the cars shall be stopped unless the leak is so localised and removed within 24 hours." The first question, then, was, was it a leak, either in the sense of the statutory undertaking or of that condition, that sent out that electricity which reached the cable? For, if so, the stipulated liability had been incurred. Their lordships were unable to think that it was. The language both of the statutory undertaking and of the condition seemed to point to some defect in apparatus, not contemplated as a condition of the working of the system. But the departure of the electricity from the rails arose from no defect, but from the necessary condition of things if the tramcars were to run and the rails to be used as a return. The evidence showed clearly that, if uninsulated (as was the case here), the rails of necessity conducted home to the central station only some of the electricity, the rest leaving the rails and going afield. Giving to the work "leak" whatever expression might be appropriate to its extension to electricity, their lordships did not consider the event which had occurred to fall within the undertaking and condition. The escape was, on the contrary, a natural incident of the operations legalised under the statutes. The argument of the respondents on the words "or otherwise," as limited by the preceding word "electrolysis," did not command their lordships' assent, but it was superseded by the other grounds of judgment. Their lordships would humbly advise his Majesty that the appeal ought to be dismissed, and the judgment of the Supreme Court affirmed. The appellants would pay the costs of the appeal.

SALE OF A PROVISIONAL ORDER.

In the King's Bench Division of the High Court on Wednesday, before Mr. Justice Bingham, an action was brought by the British and Foreign Light Railway Syndicate, Limited, and the Ormskirk and Southport Light Railways Company against the Electric Tramways Construction and Maintenance Company, Limited, to recover £3,500 alleged to be due under an agreement dated Jan. 30, 1902, by which defendants agreed to purchase from plaintiffs a provisional order for the construction of a light railway between Ormskirk and Southport. The terms agreed upon were £1,000 cash down, £2,500 in one month, and the balance in three months. Defendants did not pay, however, and, it was alleged, refused to carry out the contract.

Defendants now said there was no concluded bargain, and it was for the Court to say whether there was or not. The issue rested chiefly on the documents and correspondence between the parties.

His Lordship held there was an agreement between the parties, and gave judgment for the plaintiffs for the amount claimed, with costs.

A stay of execution was granted pending an appeal.

BRITISH MOTOR TRACTION COMPANY.

In the Chancery Division of the High Court on Tuesday, before Mr. Justice Buckley, a petition was presented by Charles Treswell for the compulsory winding up of this company. Counsel for the petitioner stated that the company desired time to answer certain affidavits. His Lordship ordered the petition to stand over for a week, giving liberty to amend.

A DISPUTED AGREEMENT.

In the Lambeth County Court on Tuesday, his Honour Judge Emden resumed the hearing of the case (reported in our last issue) in which the plaintiffs, the South London Electric Supply Corporation, sued William Bell, a fishmonger of Herne Hill, to recover the sum of £1. 3s. 4d. for electric light supplied from August to December last. It will be remembered that the defence alleged that the contract was bad, inasmuch as a clause had been inserted in it since it was signed, to the effect that it was to run three years. The plaintiffs now called several witnesses, including the printer of the document, to prove that the clause relating to the three years was printed in every contract before it was sent out. The defendant's daughter was called, and said she was present when the contract was brought to her father to sign and she read it carefully through, but did not see any clause binding them to take the electric light for three years.

In giving judgment, **His Honour** said this was a case of very considerable importance as between electric light companies and their customers. He did not think he was called upon to say whether or not a three years' clause was contained in the agreement at the time when it was signed, inasmuch as at that time the defendant had nothing like a three years' tenancy of his premises to run; therefore the agreement must fall on that point. With regard to the clause in dispute, he noticed that it was printed in very much smaller type than the rest of the document, although in point of fact it was the most important clause in the agreement, and might very easily not be noticed. He also thought that when agreements of this kind were entered into the electric light companies ought to supply their customers with a copy, so that they could clearly see what their liability was. In this case he should hold that inasmuch as the agreement provided for the supply of light for a not less period than three years, and that the defendant's tenancy would expire long before that period had elapsed, the agreement was bad, and therefore judgment must be for the defendant with costs.

GLASGOW TRAMWAYS.

The Speed Question Again.

At Glasgow on Monday before Sheriff Fyfe, Mr. T. Simpson, a coal-master, of Pollokshields, again prosecuted the Glasgow Corporation for running electric cars at excessive speed. The complainer alleged that on Feb. 17 and 18 12 cars going east and 12 cars going west along Albert-road, Pollokshields, were run in excess of the speed allowed by the Board of Trade regulations. At the outset, objections to the relevancy of the complaint were taken by Mr. Campbell on behalf of the Corporation. Without hearing Mr. Lamond for the complainer, his Lordship repelled the objections, and the case was adjourned for trial until May 28.

POST OFFICE AND STREET OBSTRUCTION.

At the City Summons Court on Tuesday two adjourned summonses against the Post Office for obstructing Fleet-street when the telephone mains were being laid under that thoroughfare were disposed of.

Chief Inspector Palmer said that these were the cases in which the Post Office solicitor set up a statutory right to have trucks, tents, or other obstructions in the streets under the Post Office Telephones Act.

Mr. Menckton (the clerk): He practically contended that under that Act they could do as they liked?

Inspector Palmer said that was so, but since the cases were adjourned the solicitor had given way, and there was a promise that in future the workmen should obey the police. In those circumstances the police wished to withdraw these summonses in the hope that the promise would be kept.

The summonses were withdrawn.

COMPANIES' MEETINGS AND REPORTS

BLACKHEATH AND GREENWICH DISTRICT ELECTRIC LIGHT.

Sir John A. Willox, M.P., presided over the ordinary general meeting of the shareholders in this Company on Tuesday at the Cannon-street Hotel, E.C.

The **Chairman**, in submitting the report of the directors for approval, remarked that the business continued to show steady

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progress. During the period under review both consumers and lamps had been more than doubled, the figures being 746 and 29,449 respectively. Since Jan. 1 last 104 new applications had been received and accepted for 4,100 8-c.p. lamps, a number far in excess of that for the corresponding period of last year. Several large installations were now being negotiated, and all the signs were of a hopeful character. The financial results also exhibited a distinct improvement. In the first year there was a small balance of £73 to credit, but this result was helped by the penalties recovered from the contractors from delay in completing the generating station. Without any such outside aid the revenue account now showed a credit balance of £2,150. During the first quarter of the present year the receipts from current amounted to £3,680, as compared with £1,880 in the same quarter of 1901. A gratifying feature of the business was the increase in the supply of energy for manufacturing purposes. A small change had taken place in the area of supply, consequent on a fairly satisfactory arrangement having been made for the sale of the Eltham area, over which the Company had obtained powers of supply, to the Woolwich Corporation, who had paid them for the whole of the expenditure which had been incurred on mains, etc., and had given them a sum of £3,500 as compensation for disturbance. The profit on the trading and the sum obtained from the Corporation had enabled the Company to cover the whole interest on the debenture stock and to close the year with a credit balance of £1,700. The directors might have applied this balance in part to depreciation, but as the Company's generating station had been at work less than two years this did not seem to be an urgent necessity. On full consideration they had deemed it judicious not to appropriate the money at all, but to keep it in hand. There was good reason to hope that the next balance-sheet would show a favourable result, and the position would be further improved by the substantial amount now carried forward.

Mr. H. W. Bowden seconded the motion, which was carried.

BRITISH COLUMBIA ELECTRIC RAILWAY.

An extraordinary meeting of this Company was held at the Cannon-street Hotel on the 24th ult., Mr. R. M. Horne-Payne presiding. The object of the meeting was to consider the following resolutions: (1) for generally approving the recommendations contained in the chairman's report, dated February last; (2) for authorising the directors to create and issue, in addition to the existing £250,000 of 4½ per cent. first mortgage debentures, further debentures to the nominal amount of £220,000; and (3) for making certain alterations in the articles of association.

The **Chairman** stated that by far the most important of the recommendations in his report was that which dealt with the installation of the water power at Coquitlam Lake for the purpose of generating electricity for the work of the Vancouver and New Westminster divisions. On receiving the proposals of the general manager, the engineers, and his (the chairman's) report, the directors decided to select two electrical engineers to make separate investigations and reports on them. Their reports, plans, and estimates were on the table, and they emphatically endorsed the views of the Company's engineer and consulting engineer, and recommended the Coquitlam and Troutlakes plans, not only as feasible, but as offering no important engineering difficulties, and as particularly favourable for the future electrical working of the enterprise. The result was that the recommendation of Messrs. Hunt, Meredith, Cory, and Allen was adopted. In the matter of cost the engineers all worked out at about the same figures, but in consequence of the fresh information now obtainable he was constrained to add to the future additional net earnings to be obtained by the Company from the water-power plant. The estimate in his report was £20,000 a year; he could not now work the amount out at less than £25,000. They would have 6,000 available electric horse-power instead of, as at present, 3,000. The earning capacity of this additional horse-power was not less than 100,000dol., and it would probably prove to be nearer 200,000dol., but taking it at 100,000dol. they would have 125,530dol. of increased net profit per annum. With respect to this year's ordinary dividend, the position was anomalous; the business had increased so much that the money had had to be used for working capital to carry on the business. The moment, however, that the resolutions before the meeting became effective the directors would invite the shareholders to subscribe £40,000 of new 5 per cent. cumulative perpetual preference stock, and as soon as the money was received they would pay the dividend, which would require £8,000. They also proposed to offer £20,000 of the new stock to the debenture holders.

The three resolutions set out above were then adopted unanimously.

BAKER STREET AND WATERLOO RAILWAY.

Mr. Theodore J. Hare presided over the half-yearly meeting of the shareholders in this Company at the Westminster Palace Hotel on the 24th ult., and in moving the adoption of the report (*vide* last issue) said that at the present time there were upwards of 1,300 shareholders on the register. The sum of £54,142 only had been spent on capital account during the half-year, as, pending the completion of the negotiations for the transfer of the contracts, the directors did not consider it prudent to expend more money than was absolutely necessary. The difficult work of driving the tunnels through the water-bearing strata under the river was now successfully completed, one tunnel having been carried as far as Waterloo Station and the other to a point in the London clay not far short of that station. It was now possible to descend at Waterloo Station and travel by contractor's train to Oxford-circus and come to the surface there. Useful work has also been done during the half-year at Waterloo and Oxford-circus Stations. On March 7 last an agreement was sealed with the Metropolitan District Electric Traction Company to carry on the construction of the works, the contract sum to be paid in cash to the extent of the Company's cash assets, and the balance in shares and debenture stock. The Electric Traction Company had now been absorbed by the Underground Electric Railways Company, and the chairman proceeded to give particulars of the amalgamation. He went on to say that the following works had now been restarted: the driving of the western tunnel on the south of the river was being pushed on in the direction of Waterloo, and the eastern running tunnel was being continued from Waterloo southwards. The Regent-street western tunnel, which had been stopped near Vigo-street, was being continued in a northerly direction. The driving of the east station tunnel at Oxford-circus would be commenced immediately the shield, which was now in course of erection, was finished, and this would be in a few days. Preparations were being made for starting the second station tunnel under the Embankment. It was at this station they would get an interchange with the District Railway. It was expected that the line, at any rate as between the Elephant and Castle and Baker-street, would be completed in two years' time. A further agreement had been entered into with the new contractors by which they took over the liability for payment of interest during construction, including arrears as from Dec. 1, 1900.

Sir Algernon West seconded the adoption of the report and accounts, which was agreed to.

ORIENTAL TELEPHONE AND ELECTRIC.

The ordinary general meeting of the above Company was held on Wednesday at the Cannon-street Hotel, Sir Auckland Colvin presiding.

The **Chairman**, in moving the adoption of the report, said the net profits on this occasion showed a very considerable increase over those of the preceding year, due to a great extent to the progress made in the electrical branch, which they had added to their telephone business some six years ago. With regard to the Company's telephone exchanges, they also had contributed their usual share to the prosperity of the undertaking, the difficulty being the finding of a sufficient space on the existing constructions to accommodate the ever-increasing number of subscribers. This difficulty has been complicated in many places by the introduction of electric lighting and of electric tramways, whose current has adversely affected the efficient working of our telephones. The prospect of further introductions of both electric lighting and electric tramways in places which have been, so far, without either, compelled them to initiate steps to effectively meet the whole question. They, therefore, in the autumn of 1900, commissioned our colleague, Mr. Grëwing, jun., to proceed to the East to personally enquire into the actual condition of their different exchanges, and to suggest a reliable and permanent remedy. This remedy, it appeared, could only be found in duplicating their wires and in consolidating them into cables, either overhead or underground, wherever practicable. In deliberating on this question two further very serious questions presented themselves—viz., the cost of the suggested improvements and the life of their present licenses in India, the latter of the two being the most important. They therefore requested Mr. Grëwing, being in India to proceed to Simla to open negotiations with the Government for the extension of the term of their present licenses. These negotiations led to a definite settlement with the Government of India, who examined their proposals in a fair and equitable spirit, and had now definitely approved them, with such modifications as were considered necessary by it, and accepted by the Board. Mr. Grëwing, jun., himself had proceeded to Egypt before the final conclusion of the negotiations in connection with the reconstructions in Cairo and Alexandria, but before leaving India he had laid the foundation of the subsequent settlement. Generally speaking, their exchanges were found to be in a commendable state of efficiency, having regard to the fact that few changes had been introduced in the methods of working them since they were originally organised. However, as already stated, changes had now become imperatively necessary, both on account of the overcrowded state of the wires and the appearance of the electric lighting and electric tramway companies. Given these improvements, the directors looked most hopefully into the future.

Mr. Henry Grewing seconded the motion.

After some discussion the resolution was unanimously agreed to.

Subsequently a special meeting was held, when an alteration in the articles of association was sanctioned by the shareholders.

INDO-EUROPEAN TELEGRAPH.

The ordinary general meeting of the shareholders in this Company was held at Old Broad-street on Wednesday, Mr. J. H. Tritton presiding.

The **Chairman**, in proposing the adoption of the report and accounts and the declaration of a dividend for the half-year ended December last of 18s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year, and a bonus of 20s. a share, said that those who attended the last meeting would remember that he expressed a strong wish on behalf of the Company that the reduction of the telegraphic rate to India should be brought about. In several quarters their Company was held to be the stumbling block, but that was by no means the case, the International Telegraph Convention providing that every interested administration should give its consent before an alteration in the rates could be made. The reduction, however, was brought into force this year, and it was unnecessary to impress upon the members the considerable decrease in revenue that might be expected owing to the reduction from 4s. to 2s. 6d. a word. The Indian Government had, however, agreed to share in the diminution to the extent of one-third of the loss that would have to

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be sustained. The rates for messages exchanged between this country and Australia had also been further reduced to 3s. per word. He had the pleasure to inform them that the managing director had just returned from Berlin, having concluded terms with the Imperial German Telegraph Department for the prolongation of the concession for 20 years from 1904. The document was signed, and only awaited the approval of the Imperial German Chancellor, which the directors expected to receive during the course of a week or so. As the shareholders were aware, the Russian and Persian concessions had been similarly renewed.

The motion was seconded and agreed to unanimously.

LEAMINGTON AND WARWICK ELECTRICAL.

Mr. H. Garcke presided over the ordinary meeting of the shareholders in this Company on the 24th ult. in London, and in moving the adoption of the report and accounts, explained that the majority of the shares were held by the British Electric Traction Company, and that company was fully informed of the position of this Company's affairs. The report and accounts were full and accurate, and required no explanation.

Mr. Purser seconded the motion, which was agreed to. A dividend of 6 per cent. on the ordinary shares was then declared.

Answering a shareholder, the **Chairman** said that since the last meeting the British Electric Traction Company had acquired a preponderating share in the Company, and under an agreement they would provide the capital for the electrification of the line.

MOTOR MANUFACTURING.

The report of the directors from May, 1900, to Oct. 31 last accounts for the delay in issuing the report and accounts partly through the prolonged negotiations with the directors of the Daimler Company, with a view of amalgamating the two companies. The amount of cash obtained when the Company was formed in 1900 was £37,300, and in round figures £36,920 was spent in paying off the old company's debts and purchasing new machinery, tools, etc. From May 30, 1900, to May 30, 1901, a loss of £7,411 was incurred, but from May 31 to Oct. 31 last the loss was £470, a very marked improvement. The Board are of opinion that it is absolutely essential that further capital should be raised. The shareholders' committee appointed to consider the subject, and your directors, after mature consideration, have arrived at the conclusion that the only satisfactory way of dealing with the position is to permanently place the Company on a thoroughly sound commercial basis by considerably reducing the present large capital of £300,000. It is, therefore, proposed to form a new company with a capital of £80,000, divided into 320,000 shares of 5s. each. The undertaking of the Company will be sold to the new company on the terms of the agreement which will be laid before the meeting. Every existing shareholder will be entitled to receive one 5s. share, credited with 3s. paid, in the new company for every share held in the present Company. The directors hope to be able to state at the meeting on the 1st prox. that an agreement has been made with responsible people who will undertake to accept an allotment of the residue of the shares (if any) in the new company to be offered to the existing shareholders and not taken up by them, and to pay the 2s. per share liability thereon. It is proposed that the first mortgage debt of £15,000 should be continued. The balance, less the expenses of reconstruction, will be available for increased working capital.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH.

The report of the directors for the half-year ended Dec. 31 last states that the gross receipts have amounted to £324,209, against £360,889 for the corresponding half-year of 1900. The working expenses, including £29,447 for maintenance of cables, absorb £120,294, against £104,640 for the coresponding period of 1900, leaving a balance of £203,915. From this is deducted £7,714 for income tax, £6,400 for interest on debenture stock, and £262 for donations to the London School of Tropical Medicine and Yangtse Flood Relief Fund, leaving as the net profit for the half-year £189,537. After adding £15,023 brought forward from the previous half-year, there is an available balance of £204,560. One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount on May 8, making, with the interim dividends paid for the first half-year, a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1901. The balance of £69,560 has been transferred to the general reserve fund. The standard revenue fixed by the Cape-Australian cable agreement for regulating the Australasian tariffs having been maintained during the past year, further reductions of rates were brought into force on Jan. 1 last for telegrams exchanged with South Australia, Western Australia, Tasmania, and New South Wales as follows: from 3s. 6d. to 3s. per word for ordinary telegrams; from 2s. 6d. to 2s. per word for Government telegrams; from 1s. 4d. to 1s. per word for Press telegrams. The last section—between Perth and Adelaide—of the Cape-Australian cable having been successfully laid, the whole line was opened for traffic on March 1 last. The Company's expenditure on account of this cable up to Dec. 31 last amounted to £1,102,442, of which £500,000 has been charged against capital, and the remainder—£602,442—taken from the general reserve fund. The directors decided to reduce the tariffs for telegrams exchanged with the Straits Settlements and Netherlands-India as follows, which took effect on the 1st prox.: for Straits Settlements, from 4s. 6d. to 3s. 6d. per word; for Java, from 5s. to 4s. per word; for Sumatra and other Netherlands-Indian islands, from 5s. 5d. to 4s. 5d. per word.

BRISBANE ELECTRIC TRAMWAYS INVESTMENT.

The report of the directors from Nov. 20, 1900, to Dec. 31 last states that the net amount in dividends received on the shares held by this Company, after deducting income tax, was for 1901 £42,430. To this has to be added the amount attributable to revenue in respect of the period from Nov. 20 to Dec. 31, 1900 (£2,821), and sundry receipts (£660), leaving a balance to credit of revenue account, £45,912. After deducting general charges in London and expenditure in Brisbane, including the insurance undertaken by this Company under its contract with the tramways company (£3,096), there remains a net balance available of £42,815. The debenture stock interest from dates of payment of instalments has absorbed £15,916, and an interim dividend calculated from the date of allotment has been paid on the preference shares amounting to £10,000. There thus remains a sum of £16,898, and the directors recommend that this be appropriated in the following manner: To payment of a balance dividend of 2s. 6d. per share on the preference shares, making up the full dividend at the rate of 5 per cent. per annum, carrying forward £7,523. The extensions which this Company undertook to construct on behalf of the tramways company are now either open to traffic or approaching completion, and the power station has recently been equipped with new additional electrical plant and boilers, thus placing the company in a position to deal with considerably increased traffic.

KIDDERMINSTER AND DISTRICT ELECTRIC LIGHTING AND TRACTION.

The directors' report for 1901 shows that the total capital expenditure to Dec. 31, 1901, on account of buildings and plant for electric supply amounted to £29,435. 3s. 4d. The gross receipts, including the amount receivable from the Kidderminster and Stourport Electric Tramway Company for dividend on the shares held by this Company amount to £5,181. 16s. 8d., which, added to £708. 3s. 3d. brought forward from last account, makes £5,889. 19s. 11d. After deducting the expenses (including interest on loans), amounting to £3,550. 12s. 5d., there remains a net profit of £2,339. 7s. 6d. The directors propose that this amount should be applied as follows—viz.: to dividend on cumulative preference shares for the year 1901, £1,500; to be placed to depreciation fund, £100; to dividend on the ordinary shares at the rate of 2 per cent. per annum, £613. 19s. 5d.; to be carried forward to next account, £125. 8s. 1d. The directors attach to the report a copy of the balance-sheet and profit and loss account of the Kidderminster and Stourport Electric Tramway Company, from which it appears that the net profits for the year in respect of the tramways amounted to £2,863. 11s. 8d., which, added to £128. 9s. 9d. brought forward from last account, makes a total sum available of £2,992. 1s. 5d. This amount has been applied as follows—viz., to dividend at the rate of 4 per cent. on £5,720 shares, £2,288; to depreciation and reserve fund, £500; to be carried forward to next account, £204. 1s. 5d. The number of private consumers now connected with the mains represent a demand equivalent to 7,628 lamps of 8 c.p., and this department of the business continues to make satisfactory progress. In the course of the year new generating machinery has been fixed at the power station which has increased the capacity of the plant by 600 kw., equal to 800 h.p.

WEST COAST OF AMERICA TELEGRAPH.

The directors' report for the year ended Dec. 31, 1901, states that the gross receipts amounted to £32,106, as against £30,888 in 1900, showing an increase of £1,218. The working expenses—£23,022—as compared with £23,046 for the previous year, show a decrease of £24. After providing £6,000 for the interest on the 4 per cent. debentures and £800 for the interest on the 4 per cent. income bonds, there remains a balance of £2,284, to which is added the sum of £588 brought forward from Dec. 31, 1900, making a total of £2,872. Of this amount £1,500 has been placed to a general reserve fund and £1,000 to a maintenance ships' reserve fund, leaving a balance of £372 to be carried forward.

SUBMARINE CABLES TRUST.

The report of the directors states that for the financial year to April 15, 1902, the revenue amounted to £24,615 and the expenses to £1,250, leaving a balance of £23,364, to which is added the sum of £44 brought forward, making an available balance of £23,408. After providing £19,725 to meet payment of the coupons, £3,611 has been transferred to the redemption fund, leaving a balance of £71 to be carried forward to the next account. In accordance with the terms of the trust deed, 31 certificates have been redeemed, since the last report, by purchase in the open market, costing £3,611, as above.

SWANSEA TRAMWAYS.

The report of the directors for the last half year shows gross receipts of £13,409, an increase of £1,040. The expenses (including debenture interest) were £9,428, an increase of £2,494. The directors propose applying £1,000 to the reduction of the Company's debt to the British Electric Traction Company, to pay preference dividends, and to bring the ordinary dividend up to 2½ per cent. for the year, while £181 is carried forward to the next account.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Edinburgh.—The Corporation invite tenders for annual supplies from May 15 for the electric supply department.

Alicante (Spain).—The Harbour Board require tenders for the supply of two movable cranes. Tenders by May 14.

Shanghai.—The last day for receiving tenders for the proposed municipal tramway and motor 'bus service is June 30.

Woolwich.—The Borough Council invite tenders for 10,000 pairs of arc lamp carbons and a 70-b.h.p. motor. Tenders by May 15.

Erith.—The Urban District Council invite offers from firms willing to take up free wiring in the district. Offers by May 5. Details in our advertisement columns.

Cleckheaton.—The Council invite tenders for the supply, delivery, and erection of continuous-current electric motors. Tenders by May 3. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of motor-driven boosters and relative switching apparatus. Tenders by May 5. Details in our advertisement columns.

Valparaiso.—The Municipality are inviting tenders for electric lighting and tramways. We understand that particulars may be obtained from the Chilian Consul. Tenders by Sept. 1.

Glasgow.—The Corporation invite tenders for the supply of electricity meters required for the year from June 1 to May 31, 1903. Tenders by May 3. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply, delivery, and erection complete of material for the extension of switchboard at Coplawhill sub-station. Tenders by May 7. Details in our advertisement columns.

Bedford.—The Electricity Committee invite tenders for the supply and delivery of economisers. Specification, etc., can be obtained from the Borough Electrical Engineer, Cauldwell-road, Bedford. Tenders by May 17.

Bury.—The Corporation invite tenders for supply, delivery, and laying in the borough of Bury (Lancs.) of tramway feeder and pilot cables, conduits, and accessories. Tenders by May 8. Details in our advertisement columns.

Christiania.—The Government Telegraph Department, Karl Johansgade 14, Christiania, require tenders for a number of insulators (9,000 No. 1, 42,100 No. 2), wire, etc. Particulars may be obtained and tenders addressed to the above by May 7.

Swansea.—The Public Library Committee invite tenders for the wiring and supplying of sundry fittings for an installation of electric light at the free library, art schools, and art gallery. Tenders by May 10. Details in our advertisement columns.

Oldham.—The Electricity Committee invite tenders for the supply, delivery, and erection, complete, of lighting and traction switchboards, with connections and instruments comprised in Specification No. 5. Tenders by May 6. Full details in our advertisement columns.

Dewsbury.—The Corporation invite tenders for the supply, delivery, and erection of a traction switchboard. Specification, etc., may be obtained upon application to Mr. R. H. Campion, borough electrical engineer, Bradford-road, Dewsbury. Tenders by May 12.

Sydney.—The Municipal Council invite tenders for supply and erection of plant and machinery required for the complete equipment of their proposed electricity supply stations and sub-stations. Particulars may be obtained from Messrs. Preece and Cardew, Westminster. Tenders by May 7 at noon.

Fulham.—The Establishment Committee invite tenders for the supply, delivery, and erection of one 600-kw. two-phase steam alternator, with Willans, Belliss, or Allen engine; or one 600-kw. two-phase Parsons turbo-alternator. Tenders by May 5. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of special (permanent way) track work, cross-over roads, and points and crossings. Specifications, etc., may be obtained on application to Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders by May 3.

Astrachan.—Erection of electric generating station and installation of public and private lighting, commencing with 150 arc and 6,000 incandescent lamps. Manufacturers who will undertake to finish the work within two years can obtain particulars from the Municipality. Agents will not be able to tender. Tenders by June 7-20.

West Ham.—The Council invite tenders for two steel chimneys, four fans and engine for induced draught, all brickwork in connection with the flues, and economisers. Specification, etc., may be obtained from the borough electrical engineer, Mr. James K. Bock, Abbey Mills, West Ham. Tenders by May 13. Details in our advertisement columns.

Aberdeen.—The Electric Lighting Committee invite tenders for the supply and erection of a 20-ton electrically-driven overhead crane, with the necessary supporting columns and girders, for their Dee Village electricity works. Specification, etc., may be obtained from Mr. J. Alex. Bell, city electrical engineer. Tenders by May 7. Details in our advertisement columns.

Grimsby.—The Corporation invite tenders for 10-ampere and six-ampere continuous-current arc lamps for working 10 in series on 460 volts, arc lamp-posts, stoneware pipes for conduits, and cables, etc., paper-covered distributors and service cables. Specification, etc., can be obtained from the Borough Electrical Engineer, Corporation Electricity Works, Grimsby. Tenders by May 5.

Swindon.—The Corporation invite tenders for the supply, delivery, and erection at the electricity works, Swindon (Wilts), of 252 accumulator cells and accessories. Specification, etc., may be seen at the offices of the engineers, Messrs. Lacey, Clirehugh and Sillar, 78, King-street, Manchester, and at 2, Queen Anne's-gate, Westminster. Tenders by May 19. Details in our advertisement columns.

Belfast.—The Great Northern Railway (Ireland) invite tenders for the supply of one Otto Crossley high-speed gas-engine of 41 effective horse-power working load complete; also for one four-pole dynamo, with regulating resistance in shunt winding, giving an output of 420 amperes at 65 volts, complete with slide rails, delivered and fixed on foundations put in by the company. Firms tendering to state the price they will allow for one 7½ b.h.p. maximum gas-engine, made by Messrs. Crossley Bros. in 1894, and which will not be required when the new gas-engine has been erected. Tenders to be delivered to Mr. T. Morrison, secretary, Amiens-street Terminus, Dublin, by 10 a.m. on May 12.

RESULTS OF TENDERS.

Llandudno.—The Urban District Council have received the tender of Mr. Edward Owen for the necessary repairs and extensions at the electric lighting station, at £1,442.

Plymouth.—The Corporation have received the following tenders for electrically wiring the destructor works: Heath and Co., Plymouth £67 (accepted); Lord and Shand, Plymouth, £70. 7s. 6d.

Keynsham.—The Parish Council have accepted a tender from the Keynsham Electric Lighting Syndicate to supply street-lighting for the ensuing year for the sum of £188. 10s., or with six additional lamps, at £202.

Dundee.—The Tramways Committee have accepted the tenders of Hurst, Nelson, and Co., Motherwell, for the bodies, and that of Dick, Kerr, and Co. for the equipment of the cars for the Constitution-road route.

Dartmouth.—The Town Council have decided to accept the tender of the Urban Electric Supply Company for lighting the town for 10 years by the electric light, at £390 per annum. Details will be found in another column.

Falkirk.—The Corporation have accepted the following tenders: (Contract No. 1), three 100-kw. steam dynamos—Mavor and Coulson, Glasgow, £2,480. 10s. (with Belliss engines), spare armature £148; (2) two dry-back marine-type boilers—G. Sinclair, Leith, £1,378; (3) economiser—Clay Cross Company, Clay Cross, £218.

Bristol.—The Electricity Department have received the following tenders for power cables: British Insulated Wire Company (accepted); Siemens Bros. and Co.; Telegraph Manufacturing Company; St. Helens Cable Company; Johnson and Phillips; W. T. Henley, Limited; Western Electric Company; W. T. Glover and Co.; Callender's Cable and Construction Company.

Kensington.—The Borough Council have received the following tenders for providing an installation of electric light at the public mortuary: A. Grundy, £28. 10s.; H. C. Poole, £19. 18s. 6d.; W. Seymour, £18; H. Nash, £17. 10s. (accepted). The Council have also accepted the tender of the Kensington and Knightsbridge Electric Lighting Company, Limited, for extending the electric light service from the town hall to the mortuary by means of an underground cable at £17. 17s., the company offering to bear half the cost of the work.

Southampton.—The Corporation have received the following tenders for the construction of tramways in St. Deny's-road:

Saunders and Saunders, Birmingham	£7,178	4	0
Coston and Co., Southampton	5,208	0	0
F. Osman, Southampton	5,160	7	1
Griffiths and Co., London	4,905	16	7
Wimpey and Co., London	4,841	0	0
F. Grace, Southampton	4,733	0	0
Douglas and Richards, Southampton (accepted)	4,666	0	0

Oban (Scotland).—The Corporation have accepted the following tenders for supply and erection of: (No. 4) steam, exhaust, drain, and other pipes, pumps, condensing plant, etc.; (5) balancing transformers and motor-generators; (6) storage batteries; (7) switchboard; (8) arc lamps, incandescent lamps, and fittings; (9) cable work; (11) travelling crane. Accepted tenders:—Babcock and Wilcox, Limited, Oriel House, Farringdon-street, London, E.C., steam-pipes; B. Thomas, Cornbrook Telegraph Works, Manchester, balancing transformers, etc.; British Power, Traction, and Lighting Company, Hull-road Works, York, storage batteries; B. Thomas, switchboard; Oliver and Co., Cambridge-place, Burrage-road, Woolwich, Kent, arc lamps, &c.; St. Helens Cable Company, Limited, Warrington, cable work; J. Carrick and Sons, Limited, Dalry Ironworks, Edinburgh, travelling crane.

Hull.—The Electric Lighting Committee have received the following tenders for pipework, pumps, motors, etc., and work required to be executed at Sculcoates-lane generating station:

Barker and Aspey, Cleveland-street, Hull	£3,816	0	0
Rose, Downs, and Thompson, Old Foundry, Hull	3,767	0	0
Sir Hiram Maxim Electric and Engineering Company, 65 and 66, Gracechurch-street, E.C.	3,676	0	0
Babcock and Wilcox, 30, Farringdon-street, E.C.	3,562	0	0
Crompton and Co., Salisbury House, London-wall, E.C.	3,516	0	0
Korting Bros., 53, Victoria-street, Westminster, S.W.	3,450	9	2
Aiton and Co., Hythe-road, Willesden Junction, N.W.	3,369	0	0
Thornton and Crebbin, Hammerton-street, Bradford (accepted)	3,312	0	0
J. Spencer, Limited, Wednesbury	3,207	0	0

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BUSINESS NOTES.

TRACTION.

Auckland (N.Z.).—A system of electric tramways on the conduit system is being laid down in the city.

Bray.—The Urban District Council have approved the proposals embodied in the tramways scheme for Bray.

Stockport.—Public notice has been made that the Board of Trade have granted the Corporation a tramways provisional order.

Heywood.—Notice is made that the Board of Trade have granted the Corporation a provisional order for the construction of electric tramways in the borough.

Maidstone.—The Town Council on Tuesday decided to apply for an order under the Light Railways Act to enable them to construct tramways in the borough.

Toulouse.—There are 39½ miles of tramways in this town, and a scheme is being prepared to transform 30 miles of the same into 4ft. 4½in. gauge electric lines.

Tanat Valley.—The Denbigh County Council have arranged to make a further loan of £1,500, making altogether £4,500, to the Tanat Valley Light Railway.

Ipswich.—The Ipswich Tramway Company, whose undertaking has been purchased by the Corporation for £17,552, held their winding-up meeting last week.

Wrexham.—The estimated outlay for providing additional generating plant at the Corporation power station in order to meet the anticipated tramway load is £6,572.

Bacup.—The Town Council have approved clauses recommended by the Tramways Committee for the protection of the Corporation in the Rossendale Tramways Tramway Bill.

Northampton.—On Monday the Town Council unanimously decided to replace the present system of horse trams by electric traction, at an estimated cost of £120,000.

Proposed Trolley Omnibus Line.—It is announced that an electric trolley omnibus line is to be constructed between Bunnen, Gersau, Vitznau, and Weggis, on the Lake of Lucerne.

Reading.—Work was commenced last week on the reconstruction of the tramways for electric traction. The buildings for the generating station in Hull-lane are also in progress of construction.

Doncaster.—In consequence of the objection of the County Council to the laying of the tramlines at the side of the roads, the Corporation have decided to construct the tracks in the centre of the roads.

West Bromwich.—The Corporation have adopted the recommendation of the Finance Committee to raise the estimated expenditure of £178,000 on the tramway conversion by the issue of 3 per cent. redeemable stock.

Islington.—The Borough Council have withdrawn their petition against the Great Northern Railway (No. 2) Bill, clauses having been agreed upon for the protection of the Council's interests as the sewer and road authority.

Shoeburyness.—An interview is being arranged between the representatives of the British Electric Traction Company and the Urban District Council with reference to the construction of a light railway through this district.

Ayr.—A *plébiscite* of the ratepayers was taken on Saturday on the question of whether or not the Corporation should continue to run the electric cars on the Sabbath. The result was a majority of 821 in favour of Sunday cars.

London United Tramways.—The London United Tramways Bill came before Lord Morley and the House of Lords Committee on Standing Orders on Friday, and certain sections of proposed lines being omitted the Bill was allowed to proceed.

Tyneside Tramways Bill.—After a short consideration of the proposals embodied in this Bill, the Select Committee of the House of Lords of which Lord Stanmore is chairman have passed the preamble, and the measure will be reported to the House in the usual way.

Wealdstone.—At the next meeting of the Council a resolution will be discussed to the effect that application be made to the Middlesex County Council to bring the electric trams along the route already arranged, and on the terms agreed to by the Wealdstone Council.

Preston.—The Corporation Bill has been ordered to be reported for third reading. The Bill contains proposals for the conversion of the present horse tramways to electric traction on the overhead trolley system at a cost of £170,222, with £23,320 for cars and car depôts.

Appointments.—Mr. J. W. Donnet, the superintendent of Pinkston power station, having been appointed resident engineer to the Trafford Power and Light Supply Syndicate, Trafford Park, Manchester, Mr. James L. Graham has been appointed to the vacant position at Glasgow.

Midhurst.—In response to a communication from the rural railway company, the Rural District Council have decided to give a general approval to a scheme for constructing a light railway from Ockley, *vid* Cranleigh, into the Midhurst district, such approval, however, being subject to an examination of the plans and sections.

Another Tube Combination.—The Islington and Euston Railway Bill was before Lord Morley's Committee on Friday, on a petition to insert a further provision proposing certain financial arrangements to allow of combination with the City and South London Company. The clauses were inserted and the Bill allowed to proceed.

Greenock.—For the week ended April 11 the receipts of the Greenock and Port Glasgow Tramways Company amounted to £454, showing an increase of £263 when compared with the corresponding week of last year. For the 14½ weeks of the present year the receipts aggregate £5,518, being an increase of £3,058 over last year.

Embankment Tramways.—The scheme of the London County Council for constructing a tramway along the Victoria-embankment has passed the House of Commons on second reading. The Court of Common Council at their last meeting decided to oppose the Bill at its committee stage as well as in the House of Lords if necessary.

Northumberland Tramways.—The Bill promoted by the Northern Counties Supply Company was before Lord Stanmore's Committee of the House of Lords on the 25th ult. on the opposition of the North-Eastern Railway Company. It was stated that this opposition had now been withdrawn, and the preamble was found proved.

Beckenham.—Owing to the antagonistic attitude of the Beckenham District Council, the British Electric Traction Company have had to abandon their tramway scheme so far as it affected Beckenham, and are now proceeding only with those lines which will be within the boundaries of the Croydon Corporation and of the Penge District Council.

Eccles.—The work of constructing the tramway from Weaste to Eccles Cross is being pushed forward with great rapidity, and it is fully expected that the electric cars will be running by Whit-week. When the lines are completed round the borough their total length will be over 5½ miles, of which 2 miles 5 furlongs will be double track and the remainder single.

Motor Tour Round the World.—Dr. Lehwess, the well-known traveller, on Tuesday started from Hyde Park-corner on a journey in a motorcar round the world. The vehicle, called the Passe-Partout, is a large caravan, containing comfortable sleeping accommodation for Dr. Lehwess and his three companions, and the motor itself is of 32 h.p. It is painted a bright yellow.

Italy.—The Government Railway Department have decided to instal an electric lighting plant at the Venice railway station at a cost of about £4,000. The electric tramways at Ternis are proposed to be be extended to Visso, and application is to be made to the Government for the construction of an electric railway from Mestre to Tezze *via* Bassano and Primolano, in the province of Venice.

Stoke-on-Trent.—The Parliamentary Committee and the promoters of the local Tramways Bill have been in negotiation, with the result that terms have now been arranged under which the Council will not oppose the measure in Parliament. The only matter that stands over is the question of the purchase of the generating station, and that is to be dealt with by a committee of the House of Commons.

Hampstead.—The Borough Council have referred to the General Purposes Committee a letter, enclosing copy of an amended clause for the protection of water, gas, and electric lighting, etc., undertakings in the Tube Railway Bills this session, and enquiring whether the Council approve of this insertion of the clause in the Charing Cross, Euston, and Hampstead Railway Bill in substitution for Section 58 of the Act of 1893.

Christchurch (N.Z.).—The City Council have received proposals from the British Electric Traction Company through their local agent, Mr. Hansen, for providing the city with an electric tramway system. We understand that two forms of proposal have been made: first, that the company shall provide the capital and work the lines when constructed; and secondly, that the capital shall be found by the city authorities themselves.

Lancaster.—The contractors have started the work of laying the lines for the new electric trams, the first length being from Dalton-square to Scotforth and Williamson Park. This will cost £25,000, and it is expected that it will be completed in time for the Morecambe season. In connection with the proposal to purchase the Lancaster-to-Morecambe trams, the Corporation have decided to ask the directors to name the selling price.

Southampton.—The Tramways Committee having considered a letter from Captain W. H. H. M. Gipps, of the 1st H.V.A., asking them to allow sailors wearing his Majesty's uniform to ride any distance in the tramcars for 1d., the same as soldiers in uniform, it has been agreed that the same privilege that applies to the army and to the police be extended to seamen and petty officers of the Royal navy and Royal navy reserve when in uniform.

Dover.—During the last 12 months the municipal electric trams have carried over 3,000,000 passengers without a single accident. After paying interest and instalment of loan capital, there remains a profit balance of £1,100. It is hoped that the scheme for an electric railway from London to Dover will be taken in hand in the next session of Parliament. After preliminary surveys of two routes, that *via* Chatham and Canterbury has been decided upon.

Bradford.—A practical test as to the efficiency of the lifeguards attached to the Corporation electric cars was witnessed on Wednesday. A boy ran in front of car No. 73, and before the driver had time to pull up he was knocked down. The guard acted promptly, and, picking the lad up, carried him some distance before the car was brought to a standstill. The boy was taken to the Royal Infirmary, where he was found to have escaped with a few scratches.

Rhondda.—The Urban District Council Tramways Bill, which has already passed through the House of Lords, on Tuesday came before Mr. Campion, one of the examiners of the House of Commons, for proof of compliance with the further Standing Orders. There was no opposition at this stage, and the necessary formal proofs having been given, the examiner decided that the further orders had been duly complied with. The Bill will accordingly in the usual course be reported to the House.

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Wolverhampton.—Colonel Yorke, R.E., visited Wolverhampton on Saturday, and made an official inspection of the new tramway route from the railway station drive to Coleman-street. This section of the line runs past the main entrance to the exhibition. The inspector, who was accompanied by a number of Corporation officials, made a thorough test of the line, and afterwards inspected the first section of the tramway in Cleveland-road and Bilston-road. The cars commenced running on Monday.

Calcutta.—The experiment of electric cars in Calcutta, says *Indian Engineering*, has proved a conspicuous and undeniable success, and it has become quite the fashion for the better classes to take the air at night in the first-class cars on the Kidderpore line. The second-class cars are as heavily patronised as usual by the working classes, who have taken to the new traction quite naturally. The extension of the system will undoubtedly mark a new era of prosperity for the Calcutta Tramways Company.

Cheltenham.—The Light Railway Commissioners have fixed Thursday, May 15, for the local enquiry as to whether Mr. Nevins, the promoter of the existing Cheltenham and district light railway, shall be allowed to extend his line to Charlton Kings and Leckhampton, about seven miles in length, mostly double line. Mr. Edward Dodd, of Dodd and Dodd, civil engineers, Birmingham, prepared the necessary parliamentary plans and estimates. He will give evidence at the enquiry in support of the extensions.

Gloucester.—It will be remembered that the Corporation recently decided to purchase the tramways, and equip them for electric traction. They accordingly applied to have the provisional order transferred. To this, however, the County Council offer strong opposition. In a supplementary report the committee of the Corporation appointed to deal with the matter express the opinion that the whole question should go before the Light Railway Commissioners, and with this view the Council are in complete agreement.

Bilston.—At the last meeting of the District Council the question was brought up of the differences between the British Electric Traction Company and the Wolverhampton Corporation with regard to the tramway between Stowheath-lane and Ettingshall-road. The opinion was that pressure should be brought to bear on the traction company to try and arrange for a settlement of the difference. The Chairman said if the present mode of communication with Wolverhampton continued, it would no doubt keep thousands of people from the exhibition.

Dundee.—A special meeting of the Tramway Committee of the Town Council was held. Owing to a technical objection taken by the directors of the tramway company to the procedure adopted by the Town Council in coming to the resolution to acquire the company's undertaking within the burgh, the Board of Trade have notified their inability to signify their approval of the notice as desired by the Council. It was explained at the meeting of the Tramways Committee this week that the objection was of a most technical nature, and the only possible effect it could have would be to delay the actual taking over for a period to enable the Council to take the necessary steps for bringing forward a new resolution.

District Railway Bill.—The committee of the House of Commons of which Mr. H. Hobhouse is the chairman concluded consideration of this Bill on Friday, amending the clauses in conformity with the decision on the preamble given on Wednesday (*vide* last issue). In the clause subjecting the street works to the approval of the Board of Trade, it was provided that consideration should be given to representations from the local road authority. A new clause was inserted exempting the proposed generating station from the provisions of the London Building Act, and declaring that the materials used in construction shall be of a description to secure stability and the minimum risk from fire. The Bill was ordered to be reported for third reading.

Scarborough Tramways Bill.—This Bill came before the Committee on Unopposed Bills of the House of Commons last week. Power is sought by the Bill to incorporate a tramways company, to empower the company to make and maintain tramways, and to empower the Corporation of Scarborough to provide golf links and recreation grounds in the borough. The Bill also seeks power to enable the Corporation to subscribe towards and hold shares in the capital of the tramway company, which is to be called the Scarborough Tramways Company. The capital of the company is to be £96,000, in 9,600 shares of £10 each. Provision is taken in the Bill to use electrical power. The cost of the golf links is estimated at £2,500. Formal evidence having been given, the preamble was declared proved, and the Bill ordered to be reported to the House in the usual way.

Newcastle.—A further extension of the tramway system has been made by the running of Westmorland-road cars to Jesmond-road *via* the Royal-arcade, thus utilising that part of the track in Pilgrim-street, over which there has been no traffic for several weeks past, as well as that part of Jesmond-road east of Osborne-road. The Jesmond-road terminus is, *pro tem.*, at the old cemetery gates, but before many days the route will be opened to the western end of the Armstrong Bridge. The Corporation Tramways Extension Bill is this week being enquired into by Lord Stanmore's Committee of the House of Lords. The estimate for the electrical equipment of the proposed lines is £113,200. The motormen and car conductors in the employ of the Corporation Tramways Committee are agitating for more favourable terms, and during the past week the situation has assumed rather disquieting proportions. Up to the present the Corporation have refused to receive the representatives of the men.

North Metropolitan Tramways Bill.—This Bill came before the Select Committee of the House of Commons of which Mr. H. Hobhouse is chairman on Wednesday. It is sought by the Bill to empower the company to work their lines between Wood Green and Finsbury Park and from Finsbury Park to Edmonton, in the county of Middlesex, by electricity. Mr. Wheeler, K.C., for the promoters, urged the committee not to impose any conditions on the company in respect to an all-night service. In reply to the chairman, he said that the question of working cars by electric power within the administrative county of London was one for the London County Council. The committee found the preamble proved, and the Chairman said: "We are not prepared to make any recommendation to the House in regard to times of car service. We feel sure that the company in their own interest will do all that is reasonable for the benefit of the district they serve, and that the London County Council will look after the requirements of the public."

Shallow Underground Tramways.—The House of Commons Committee over which Mr. H. Hobhouse presides having passed the preamble of the London County Council (Subways and Tramways) Bill, went through the clauses on Friday. Mr. R. Berkeley, on behalf of the Corporation of Westminster, submitted a series of clauses to give the Corporation certain rights over alterations of drains and sewers and street traffic during the construction of works within the borough. Mr. Wilkinson, on behalf of the London County Council, opposed these clauses, as being inconsistent with the statutory powers the Council already possessed over the whole of London in respect to sewers and street traffic. The clauses were rejected, and, other clauses being amended, the Bill was ordered to be reported to the House for third reading. A meeting of London Unionist Members of Parliament was held on Monday at the House of Commons for the purpose of taking steps to oppose the proposed shallow tramway between Holborn and the Embankment when it comes before the House.

Alexandra Park.—The *Islington Daily Gazette* says: "It could hardly be expected that so flagrant a perversion of the Alexandra Palace Act as that contained in Mr. Henry Burt's scheme to surrender a large portion of the park at Muswell Hill to a tramways company for light railways and an electric generating station would be allowed to proceed without expostulation. Consequently the trustees when they met on Friday were confronted with a lawyer's letter, in which they were threatened by owners and occupiers in the Muswell Hill district with an injunction should they persist in confirming the minutes sanctioning the scheme. At the same time another contributory Board, the Edmonton District Council, sent a letter protesting against the scheme as illegal, and saying that had they anticipated it they would not have contributed to the purchase of the palace and park. This is the fourth contributory authority that has protested, and Islington, as we know, has gone further in obtaining legal opinion, which bears out the position of the Muswell Hill residents that the proposed vandalism is *ultra vires*, and contrary to the Alexandra Palace Act. Mr. Burt and his friends, who are still defiant, accepted the challenge sent by Messrs. Edgar Robins and Clark, and thus where argument and persuasion have failed the law must now decide."

New Zealand.—The firm of Noyes Bros., as previously noted in these columns, are carrying out the electrification of the Dunedin City tramway system on terms which, it will be remembered, are exceedingly favourable to them. We understand from the *New Zealand Mining Journal* that, in addition to the Dunedin work, this firm are acting as consulting engineers to the Auckland City Council respecting the electric lighting of the city of Auckland, and the Auckland Harbour Board respecting electric power for the cranes on the wharves. Messrs. Noyes are the Australian representatives of the British and American Westinghouse Electric and Manufacturing Companies. They are also carrying out the work of installing the electric tramways in Adelaide, a system of over 66 miles in length and the contract amounting to over £700,000. Messrs. Noyes Bros. were also recently awarded the contract by the Queensland Government without competition to instal the plant for operating all the machine tools in the new railway workshops, Ipswich, Queensland. The plant consists of three 250-h.p. engines, and two-phase generators, switchboards, steam-piping, pumps, and all motors for driving the machines. We understand from the same source that the Wellington Council will soon have matters far enough advanced to enable the City Council to advertise their tramway proposal, as is required to be done under the Tramways Act.

Cardiff.—Mr. Harpur, the borough engineer, has submitted plans showing proposed extensions of the tramway system in the following directions: in Meteor-street, from Constellation-street, past the infirmary to join the tramway in Castle-road; in Moira-terrace, connecting the before-mentioned tramway with that running through Adamsdown; in Fitzalan-road, connecting Queen-street with the tramway to be laid through Moira-place to Splott; an extension in Cowbridge-road as far as Victoria Park; an extension in Ninian-road to Roath Park Lake; an extension in Cathedral-road to Llandaff Fields; and an extension of the Castle-road section over the Rhymney railway bridge and up Crwys-road as far as the barracks. The Board of Trade certificate authorising the Corporation to run electric cars in the completed portions of the tramway system was expected to be received in Cardiff yesterday (Thursday). At the last meeting of the Tramways Committee Mr. Ellis, the electrical engineer, urged the necessity of increasing the number of electric cars. There were 54 at present under order, but that number would not be anything like sufficient, and he suggested that a further 20 be ordered. Eventually it was decided to write to Messrs. Dick, Kerr, and Co. asking them in what time they would be able to supply 20 more four-wheeled and 20 double-decked cars, and pointing out that the Corporation would hold them responsible for any loss sustained through their failure to carry out the present contract.

Cavehill and Whitewell Tramways.—The Corporation of Belfast apparently feel very much aggrieved at their failure before the Select Committee of the House of Commons presided over by Sir Samuel Hoare to obtain the insertion of a purchase clause in the Cavehill and Whitewell Tramways Bill, which provides for the electrification of the lines in question. The matter was discussed at a meeting of the Law Committee at the end of last week, when it was resolved that the Council should be recommended to pass a resolution offering to the

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Cavehill Company terms equal to those proposed by the British Electric Traction Company, and to defray the costs incurred by them in promoting their Bill, undertaking also to promote a Bill to confirm these objects. It will be recollected from our note last week that the British Electric Traction Company have agreed to turn the present capital of the Cavehill Company into 6 per cent. preference shares, and to find an additional £45,000 wherewith to convert the lines to electric traction. From what we know of this matter the Corporation of Belfast have only themselves to blame for their failure to obtain a right of purchase after a certain number of years. They were fully wideawake to the exigencies of the case, and for the past two or three years have had full indication that the company intended to electrify their lines at the first opportunity. In spite of this, the Belfast Corporation, instead of promoting a special Bill empowering them to purchase the undertaking with a view to introducing electric traction, and eventually joining up the Cavehill and Whitewell tramways with the street tramways in the city, refused to take any action in the matter until the company made the present and second application for powers to electrify their lines. They have now lost their opportunity, and unless they are able to come to an agreement with the company on the lines as stated above—which is very unlikely—or are successful in their opposition to the Bill in the House of Lords, the company will have the right to retain and work the undertaking in perpetuity.

Salford.—A very concise review of the tramway situation in Salford is given in one of the local papers. It is now nearly 12 months since the Corporation commenced to run their own tramcars, the actual date of the running of the first car being Thursday, May 2, 1991. The receipts on that day were £226, but on Thursday, April 17 last, the receipts amounted to £290. The first electric cars commenced to run to Broughton and Kersal on Oct. 4. The Pendleton route was opened on Nov. 21, and the Weaste and Trafford Bridge routes on April 4. During the 11 months which have elapsed since the Corporation took over the tramways about 32 miles of tramways have been relaid and electrically equipped. The total number of miles of tramways which will be covered by the Salford cars is about 50, and about 18 miles remain to be completed. The largest sections of the uncompleted portions are the loop round Swinton and Pendlebury from the Height, and the tramways from the Ladywell Sanatorium through Eccles and along Eccles Old-road to Pendleton. Work on the latter section is now being proceeded with. During the period of 11 months no less than £85,000 has been taken on the cars, and the total number of passengers carried has exceeded 20 millions. No fewer than two million of car miles have been run. Borrowing powers have been sanctioned for the sum of £414,753, including the cost of the cars, the laying of 34½ miles of track entirely within the borough, the poles and overhead equipment, and the land and buildings. The new car-shed alone costs £35,000. Each of the new electric cars costs £575, and consequently £57,500 will represent the outlay on the 100 cars at present ordered. The gross profits of the tramways are considered as very satisfactory, and they bear favourable comparison with the gross profits made in Manchester and other towns. Unfortunately, however, these profits cannot yet be devoted to the relief of the rates, as they are swallowed up by the payment of interest and sinking fund charges. What is, however, still more unfortunate is the fact that the Salford tramways undertaking is handicapped by being compelled to pay £3,000 per annum interest and sinking fund charges on the capital outlay of the old tramway track left to the present committee as a legacy, and which sum ought to have been paid some years ago. The electric cars are to be placed on the Lower Broughton routes to-day.

Birmingham.—In a report to be submitted to the City Council on the 16th inst. the Tramways Committee state that the lease to the Birmingham and Aston Tramway Company of the lines in Corporation-street, Aston-street, and Aston-road to the city boundary expires on Dec. 31, 1903, and the Aston Manor Urban District Council have obtained powers and given the necessary notice to acquire from the company that part of the Aston system within Aston Manor constructed under the earliest of the provisional orders. Negotiations are taking place whereby the Aston Manor District Council are seeking to acquire all the undertaking of the company, including the short term still outstanding of the Corporation lease. The committee have informed the Aston Manor District Council that they will assent to the assignment of the remainder of the lease to them. The District Council propose to equip the route in Aston Manor on the overhead trolley system, and it is desirable that the Corporation should be in a position to join with them in providing an efficient through system at the earliest possible date. The Tramways Committee have, therefore, had to consider the best means of working the Aston traffic by electric traction, with the probability that the Corporation-street lines and the Old-square terminus will still for three years be required for the steam traffic of the City of Birmingham Company. The committee now recommend to the Council that the Aston traffic should be diverted from the existing route near the junction of Aston-street and Lancaster-street, and should be carried over a new line to be constructed along Steelhouse-lane (recently widened) to a terminus near to its junction with Bull-street and Snow-hill, and that that part of the Aston system within the city should be equipped on the overhead trolley system. The lines in Corporation-street and the Old-square terminus would thus be relieved of the whole of the Aston traffic, while the distance from the new Steelhouse-lane terminus to New-street is very slightly in excess of that from the Old-square. The new line will be about 500 yards in length, and, with the electrical equipment of the tramways in Aston-road and Aston-street, is estimated to cost £8,940. With regard to the General Powers Bill, the committee state that, with the exception of the substitution of the proposed tramways in Steelhouse-lane for those originally proposed in Edgbaston and Harborne, they recommend that the provisions as to tramways included in the General Powers Bill, approved by the Council in December last, should be included in the revised Bill to be promoted during next session, and they submit the proposed clauses for provisional approval by the Council.

Aberdeen.—In the House of Commons on Tuesday, Mr. Pirie, representing the Northern Division of Aberdeen, asked leave to move the adjournment of the House in order to call attention to a definite matter of urgent public importance—namely, the act of the Secretary for Scotland in interfering with the action of the Commissioners holding an enquiry, under the Private Legislation Procedure (Scotland) Act, 1899, in regard to the Aberdeen tramways provisional order, and in taking upon himself the appointment of the place of enquiry, which by statute was in the discretion of the said Commissioners only. Having obtained leave of the House, Mr. Pirie said this was not a mere local question: it was one in which great principles were at stake. He contended that the enquiry referred to in his motion should have taken place at Aberdeen instead of at Edinburgh. There had been a gross illegality, and a grave injustice had been done to the localities concerned. Mr. Caldwell seconded the motion, declaring that this was a case of unwarrantable interference with the intention of Parliament. The Lord Advocate explained that there was no desire at the Scottish Office to interfere with the powers of the Commissioners to fix the place of enquiry under the Scottish Private Bill Procedure Act, and in this case there was no interference whatever. If the Aberdeen tramways people had thought it was expedient that the commission should go to Aberdeen there was no reason why they should not make the application, and there was no reason in law why the Commissioners should not have exercised their discretion as to granting or refusing that application. Mr. Bryce said that the statute had not been observed in this case, and he hoped that in future steps would be taken to guard against any similar occurrence. After the explanations given by the Lord Advocate everybody would feel that the discussion had served a useful purpose. The motion was by leave withdrawn. The enquiry into the application for the order above referred to was held in Edinburgh on Monday and Tuesday. In the result the Commissioners found the preamble proved, and sanctioned the clause giving the Corporation power to enter into an agreement as to running powers, with a proviso providing that by no such agreement was the Corporation to make any profit by charging outside the municipal boundaries. They also approved of the clause relating to the supply by the Corporation of electric power. These latter points were settled on the adjustment of clauses, and were stoutly resisted on behalf of the Great North of Scotland Railway Company. The Commissioners felt, however, that the proviso in the running powers agreement clause was quite satisfactory; while the chairman said that, as to the supply of electric power, the Corporation were perfectly entitled to sell it to whoever wished to purchase.

London County Council Tramways.—Now that the work of reconstructing the Westminster Bridge and Tooting section of the Council's southern tramways for electric traction has been going on two or three weeks, the department responsible for the scheme have just awoke to the fact that the South-Eastern and Chatham Railway bridge at Clapham is only 15ft. 2in. over the road, while the height required in order to allow of an electric car with passengers to pass under the bridge is 16ft. In these circumstances the Highways Committee have had to consider the best way of getting out of the difficulty which lack of foresight on the part of some responsible person has got them into. Fortunately the committee have been able to arrange with the Wandsworth Borough Council for the carriageway to be lowered by the County Council to the extent of 10in. at the same time as the reconstructing of the tramways is being carried out. Messrs. Griffiths and Co. are the sub-contractors for the road work under Messrs. J. G. White and Co., the contractors for the reconstruction of the tramways, and the committee are advised that it will be a matter of convenience for the lowering of the carriageway under the bridge to be carried out by them. Messrs. Griffiths have offered to do the work for the sum of £1,712. 2s., which is, practically, the amount of the engineer's estimate of the cost. This sum includes the cost of repaving with new wood blocks the portion of the carriageway outside the tramway track, as the blocks at present in the carriageway are much worn, having been in use for five years. The estimate approved by the Council on Feb. 19, 1901, on capital account for this and other works in connection with the reconstruction of the tramways, did not provide for this additional work, the necessity for which was not foreseen when the estimate was prepared, and the committee therefore, at the usual weekly meeting on Tuesday asked the sanction of the Council to the extra expenditure, which was given. At the same meeting the Highways Committee also submitted a report with regard to the contract for the supply of rails, which, it will be remembered, they entered into on March 4 last with Messrs. P. and W. Maclellan, Limited. The materials to be supplied under the contract include 155 tons of sole-plates of a special pattern, with regard to which it appears that Mr. Leonard Cooper, of Leeds, holds certain patent rights. The committee have been in communication with Messrs. Maclellan and Mr. Cooper upon the subject of the use of sole-plates of this pattern, and, after considerable negotiation, the difficulty has been adjusted in a manner which is, the committee think, satisfactory, not only to the Council, but also to the other parties concerned. Under the arrangement arrived at, the sole-plates required will be supplied direct to the Council by Mr. Cooper, the patentee, for the sum of £1,846. 5s., while an item of 155 tons of track rails will be added to Messrs. Maclellan's contract in place of the sole-plates, and by way of compensation for the reduction in the value of the contract. The amount of the tender accepted by the Council was £41,742. 4s. 4d., which, under the new arrangement, will be reduced to £40,509. 19s. 4d.; but there will be, in addition to that amount, the sum to be paid to Mr. Cooper, so that, as the amount of the combined contract prices will be £42,356. 4s. 4d., the net increase of expenditure over the amount already sanctioned by the Council will be £614. Against this addi-

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tional expenditure must, however, be set the additional 15£ tons of rails, valued at £1,023, which the Council will obtain. The extra cost incurred is covered by estimates passed by the Council on Jan. 28 last. The committee asked the Council to confirm the arrangement which they have made, also to sanction the extra expenditure incurred thereby. This was agreed to.

LIGHTING AND GENERAL.

Whitby.—The Electric Lighting Committee have been reappointed with additions.

Exmouth.—A tentative offer for the leasing and working of the Council's electric light provisional order is before the Electric Light Committee.

Ramsgate.—The Town Council are discussing in committee what steps should be taken with regard to carrying out the Ramsgate electricity order.

Tipton.—The preamble of the Bill confirming the electric lighting provisional order granted by the Board of Trade to Tipton has passed the House of Commons.

Darwen.—The Corporation have fixed eight Nernst lamps in the streets as an experiment, which has, to judge from local accounts, so far proved eminently satisfactory.

Stafford.—Electric cables are to be laid in Newport-road and Wolverhampton-road by the Callender Cable and Construction Company at an estimated cost of £1,150.

Edinburgh.—The Town Council have agreed to light Duddington and its accesses by the erection of 165 lamps, 62 to be erected next year and the remainder during the four following years.

Camberwell.—The Borough Council have withdrawn their application in the present session of Parliament for the granting of a provisional order for the supply of electricity in the borough.

Cromer.—The Urban District Council have entered into an agreement with Edmundson's. Mr. Cozens-Hardy is the consulting engineer, and application will be made for a loan of £25,000.

Beverley.—Colonel W. Langton Coke has held an enquiry into the application of the Beverley Corporation for permission to borrow a sum of £15,000 for the laying down of electric light in the borough.

Brussels.—The recent experiments with a single-wire telephone to Marseilles are stated to be very successful. The distance is about 800 miles. It is now proposed to connect Antwerp and Marseilles.

Teddington.—The Postmaster-General is about to lay a new telephone main in the footpaths in Ferry-road, High-street, Broad-street, and Park-road, under the usual agreement with the District Council.

Stockton.—The Bill confirming the provisional orders made by the Board of Trade under the Electric Lighting Acts with reference to Stockton (Rural District) and Thornaby, has been read a third time in the House of Commons.

East London Technical College.—Two special courses of six lectures each will be delivered by Mr. J. T. Morris, A.M.I.E.E., on "Wireless Telegraphy" and "Electric Traction." Details appear in our advertisement columns.

Enniskillen.—Electricity is about to be introduced into the premises of the Scottish Co-operative Society at Enniskillen, and the Urban District Council have decided to open negotiations with the manager of the company with regard to street-lighting.

Royal Aquarium.—The familiar tank in the centre of the Royal Aquarium at Westminster has disappeared and a circus reigns in its stead, which has already, and deservedly so, become a most popular feature with the great number of Londoners and country visitors daily to be found at the hall. We learn that the last electrical exhibition has been very successful.

Southampton.—In a report upon the site of the proposed electric generating station, Mr. W. Vaux Graham recommends that additional borings be made over the site of the proposed chimney stack. This matter has been left with the borough engineer and borough electrical to carry out. Taken as a whole, Mr. Graham's report is favourable to the site on the Western Shore-road.

Sale of Business.—The electrical business and patents recently carried on by the Doe Portable Electric Light and Power Syndicate, Limited, makers and patentees of the "Doe" non-polarising primary battery, is for sale. Particulars and reports of the late Prof. John Hopkinson, D.Sc., F.R.S., and H. F. Parshall, M.I.C.E., M.I.E.E., may be obtained from G. H. Tyler, liquidator, 58, New-street, Birmingham.

Lady Ambassador.—Admiral Sir Henry Nicholson, K.C.B., presided at a luncheon last week given by the Board of the Electric Lighting Boards, Limited, to Miss A. Ashton Bence on her departure for the Cape on the company's behalf. We are informed that Miss Ashton paid a similar and very successful visit to the United States in 1901, when the company's properties in America were sold for a very large consideration.

Wrexham.—The following scale of charges will be adopted from June 30 next: up to 100 units, 6d.; from 100 to 300 units, 5d.; from 300 to 1,000 units, 4½d.; from 1,000 to 1,500 units, 4¼d.; from 1,500 units, 4¼d. The present rates of discount is to be withdrawn and cancelled, and a uniform discount of 2½ per cent. on all lighting accounts allowed on payment before the end of the month in which the same are delivered, the charge for hire of meters to be 2s. each per quarter.

Removals.—Messrs. Moores, Farrell, and Co., manufacturing electrical engineers, have removed to larger premises at Mynshull's House, Victoria-street, Manchester. They are sole agents for the Brockie-Pell arc lamp, Consolidated telephones, Everett-Edgecumb's instruments, volt and ampere meters, "Unity" steel conduit tubing, and Wm. Rickard, Limited, Derby, for cables and flexibles.—The British Thomson-Houston Company, Limited, electrical engineers and manufacturers (head office and works, Rugby), have removed their Irish office from 21, Lincoln-place, Dublin, to Belfast—9, Donegal-square West.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to British Westinghouse Electric and Manufacturing Company's £500,000 4 per cent. mortgage debenture stock, and Electrical Power Distribution Company's ordinary shares of £10 each fully paid and 6 per cent. cumulative preference shares of £10 each fully paid, and to allow Eastern Telegraph Company's further issue of £102,377 4 per cent. mortgage debenture stock to be quoted in the official list. The Stock Exchange Committee have ordered the Brisbane Electric Tramways Investment Company's £400,000 4½ per cent. first debenture stock (redeemable), in lieu of the provisional certificates now quoted, to be quoted in the official list.

Durham.—At the annual meeting of the County Council the following resolution was carried: "That seeing that electricity is becoming a popular and useful agent for lighting purposes and the provision of motive power, and furnishes every prospect of becoming an agent of general and valuable public utility, this Council appoint a special committee to investigate and report upon the following points: (1) how far the county of Durham is covered by electric supply companies working under Acts of Parliament; (2) enquire as to any special facilities existing in the county for generating electricity by water-falls, etc., and as to the practicability of such facilities being employed to advantage in the county; (3) enquire as to the financial results of electric schemes undertaken by municipal bodies; (4) enquire how far it would be practicable and wise to develop a scheme for an electric supply for the county or through the medium of urban and rural councils, consistent with Acts of Parliament already obtained by existing companies; (5) report as to the best mode of procedure for giving effect to their findings and recommendations."

New Issue.—The South Wales Electrical Power Distribution Company, with a share capital of £750,000, divided into 75,000 shares of £10 each, with power to issue £250,000 debenture stock, are just making a first issue of 45,000 shares, of which 2,250 shares will be taken by the company who obtained the Act of Parliament, and the remaining 42,750 shares are now offered for public subscription at par, particulars of which will be found in another column. The board of directors is as follows: chairman—Archibald Hood (deputy-chairman Barry Railway Company, director Glamorgan Coal Company, Limited); deputy-chairman—Lieut.-General Sir Richard Hieram Sankey, K.C.B., R.E.; Robert Forrest, St. Fagans, Cardiff (director Cambrian Colliery Company); Walter Stowe Bright McLaren (director of Tredegar Iron and Coal Company); Joseph Weston Stevens (director Taff Vale Railway Company, Guest, Keen, and Co., etc.); Hugh Watts (Watts, Watts, and Co., shipowners, Cardiff and London, director United National Collieries Company). Our readers are no doubt aware this company was incorporated by Act of Parliament for the purpose of providing and distributing electric energy in the county of Glamorgan, a district which, within its area of 1,034 square miles, comprises some of the most important industrial and manufacturing centres in the world. It contains a population of over 1,000,000; the industries carried on in it consist of collieries, steelworks, tinplate and copper works, stone quarries, railways, tramways, engineering and ship repairing works, chemical works, and factories of all kinds. There are over 2,400 collieries and factories, etc., large and small, in the district, and this number is constantly being added to. Electric tramways are now being constructed or promoted in many parts of the area. All these have need of electric power. The Act of Parliament of the company contemplates, as a preliminary only, the establishment of a total horse-power for the district of 30,000, to be generated at three centres. These centres will be Neath, Pontypridd, and Pontypool. The generating stations at Pontypridd, in the Rhondda district, and that at Neath are in course of erection. The company have entered into agreements with the Rhondda Urban District Council (general supply), the Glamorganshire County Council, and the Bridgend Urban District Council. It is also stated that many other agreements with local authorities and with private customers are in course of being completed, and the prospects of business are considered by the directors to be very satisfactory. In these agreements the prices at which current is to be supplied range from 1½d. per Board of Trade unit to 3d. per Board of Trade unit, varying with the varying conditions. If 8,000 kw.—say 11,000 e.h.p.—only of electricity were used for only 3,000 hours of the 8,760 in each year, and such electricity was sold at the low average price of 1⅜d. per unit, there would be a gross income of £137,500. It is anticipated that in many of the undertakings which would be suplied with power by the company, such as tramways and light railways, the supply required would certain y be from 5,000 to 6,000 hours per annum, and in the case of pumping in the collieries, and for electro-chemical industries, and other similar cases, the use of the current would be practically continuous. The cost of production, including all expenses except management, depreciation, and interest on capital, should not exceed, allowing for loss in transformation, transmission, etc., ¾d. per unit, are estimated at £75,000, which would leave a net profit per annum of £62,500; leaving for reserve fund and depreciation, etc., £14,000, sufficient to pay a dividend of 8 per cent. on the undivided shares or give 6 per cent. on the preferred and 10 per cent. on the deferred half shares. The Act fixes the standard price at 2½d. per unit, with a dividend of 8 per cent. For every 1¼ per cent. reduction upon this standard price in the charge made for electricity, the company may increase its dividend by ¼ per cent. per annum. The Act further allows that if in any year the profits are less than 8 per cent., the excess profits of future years may be applied to making up the dividends of those past years when the profits were less than the standard rate.

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Brighton.—A smoking concert in aid of the funds of the Brighton Electricity Works Club was held on Monday evening. There was a large muster of the employés present, and also a good number from the tramways department.

Llandudno.—Profitable extensions of mains are to be made—one at £60 and one to the new Grand Hotel which will cost £159, and which is expected to bring £250 per annum from the hotel alone, where about 900 lamps are to be installed.

Lighting Orders.—An Electric Lighting Provisional Order Bill, which is to confirm the provisional orders granted for electric lighting purposes to Amble, Leadgate, and Stanley, has been read a second time in the House of Commons.

Southwark.—It has been decided not to proceed with the application of the Borough Council for an electric lighting order in respect of the parishes of Rotherhithe and St. Olave, which form part of the metropolitan borough of Southwark.

Chiswick.—The Board of Trade have refused to grant the Urban District Council an order for electric street-lighting. The order originally granted to the Council has been transferred to a local company who are supplying current in the district.

N.S.W.—The Roslyn Borough Council propose lighting the streets of the borough by electricity. Their present contract with the Caversham Gas Company expires in about 11 months, and they hope to have a full installation ready for use by that time.

Barra.—On the 24th ult. a meeting of fish buyers, fish salesmen, merchants, and fishermen was held at Castlebay to urge the immediate repair of the cable connecting Barra with South Uist. It was resolved to communicate at once with the Postmaster-General.

Stoke-on-Trent.—Ninety-two applications have been received for the post of resident engineer for the electric lighting and destructor works to be erected in the borough, and the Council have appointed Mr. P. J. S. Tiddeman, St. Annes, at £250 per annum.

Blackburn.—On Saturday evening a lecture was given at the technical school by Mr. H. Stansfield, the principal of the physics and electrical engineering department, on "Electric Lamps." The lecture was illustrated with arc and incandescent lamps of various kinds.

Superheaters.—Messrs. Easton and Co., Limited, report that within the last few weeks they have received orders for Schmidt superheaters from Messrs. Tangyes, Limited, and Messrs. Belliss and Morcom, Birmingham, and Messrs. Willans and Robinson, Rugby.

Lima.—A report is being prepared for the Peruvian Government with the object of bringing in legislation making the construction of overhead wires for electric light illegal. It is also proposed that the lines already existing be replaced by underground conduits or by some other system.

Fylde.—With regard to our note on the recently opened isolation hospital, Messrs. Brook, Hirst, and Co., Northgate Electrical Works, Chester, have been good enough to inform us that they carried out the whole of the electrical installation at this building, to the instruction of the architects.

Spain.—The Government have decided to purchase 12,000 celluloid insulators for the telegraph department. Hitherto experiments of this kind of insulator have not proved very successful, and if, as had been suggested, a new line is to be furnished entirely with this appliance, a good opportunity will present itself of judging its merits.

Vulliamy's Dolphins.—The London County Council have installed electric incandescent lamps into the lanterns of the beautiful dolphins on the Embankment, and whether from poverty of invention or other causes are perpetrating the same design for the lamps on the Highgate Archway, where the appropriateness of marine monsters is somewhat difficult to fathom.

Rochdale.—The electricity works have now about 100 customers. The committee propose to stimulate the sale of current by arranging for the wiring of houses on easy-payment terms, the Corporation collecting the money. During the next financial year the new tramways department will begin using current, which will improve matters considerably.

Change of Address.—We are informed by Mr. John F. C. Snell, borough electrical and tramways engineer of Sunderland, that in future all communications for the electric lighting and tramways departments of the Sunderland Corporation should be addressed to the Central Offices, Town Hall, Sunderland, and not, as in the past, to the electric lighting station, Dunning-street.

Macclesfield.—A circular is to be issued to residents in the compulsory area laid down in the provisional order granted to the Corporation by the Board of Trade with the object of ascertaining the extent for which there is likely to be a demand for a supply of electricity if provided at 6d. per Board of Trade unit. A company has offered to take a lease of the Corporation's order.

Dungannon.—The Urban District Council's proposed electric lighting scheme is estimated to cost £4,000, with an annual expenditure of £700. The Council would raise £200 of this sum for public lighting, and would require £500 to be contributed by private consumers. Anything above that sum would be clear profit. Mr. E. G. Cruise, London, has been appointed to report and give an estimate.

Strike.—It is reported that a number of scientific instrument makers employed at the Edison and Swan electrical works are out on strike. They protest against what is described as the "piecemaster system" of work, which the firm has shown a disposition to introduce. All the men are members of the Scientific Instrument Makers' Union, and are receiving the financial and moral support of that organisation.

Leatherhead.—Messrs. Handcock and Dykes have informed the Urban District Council that the work of laying the mains for the electric light would be commenced almost immediately, and asking if the Council was prepared to receive a tender for the electric lighting of the streets where such mains were laid. The present contract with the gas company expires on July 1. The matter is before the Lighting Committee.

Personal.—We are informed that Mr. Reginald J. Wallis-Jones, M.I.E.E., A.M.I.C.E., sailed on Saturday last for New York on a short business visit to the United States in connection with electric welding and other matters.—Mr. E. Macgregor Duncan has resigned his position upon the staff of Messrs. Kennedy and Jenkin in order to commence practice as a consulting engineer. His office address is 29, Old Queen-street, Westminster.

Cheriton.—The District Council are asking the Hythe Town Council and Sandgate District Council to appoint a small committee to meet them and to consider the advisability of formulating a joint scheme respecting electric lighting orders as extended by the Kent Electric Power Bill, to which syndicate the Council had given their support. By the terms of the agreement it is compulsory to have a joint scheme between Hythe, Sandgate, and Cheriton.

Paddington.—At the last meeting of the Borough Council the Electric, Gas, and Water Committee submitted a scheme for substituting gas for electric light in Westbourne-terrace. The present 14 arc lamps cost £420 per annum, and it was proposed to substitute for them 50 incandescent gas lamps, costing £199. 7s. 8d. to instal and £168. 16s. in yearly maintenance, the saving effected by the change being estimated at £253. 14s. annually. The consideration of the matter was postponed.

Leeds.—An explosion occurred on Monday, during the workmen's dinner hour, at the electric lighting works of the Corporation in Whitehall-road. It is attributed to the bursting of a superheater attached to the boilers in the north boiler-house. Bar a general shattering of glass, both on the boiler-house roof and among the office windows, no damage appears to have been done. The current was turned off for about five minutes on both sides of the works, and at the end of that time the ordinary supply was resumed.

Dorking.—At the last meeting of the Urban District Council the Special Committee on Electric Lighting reported that, should the Council desire to insure against risk of loss under their contract with Messrs. Edmundsons, Limited, a premium of 1 per cent. on the whole of the amount of the contract would be charged. The committee considered that, under the circumstances, it was undesirable to insure. Mr. Trentham has been asked to act as the Council's engineer in connection with the electric lighting scheme. The contract with Messrs. Edmundsons has been executed.

Cults.—Last Saturday the electric light in Cults was cut off, arrangements to float a local company in order to pay off a debt of £2,000 owing to the Town and County Bank having failed. There is, however, a strong feeling in the community that if the works and plant could be got for a reasonable sum, a company could be formed to again carry on the business. At present about 70 houses and shops have been supplied, and between 30 and 40 other premises are wired and ready for the light, and are prepared to take it in, provided there is a likelihood of the supply being satisfactory and continuous.

Poplar.—The following paragraph in the Electricity Committee's report of the Borough Council was wholly debated last week and finally referred back for further consideration: "We beg to report that the borough surveyor has submitted to us plan of the transformer chamber or reducer house to be erected upon the portion of the Island Baths site transferred to the electricity department, and we recommend that tenders for erection of the building be invited by public advertisement and stand referred to your committee, and that the surveyor enter into competition for performance of the work by direct labour."

Cables.—The British Insulated Wire Company, Limited, inform us that they have recently received orders from the undermentioned: South Shields Corporation, extensions; Brighton Corporation, 1in. cable; Salford Corporation, high-tension cables for one year; British Electric Traction Company, cables for Lye tramways; Islington Corporation, high-tension arc lighting cables; Partick, extensions; Guernsey, telephone cable; Coventry, extensions; Blackheath and Greenwich Electric Supply Company, extensions; Great Central Railway, supply of copper wire for one year; Bexhill, extensions Cleckheaton, extensions.

South Wales Electricity Supply.—A joint meeting of sub-committees of the Neath, Aberavon, and Margam District Councils was held on the 24th ult., when the question of supplying the district with electrical power for lighting and other purposes was discussed. Mr. Edmund Hill, manager of the South Wales Electrical Power Distribution Company, was present, and the committees agreed to recommend to their respective councils that energy should be supplied by this company. In the first place it was proposed to put down in the district plant for dealing with energy to the extent of 7,000 h.p., but developments are expected which will increase this figure to 25,000 h.p. or 30,000 h.p.

France.—As a comparison to English electric lighting rates, the following figures might be of interest: The Energie electrique du Littoral, a company in the South of France, propose to supply Antibes at the following rates: flat rate, 19s. 4d. per 16-c.p. lamp per year; by meter, 6½d. per unit for private and £1. 2s. 6d. per year per 16-c.p. lamp for public lighting, if each lamp is kept burning during the whole of the night, 12 arc lamps, including maintenance, at £12 per year; motor power, 2·4d. per unit for private purposes, and the town authorities are to have a call upon 100 h.p. at a rate not exceeding 1½d. per kilowatt-hour, or £5. 4s. per horse-power per year. In the case of tramways being established current is to be supplied to them at 1¼d. per kilowatt-hour.

Fulham.—The borough electrical engineer's last report states that from April 7 to 21, 1902, applications equivalent to 303 8-c.p. lamps

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had been received, making a total in all of 30,734 8-c.p. lamps. The borough electrical engineer further reported that 395 services had been completed and connected to the mains, representing an equivalent of 17,098 8-c.p. lamps. At the last Council meeting the borough electrical engineer also submitted the following statement as to the refuse destroyed and clinker sold from April 7 to 21, 1902: 803 loads of refuse (1,161 tons 3cwt. 3qr.) at 1s. 2d. per load, £46. 16s. 10d.; 22 loads of trade refuse burnt at 1s. 6d. per load, £1. 2s. 6d.; amount received for picking, £10. 15s.; less 646 tons 18cwt. clinker barged away at 6d. per ton, and 55 loads of clinker carted away at 6d. per load, £17. 10s. 11d.—total, £41. 3s. 5d. The Council have secured the loan of £10,720 granted by the London County Council for the purchase of the fee simple of land at Townmead-road in connection with the generating and supply of electric light.

Gravesend.—The last report of the Council's consulting electrical engineer, Mr. W H. Trentham, shows that considerable progress is being made with the machinery for the new generating station. Applications have been received from Mr. Hubert Russell, the managing director of the Alliance Electrical Company, Limited, who have opened a local office, stating that Mr. Arnold, of Milton Hall, Mr. Paine, of Dunton House, and Mr. Russell, of Hillside, all in the Old-road, would be prepared to adopt the electric light if the Council could see their way to lay a main cable, and adding that between them they would require roughly 400 lights. The electrical engineer stated that such a number of lights would bring an income of about £300 a year, or a gross profit of £150, and that the capital outlay in laying a main cable would be from £450 to £500. With regard to the difficulties in connection with the building, we understand that Mr. E. H. Bennett has been appointed to supervise the building work, and that further expert advice is to be obtained.

Dartmouth.—The Town Council have concluded a contract with the Urban Electric Supply Company on slightly modified terms to those proposed last week. The work is to be finished by Aug. 15, and the yearly price will be £390, with slight modification of hours and candle-power, for a period of 10 years, as follows: In the town—10 arc lamps, at 750 c.p. each, burning from dusk to 11 p.m. nightly; 20 incandescent electric lamps at 25 c.p. each, connected to arc lamp columns, to burn from 11 p.m. until dawn. This will give eight times the amount of candle-power at present gained by gas. Outlying streets—100 incandescent electric lamps at 25 c.p., burning from dusk to 11 p.m. nightly; 20 incandescent electric lamps at 25 c.p., burning from dusk to dawn, making a total of 120 incandescent electric lamps against 114 gas lamps, which will give 1·8 times the amount of power gained by gas; total candle-power of gas at present, 2,530; total candle-power if all flat flame burners were converted into incandescent gas burners, 6,528; total candle-power by electricity, 10,500.

Accrington.—Lieut.-Colonel A. C. Smith has held an enquiry into the application of the Corporation for sanction to a loan of £2,000 for purposes of electric lighting; £525 for the lighting of the shops in the market; and £1,200 for refuse destructor purposes. Mr. Gray, the borough engineer, explained that the £2,000 was for the purpose of laying cables, £1,546 being the cost of the new mains, £354 excavating and levelling, and 5 per cent. for contingencies. With regard to the application for refuse destructor purposes, Mr. Beckell, the borough accountant, said that £8,000 had been the capital outlay on the destructor, and the £1,200 for this purpose is to put down a clinker-crushing plant, so as to more economically dispose of the clinkers left as refuse in the destructor. At present the Corporation are put to the expense of having to cart clinkers to a tip, but when the proposed plant is laid they expect to make a profit by the manufacture of concrete, etc. The proposal for lighting the market by electricity was at the suggestion of the market tenants themselves, who had agreed to pay a slightly increased rent.

Coronation Expenditure.—The Local Government Board has issued an order sanctioning any reasonable expenses which may be incurred by county councils, metropolitan borough councils, councils of boroughs and urban districts whose accounts are subject to audit, rural district councils, and parish councils in the preparation of any address to his Majesty or otherwise in connection with the public celebration of the Coronation. The effect of the sanction will not be to legalise any expenses in this matter; it will only prevent the disallowance of such expenses, if reasonable, by the district auditor at the audit. The Board cannot undertake to advise individual authorities as to whether any particular kind of expenditure may be incurred or not. In case of a parish council the order will not affect the provisions in Section II. of the Local Government Act, 1894, which direct that a parish council shall not without the consent of a parish meeting incur expenses involving a rate exceeding 3d. in the pound, and that the sum raised for their expenses in any year shall not exceed a sum equal to a rate of 6d. in the pound on the ratable value of the parish.

Stirling.—The Town Council are gradually transforming the lighting into electric lighting. Mr. A. C. Hanson, burgh electrical engineer, in his statement on the progress of the electric light undertaking for four weeks ending March 22, 1902, shows that during that period 13,129 units were generated. The equivalent of 754 8-c.p. lamps has been applied for, and 102 connections to the mains, making a total of 7,186 equivalent 8-c.p. lamps for private lighting and motors, and 8,036 including public lamps. Messrs. Arnott are fitting up the damper gear, drains, and other fittings to the boilers, and are practically finished. Messrs. Babcock and Wilcox have connected up the extension to the steam-main to the engine-room, and will, in another week or so, be ready to connect on to the engines. The building is practically finished as far as brickwork is concerned, and Messrs. Davie are making progress with the roofing. The St. Ninians-road extension is being carried out, and the lamps will be lighted by next week. Clifford-road and Livilands-road are to be lit at a cost of £173, and Mr. Hanson has been instructed to submit a report for the electric lighting of Snowdon-place.

Oban.—Good progress is being made with the electricity works. The buildings are well advanced, and gangs of men are engaged on the system of distribution. When completed the power will be generated from Babcock boilers, three 100-h.p. steam dynamos, and accumulators. Recently Mr. H. R. T. Burstall (of Messrs. Burstall and Monkhouse, London), the consulting engineer, gave an interesting lecture in the Oban Hall, and with the assistance of numerous lantern slides described the system being adopted. Mr. Robertson, the convener, explained that they hoped to be able to supply the current for lighting at 6d. per unit and for power at 3d. per unit, and, if so, consumers would find there would be a large saving in comparison with the cost of gas, which at present is charged at 7s. 6d. per 1,000ft. in Oban. A contract has been entered into with Messrs. Claud Hamilton, Limited, electrical engineers, Glasgow, whereby this company is appointed official wiring contractors to the Council, and will undertake the fitting of buildings for lighting and power on a deferred payment system, extending over five or seven years, at rates approved by the Council, the work being carried out to the specification and approval of their engineer.

Bath.—The Joint Electric Light Committee recommend that the Corporation retain possession of the electric lighting works. Tenders have been received for the lease of the works from the Sir Hiram Maxim Electrical and Engineering Company, Limited, and from the Standard Electric Tramways, Limited. In both of the tenders the offer is made to lease the undertaking at an annual rent of a sum equivalent to the interest and sinking fund payable by the Corporation. In the tender of the Standard Electric Tramways, Limited, the offer is to lease the works for the term of the tramways concession. This concession is in perpetuity, subject to the right of the local authority to purchase at the end of 32 years. In the other tender the offer is to lease till the expiration of the period of the last loan obtained by the authority for the undertaking, but with the provision that the Council may determine the lease at the expiration of 10 years "upon payment of a sum equal to 15 per cent. on the whole of the capital expended upon the undertaking." The committee's recommendation is as follows: "Having regard to the increasing returns which the undertaking shows even under the present very adverse conditions, your committee do not think it is possible that in 10 years' time the charge upon the rates would approach any such a sum, and they therefore recommend that the thanks of the Council be given to the companies for their tenders, but that the Council retain the works under their own control, and that for the remainder of this year this Joint Electric Light Sub-Committee continue to carry on the work of the undertaking and report direct to the authority."

Devonport.—The Corporation electrical works in Newport-street, Stonehouse, were formally opened on Monday by Councillor G. H. Smith, jun., chairman of the Electric Power Committee. Current had already been supplied from the station for some months past for driving the Devonport and District Company's and the Plymouth, Stonehouse, and Devonport tramcars, but additions were required to meet the demand for traction purposes as well as for the inauguration of the electric lighting of Fore-street between the dockyard gates and the technical schools. The total expenditure on the completed works is £78,756. On the day of the opening the Corporation concluded, at a sum exceeding £147,000, the acquisition of the gas company's property. The Mayor (Mr. E. M. Leest) presided at a numerous gathering, and attended a subsequent luncheon by Mr. Furness, at which the customary complimentary speeches were made. Special mention was made of Mr. Harman Graves, who laid the foundation stone; Alderman J. B. James, the former chairman of the committee; both the electrical engineers, Mr. Furness, who directed the scheme from beginning to end, and Mr. Spark, who has succeeded him. Mr. Furness afterwards named one of the generating sets, "Alice," after his wife. At the works there have been erected five boilers, ranging from 250 i.h.p. to 700 i.h.p., making a total of 2,000 i.h.p., together with a compound steam pump and an electrically-driven pump for feeding the boilers. There is also a Green's fuel economiser. In the engine-room are four high-speed compound engines coupled direct to multipolar dynamos, the power of the engines ranging from 250 i.h.p. to 750 i.h.p., and each capable of taking an overload of 33 per cent. for an hour, making a total indicated horse-power of 1,900 nominal. The dynamos range from 150 kw. to 550 kw. capacity, making a total of 1,360 capacity, or sufficient for lighting 45,000 lamps of 8 c.p. Also installed is a balancing transformer for use on the town's lighting, as well as two motor-driven boosters for battery charging. The switchboard is constructed to distribute energy both for traction and lighting, and any dynamo can be switched on for either purpose. On the top floor is a storage battery for use on the town's lighting, having a capacity of 1,000 ampere-hours.

London County Council.—Notices under Electric Lighting Acts and Orders have been agreed to as follows: From the Blackheath and Greenwich District Electric Lighting Company, under the Blackheath and Greenwich District Order, 1897, of intention to lay high-tension mains along portions of Burnt Ash-road and High-road, Lee, and to lay high-tension mains along a portion of Victoria-road, Charlton, and to construct a transformer box at the junction of Victoria-road and Woolwich-road; from the Charing Cross and Strand Electricity Supply Corporation, under the Strand District Order, 1896, and the company's Further Powers Act, 1900, to lay extra-high-tension mains from the City boundary, along the Strand and a portion of Wellington-street, and to lay mains, casings, and boxes for the erection of 11 arc lamps along the Strand between Catharine-street and St. Clement Danes Church; the County of London and Brush Provincial Electric Lighting Company, under the Wandsworth Order, 1892, to lay mains of high and low tension across High-street, Clapham, and to construct a transformer box at the east corner of St. Luke's-road and High-street; the Metropolitan Electric Supply Company to lay high-tension mains along a portion of Maida-vale; the Notting Hill Electric Light-

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ing Company, under the Notting Hill Orders, 1889 and 1895, to lay mains for the purpose of public arc lighting along portions of High-street, Notting Hill, Holland-park-avenue and Kensington-road; the St. Pancras Borough Council, under the St. Pancras (Middlesex) Order, 1883, of intention to lay mains (*a*) along Rochester road and terrace, and Crown-place, and (*b*) along Redhill-street and Little Edward-street. Notices served under orders granted to local authorities have also been received from the Bermondsey Borough Council, under the Bermondsey Order, 1899, of intention to lay temporary mains from existing mains in Abbey-street, along a portion of the Council's subway in Tower Bridge-road. The Borough Council is the undertaker under the order, and the Council has no power of approval or disapproval of works. The order contains, however, the usual clauses relative to the Council's subways, which has been agreed to under the usual conditions. The receipt of notices, as follows, served under orders granted to local authorities, and under which the Council has no power of approval or disapproval of works, was also reported: (*a*) from the Poplar Borough Council, under the Poplar District Order, 1893, of intention to lay mains across Brunswick-road, and along Ettrick-street, Abbott-road, and Leven-road; and (*b*) from the Stepney Borough Council, under the Whitechapel District Order, 1892, of intention to lay mains along Turner-street, Oxford-street, and New-road.

PROVISIONAL PATENTS, 1902.

April 21.

9150. Improvements in clock-controlled mechanism for turning on gas, electric current, water, and the like at predetermined times. Samuel William North, 133, Harehills-road, Leeds.

9178. Improvement in magnetic compasses. George Charles Lilley, Billiter House, Billiter-street, London. (Complete specification.)

9208. Improvements in switch and fuse boards. Arthur William York Dimmock Chapman, 23, Southampton-buildings, Chancery-lane, London.

9229. Improvements in audible electric telegraphy. Robert Oxlade and William Joseph White Richardson, 60, Queen Victoria-street, London. (Complete specification.)

9231. Apparatus for counting telephonic conversations. Johann Heinrich Meyer, 53, Chancery-lane, London.

April 22.

9256. Improvements in and relating to pendant glass shades for electric or gas lights and other purposes. Charles Millar Heron, 96, Buchanan-street, Glasgow.

9264. Improvements in the construction of electric lamp holders. William Allman, 158, Edmund-street, Birmingham.

9265. An accessible, watertight, and insulating coupling for electric cables. Arthur John Morgan, Swiss Cottage, Cardiff-road, Llandaff.

9267. An improved dynamo-electric machine or motor. Archibald Henry Findlay, 2, Wellington-place, Belfast.

9278. Improvements in incandescent electric lamps. Masanoské Hayashi, 1, Broad-street-buildings, Liverpool-street, London.

9288. Improved indicator for electric signalling on railways, tramways, and the like. Harry Gulliver and Henry Greer Robinson, Clun House, Surrey-street, Strand, London. (Complete specification.)

9315. Improvements in electric controllers. Carl Tunstill John Oppermann, 53, Chancery-lane, London.

9317. Improvements in current meters. George Lewis Gowlland, 53, Chancery-lane, London. (Complete specification.)

9325. Improvements in insulating tubes for the windings of electric machines, such as motors and the like, and in the process of making same. Max Meirowsky, 55, Chancery-lane, London. (Complete specification.)

April 23.

9367. Improvements in trolley poles for electric tram and other cars. S. R. Jackson, 36, Great George-street, Leeds.

9371. Improvements in cycle and motor or motorcar ways with or without the formation of space for sheltering electric wires, or chambers for rifle-firing practice. John Carrington Sellars, 68, Bridge-street, Birkenhead.

9380. Improved fuse head for electric blasting. Frederick Render, 6, Bank-street, Manchester. (Complete specification.)

9397. Improvements in dynamo-electric machines. Henry Chitty, 40, Weston-park, Crouch End, London.

9419. Apparatus for sounding and recording code signals for electric fire-alarm and other purposes. George Bennett Bowell and the Pearson Fire-Alarm System, Limited, 53, Chancery-lane, London.

9423. An improved flexible electrical conductor from any point of which a current may be taken. Henry Bevis, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

9439. Improvements relating to protecting apparatus for controlling the consumption of current. Friedrich William Schneider and Abraham Strauss-Collin, 27, Chancery-lane, London.

9441. Improvements in electromagnetic traction for railways and the like. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Antoni Pacinnotti, Italy).

April 24.

9488. New or improved mountings or fittings for incandescent electric lamps for illuminating shop windows or for outlining buildings or other illuminations or other analogous purposes. Alfred William Beuttell, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

9504. Improvements in electric lamp sockets. Mortimer Norden, 33, Chancery-lane, London. (Complete specification.)

9519. Improvements in brakes for submarine cable laying machines and the like. Walter Claude Johnson, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

9529. Improvements in terminals and binding screws for electric batteries and connections. William Rowland Edwards, 65, Chancery-lane, London.

9531. Improvements in electricity maximum demand meters. Gustav Byng and Egerton Sayer, 4, South-street, Finsbury, London.

April 25.

9592. Improvements in or relating to electrical fuse boxes. Ernest Francis Moy, Percy Henry Bastie, and Ernest F. Moy, Limited, 3, Greenland-place, Camden Town, London.

9630. Improvements in railways and cars and magnetic appliances therefor. Albert Christian Albertson, 6, Lord-street, Liverpool. (Complete specification.)

April 26.

9663. Improvements in electric tramcars and other like tramcars. Thomas Rhodes, 2, Market-street, Bradford.

9669. Improved apparatus for starting alternating-current motors. Thomas Harding Churton, Atlas Works, Ingram-street, Leeds.

9701. Improvements in electric tram and railways on a sectional conductor system. John Leighton and Robert Hacking, 24, Southampton-buildings, Chancery-lane, London.

9704. Improvements in and relating to electric switches and wall plugs and bases for the same. Albert Vandam and Thomas Herbert Marsh, 322, High Holborn, London. (Complete specification.)

9720. Improvements relating to automatic electric fire alarms. Peter Offenbroich and Lorenz Mafell, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

9721. A new or improved high-tension electric condenser. Alevander Vosmaer and Adriaan Lebret, 4, South-street, Finsbury, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published May 15.

1901.

6757. Electric fire-alarm which might also be applied to notify overheated bearings in machinery. Barnard and Steadman.

8280. Accumulators or secondary batteries. Fortun and Semprun.

8629. Mean applicable for use with overhead electric conductors for the prevention of danger in case of fracture. Wilson.

8943. Apparatus for measuring the magnetic properties of material. Baily.

10537. Electrical lamp holders. Sperryn and Wood.

11071. Electrical connections. Gray.

11703. Electrical distribution boards. Grundy.

11838. Regulators for electric or other motors operating air or other fluid compressors. Justice. ("Long Arm" System Company.)

12456. Trolleys for use in electric traction. Lister.

13568. Plates for electric accumulators. Tommassi. (Date applied for under International Convention, Jan. 17, 1901.)

14579. Transmission of electrical energy. Lake. (Tesla.)

14670. Electric circuits. Howard.

15509. Electric controllers. British Thomson-Houston Company, Limited. (Linn.)

16042. Electric quantity meter. Imray. (Firm of Hartmann and Braun.)

19462. Electromagnets. Ducretet.

1902.

914. Electric arc lamp for light-cure purposes. Otto.

4377. Electrically printing or inkless typewriters. Fell. (Union Typewriter Company.)

5065. Overhead electric trolley wires. Cribb.

5530. Apparatus for measuring and indicating an electricity supply. Merz.

6026. Magneto-electric generators. Wilson.

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6331. Electrical cooking apparatus. Bayno.

6346. Electromagnetic circuit breakers or cut-outs. Joseph and Gardner.

6354. System of electrical distribution. Newton. (Bliss Electric Car Lighting Company.)

6355. Brush mechanism for dynamos. Newton. (Bliss Electric Car Lighting Company.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	Apr. 19	645	634	+ 11	—	—
Birmingham Tramways	,, 26	4,868	4,473	+ 395	78,522	70,226
Blackburn Corporation	,, 25	710	727	- 17	10,647	9,310
Blackpool Corporation	,, 19	278	269	+ 9	3,601	2,242
Blackpool-Fleetwood Tramways	,, 26	288	347	- 59	3,889	3,590
Bolton Corporation	,, 27	1,536	1,414	+ 122	22,701	21,046
Bradford Corporation	,, 13	2,635	1,003	+ 1,632	30,358	11,549
Bristol Tramways Company	,, 25	4,241	4,648	- 407	—	—
Carlisle Tramways Company	Mar. 15	122	123	— 1	1,282	1,192
Central London Railway	Apr. 26	6,857	6,612	+ 245	112,809	104,596
City and South London Railway	,, 27	2,993	1,848	+ 1,145	50,537	33,974
Cork E. T. and L. Company	,, 24	444	511	- 66	6.132	5,990
Darwen Corporation	Mar. 22	169	154	+ 15	1,961	1,844
Darwen-Hoddlesden	,, 14	26	—	—	—	—
Dover Corporation	Apr. 26	198	203	- 5	3,004	2,871
Dublin & Lucan Electric Railway	,, 27	102	98	+ 4	1,541	1,394
Dublin U. T., electric cars	,, 25	3,723	3,613	+ 110	—	—
Dublin S. District, Electric	,, 25	802	856	- 54	—	—
Dundee Tramways Company	,, 23	703	609	+ 94	—	—
Glasgow Corporation	,, 26	11,941	10,112	+ 1,829	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 26	1,643	1,572	+ 70	6,597	6,560
Liverpool Corporation	,, 19	9,438	8,567	+ 871	142,244	128,054
Liverpool Overhead Railway	,, 27	1,398	1,591	— 193	23,839	25,919
Newcastle-on-Tyne Corporation	,, 26	2,456	—	—	—	—
Portsmouth Corporation	,, 26	1,312	618	+ 694	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 28	3,895	—	—	—	—
Southampton Corporation	Mar. 27	775	537	+ 238	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £974 decrease.
Barcelona Ensanche y Gracia, £74 decrease. Barcelona, £416 increase.
Brisbane, £598 increase (month of March, £10,934; increase, £1,789).
Buenos Ayres and Belgrano Electric (month of March, receipts £12,184; decrease £647), £270 decrease.
Calcutta, £20 decrease.
Cape Town (month of March), receipts, £17,888; expenditure, £7,343.
Isle of Thanet Electric, £103 increase.
Mexico Electric (month of March), receipts, £19,000; expenditure, £10,500.
Perth Electric, £162 increase.
Port Elizabeth (month of March), receipts, £3,818; expenditure, £1,947.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Electric Tramways.—	£	£
Anglo-Argentine, 1-250,007	5	3¼-4¼ xd
—— Permanent 6 per cent. Debenture Stock, 1888	100	125-130
Blackpool and Fleetwood Tramroad	10	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	3-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	104-107
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	6¾-7¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	9¼-9¾ xd
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	100-102 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	13½-14½
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12¾-12¾
—— 5 per cent. Perpetual Debenture Stock	100	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	1¼-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	5-5¼ xd
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4¾-5¼
—— 5 per cent. Deb. Stock, Red.	100	103-106
—— Prov. Cert., all paid	100	97-100
Cape Electric Tramways, Nos. 1-400,000	1	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10	13-14
—— 5 per cent. Cum. Pref.	10	11-12
—— Debentures	100	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	11¼-12½
—— 6 per cent. Pref., Nos. within 1-60,000	10	14¼-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	98-99
Imperial Tramways, Ordinary	all	22-22½
—— 6 per cent. Cum. Pref.	all	14¼-15½
—— 4½ per cent. Deb. Stock	100	112-114
Kidderminster and District Lighting and Traction, Pref.	5	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100	102-104
New General Traction, Ordinary	5	2¼-3½
—— 6 per cent. Cum. Pref.	10	4-5
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10	10¼-10¾
—— 5 per cent. Cum. Pref.	10	11¼-12½
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	99-102
Potteries Electric Traction, Ordinary, 26,667-40,000	10	9¼-10¼
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
—— 4½ per cent. Debenture Stock	100	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1	1
—— £51,132 6 per cent. Preference	10s.	¼
—— £50,000 ,, ,,	1	1
—— £500,000 4½ per cent. Debenture Stock	50 p.c.	50 p.c
Commercial and Industrial.—		
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	½-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1	1/16-3/16
—— Ordinary, 1-125,000	1	3-5
British Insulated Wire, Ord., 1-70,000	5	8-9 xd
—— 6 per cent. Cum. Pref., 1-40,000	5	5¼-5⅝
—— 5 per cent. Mortgage Debentures	100	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	5¼-6
Brush Electrical Engineering, Ordinary	2	¾-1¼
—— Nos. 90,001-105,731	2	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	1¼-2
—— 4½ per cent. Debenture Stock	100	101-104
—— 4½ per cent. 2nd Debenture Stock	100	95-100
Callender's Cable, Debentures	100	111-115
—— Ordinary	5	17-18
—— 5 per cent. Pref.	5	5¼-6
Crompton and Co.	3	3-3¼
—— 5 per cent. Debentures	—	103-108 p.c
Edison and Swan United, Ordinary	3	⅛-⅜
—— 5 per cent. Debentures	5	2-3
—— 4 per cent. Deb. Stock, Red.	100	78-83
—— 5 per cent. Second Deb. Stk. Prov. Crts.	—	82-87
Electric Construction, Limited, Nos. 1 to 112,100	2	1¼-1⅞
—— 7 per cent. Cumulative Pref.	2	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	97-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10	9⅜-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	98-101
W. T. Henley's Telegraph Works, Ordinary	5	17-18
—— 4½ per cent. Preference	5	5¼-6
—— 4½ per cent. Debentures	100	111-115
India Rubber, Gutta Percha, and Telegraph Works	10	21-22
—— 4 per cent. Debentures	100	99-102
Parker, Thos., Limited, Ordinary	10	15¼-16¼
Telegraph Construction and Maintenance	12	34-37
—— 5 per cent. Bonds	100	103-106
Telegraph Manufacturing, Ordinary	5	10½-11¼
—— 5 per cent. Cum. Pref.	5	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5	8¼-9¼
—— 6 per cent. Cum. Pref., 30,001-60,000	5	6¼-6¾
—— 4½ per cent First Mortgage Debenture Stock, Red.	100	105-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1	½-¾
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	100-104
Bournemouth and Poole, Ordinary	10	11-12
—— 4½ per cent. Cum. Pref.	10	9¼-10½
—— Debenture Stock, Red.	100	103-106
Brompton and Kensington, Ordinary	5	9-9½
—— 7 per cent. Preference	5	9-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	8¼-9¼
—— Nos. 20,001-30,000	5	8-9
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	14¼ xd
—— ,, ,, £10 Ord.	6	10¾ xd
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	106-108
Charing Cross and Strand	5	9-10
—— 4½ per cent. Cum. Pref.	5	5¼-5¾
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	105-107
Chelsea Electricity Supply	5	5¼-5¾
—— 4½ per cent. Debentures	100	110-113
City of London, Ordinary	10	8-9
—— 6 per cent. Cumulative Pref.	10	12-13
—— 5 per cent. Debenture Stock	100	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	103-106
County of London and Brush Provincial, Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	6¼-6¾
—— 6 per cent. Cum. Pref.	5	5¾-6¼ xd
—— 4½ per cent. First Mort. Deb.	100	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	4-4¼
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	5¾-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	10-11
—— 4 per cent. Debenture Stock, Red.	100	101-104
Kensington and Knightsbridge and Notting Hill	100	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9⅜-10⅛
London Electric, Ordinary	3	1¼-1⅜
—— 6 per cent. Pref.	5	4¼-4¾
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	95-100
Metropolitan, Ordinary	10	15¼-16¼
—— 4½ per cent. First Mortgage Debenture Stock	100	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5	9-9½
—— Preference	4	6¼-6½
Notting Hill Electric Lighting	10	14-15
Oriental, 1879	1	1¼-1⅜
—— £5 Shares	5	7¼-8
—— £4½ Shares, New	4½	6¾-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	5-6
—— 4 per cent. Debenture Stock	100	98-101
River Plate Electric Light and Traction, Deb.	100	65-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	1¾-2¼
—— 4 per cent. Debenture Stock	100	80-90
South London, Ordinary	5	2¼-2¾
St. James's and Pall Mall, Ordinary, 101-20,080	5	14½-15½
—— 7 per cent. Pref.	5	8¼-9¼
—— 3½ per cent. Deb.	100	98-101
Westminster, Ordinary	5	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	2½	3¼-4
Electric Railways.—		
Central London, Ordinary	100	103-106
—— 4 per cent. Pref.	100	103-106
—— ,, ,, deferred	100	100-103
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	116-118
City and South London, Consolidated Ordinary	100	69-71
—— Ordinary	10	—
—— 4 per cent. Debenture Stock	100	112-116
—— 5 per cent. Pref. Stock '91	100	128-133
—— ,, ,, ,, '96	100	123-126
—— ,, ,, ,, '01	100	120-124
Liverpool Overhead, 5 per cent. Pref.	—	13-13¼
—— Ordinary, 1-50,000	—	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	102-104
Waterloo and City, Ordinary	100	91-94
Telephones.—		
National Telephone, Preferred	100	95-99
—— Deferred Stock	100	56-60
—— 6 per cent. Cum. First Pref.	10	12-14
—— Preferred, 590,001-790,000	3½	3¼-3⅜
—— 6 per cent. Cum. Second Pref.	10	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	4¼-5¼
—— 4 per cent. Deb. Stock, Red.	100	93-96
—— 3½ per cent. Deb. Stock, Red.	100	101-105
Oriental Telephone and Electric Company	1	15/16-1 1/16

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NOTES.

Electrical Conference on the 1901 Factory Act.—The Council of the Institution of Electrical Engineers has now issued invitations for this conference at 3.30 p.m. on Monday, May 12, in the rooms of the Society of Arts, kindly lent for the occasion.

King's College Dinner.—We are informed that the forty-second annual dinner of King's College, London, will be held at the Café Monico, Shaftesbury-avenue, W., on Monday, June 16, with the Right Hon. and Right Rev. the Lord Bishop of London in the chair.

Institution of Mining and Metallurgy.—The retiring president of the above institution (Mr. C. Algernon Moreing) entertained some 200 members and friends at dinner at the Hotel Cecil on the 30th ult. The chair was occupied by Mr. A. G. Charleton, the newly-elected president.

Extra Meeting.—Mr. Langdon announced from the chair last week that it had been decided to hold an extra meeting of the parent Institution on the 15th inst., when Major P. Cardew will present a paper on "Electric Traction on Steam Railways in Italy." The proceedings will open in the rooms of the Society of Arts at 8 o'clock.

Electrical Recovery of Pure Tin.—A successful process is reported to have been devised by a Mr. Gelstharp for the recovery of pure tin from waste tin cuttings. The tin is recovered by electrolysis, and the clean iron is either sold as best scrap or converted into green copperas, which may be further converted into red oxide and Nordhausen sulphuric acid, the profits derived therefrom being exceptionally large. The electrolyte in the stripping tanks is a 1¼ per cent. solution of commercial hydrochloric acid, to which is added a small quantity of oil of vitriol.

Electrical Tug-Boats.—According to a German contemporary, a company over there is building electrical tug-boats with some success, these boats being largely employed for touring purposes regularly between Zchudenick and Berlin. The average length of the boats is about 50ft., and their width about 10ft. They have a draught of just over 3ft., and are able to tow barges of 150 tons at a higher rate of speed than the steam tugs usually employed for this purpose. One of the chief advantages offered by these electrically-propelled tugs, however, is that their displacement is considerably less than that of steam tugs of equivalent drawing power, and they are, therefore, peculiarly suitable for towing purposes in shallow and winding canals and rivers.

American Institute.—The March number of the *Transactions* of the American Institute of Electrical Engineers may now be obtained. It reprints several interesting papers read at the society's meetings this session under the following headings: "Static Strains in High-Tension Circuits and the Protection of Apparatus," by Mr. P. H. Thomas; "Speed Regulation of Prime Movers and Parallel Operation of Alternators," by Mr. Chas. P. Steinmetz; and "Parallel Operation of Engine-Driven Alternators," by Mr. W. L. R. Emmet. Also the discussions on the following subjects: "Stillwell on Niagara Falls Plant," "Wurts on the Nernst Lamp," "Armstrong and Berg on the Electric Railway," "Steinmetz on High Potential," and "Mathews on Photometry."

Power Transmission in Italy.—Information has reached us to the effect that on the Cellina River in North Italy there is now in course of erection a power-house for transmitting electrical energy to Venice, a distance of 56 miles, at 36,000 volts pressure. This is said to be a record in the high-pressure long transmission of energy in any part of the world. The electrical plant which is being laid down will be capable of developing 13,000 h.p., and the current, besides being transmitted to Venice, will also be distributed in other places within a radius of 60 miles from the power-house. The intention is to generate the current in the first place by means of three-phase alternators at the comparatively low tension of a few thousand volts, and to raise it by stationary transformers to the transmission voltage.

Royal Society Nominations.—The list of gentlemen selected by the council of the Royal Society for nomination is announced as follows: Mr. B. Baker (senior science master at Dulwich College), Prof. Bovey (Queen's University, Montreal), Prof. R. Boyce (Holt professor of pathology in University College, Liverpool), Mr. J. Brown, Mr. W. B. Hardy, Mr. A. Harker, Mr. S. Hough (chief assistant, Cape Town Observatory), Mr. R. Kidston, Mr. T. Mather, Mr. J. H. Michell (University of Melbourne), Mr. H. F. Newall, Dr. Flinders Petrie, Mr. W. J. Pope, Mr. E. Saunders, Dr. A. Willey. By a limiting clause in the statutes the Royal Society may only make 15 additions to its ranks each year, always excepting the inclusion of privy councillors, and the above list represents the only ordinary nominations which will be made this year.

The Institution Conversazione.—It has now been definitely announced that the Institution conversazione will be held in the Natural History Museum, South Kensington, on Tuesday, July 1. Seeing that the tramways and light railways congress will then be sitting, many of the foreign delegates to the congress are expected to attend the conversazione. The Incorporated Municipal Electrical Association will open its convention in London on the following day, and in view of the fact that the date named is within a week of the Coronation ceremonies, when London is expected to be very full, the Council have decided, by permission of the trustees, to open one of the large side galleries, in addition to the central hall of the museum. The Metropolitan District Railway Company have, according to precedent, kindly promised to open the subway from the South Kensington Station to the grounds, for the benefit of guests travelling by their line.

Current Efficiency in the Electrolytic Preparation of Alkali Hypochlorites.—An abstract of a paper by Messrs. Fritz Foerster and Erich Muller on this subject is given in the issue of the *Journal* of the Chemical Society for May, from which it seems that by the use of a platinum anode coated with platinum black, and by the addition of a chromate to the alkali chloride solution, the current efficiency in the electrolytic preparation of alkali hypochlorites may be made almost equal to the theoretical value. By employing a small current density, the E.M.F. required may be also made to approach very closely to the theoretical 2·2 volts. For example, the authors obtained a 96 per cent. current efficiency using an E.M.F. of 2·4 volts. The current efficiency in the preparation of chlorates may be raised to nearly 95 per cent., by adding to the electrolyte quantities of hydrochloric acid sufficient to maintain the ratio of hypochlorous acid to hypochlorite between the limits 2 : 1 and 1 : 2. The presence of a chromate is necessary in this case also. These results confirm Foerster's theory of the formation of chlorate.

Chemical Action of the Cathode Rays.—When ferric and mercuric chlorides are exposed to the action of the cathode rays reduction takes place in both cases, as can be shown by testing with ferricyanide and ammonia respectively. In like manner, silver and mercurous chlorides darken on exposure to the cathode rays, owing in the first

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case to the formation of a sub-chloride. The colour changes shown by sodium and potassium chlorides when subjected to the action of the cathode discharge are attributed to the formation of sub-chloride, and the grounds for this conclusion were confirmed by Messrs. Wiedemann and Schmidt in 1898. In interpreting the action of the cathode rays in the above cases, Mr. Schmidt, in a recently-published paper, considers that the negatively charged electrons satisfy the positive valency of the metal, which is then no longer able to retain the whole of the acid radicle; the latter, if volatile, escapes. In cases such as mercuric, barium, and strontium sulphates, where the acid radicle is not volatile, the cathode rays probably cause a dissociation into ions, and only eventually a slight reduction.

Institution of Civil Engineers.—At the annual meeting of the above institution last week, Mr. Charles Hawksley, president, in the chair, the result of the ballot for the election of officers was declared as follows: President—Mr. J. C. Hawkshaw, M.A.; vice-presidents—Sir William White, K.C.B., Mr. F. W. Webb, Sir Guilford Molesworth, K.C.I.E., and Sir Alexander Binnie; other members of council—Mr. James Barton (Dundalk), Mr. Horace Bell, Mr. B. Hall Blyth (Edinburgh), Mr. Cuthbert A. Brereton, Mr. John Brown (Cape Town), Mr. R. Elliott Cooper, Colonel R. E. B. Crompton, Mr. Cecil West Darley, Mr. George F. Deacon, Mr. W. R. Galbraith, Mr. E. P. Hannaford (Montreal), Mr. G. H. Hill, Mr. J. C. Inglis, Mr. G. R. Jebb (Birmingham), Dr. Alex. B. W. Kennedy, Sir William Thomas Lewis (Cardiff), Mr. J. A. McDonald (Derby), Mr. William Matthews, C.M.G, Mr. William Shelford, C.M.G., Mr. Alexander Siemens, Mr. Henry C. Stanley (Brisbane), Mr. John Strain (Glasgow), Mr. John I. Thornycroft, Prof. W. C. Unwin, B.Sc., Mr. F. R. Upcott, C.S.I., Sir Leader Williams (Manchester).

Radiations from Radio-Active Substances.—It has been shown by several experimenters that the radiations emitted by radium partly consists of those which are deflected in a magnetic field, partly of radiations not deflected, which are further divisible into those easily absorbed and those very penetrative. The radiations emitted by uranium had been previously shown to contain deviable rays, and further work by Mr. Henri Becquerel has failed to detect any of the other—that is, the non-deviable rays—but it does not prove the entire absence of at least the penetrative rays, the action of which on a photographic plate is exceedingly slow. The radiations are also found to chiefly consist of those of radium, which are least deviated. The rays which are deflected are shown to be those which are most active in effecting the transformation of white phosphorus into red, whilst the penetrative non-deviated rays have no appreciable action. It is probable that those rays, non-deviated but easily absorbed, would also be active in this respect, but the conditions of the experiment precluded their activity being rendered evident.

Interesting Power Plant in Spain.—There has recently been laid down on the banks of the Jamara River in Spain a very interesting electrical power plant, utilising a 3,000-h.p. waterfall, which is 67ft. high and has a flow of 325 cubic feet per second. The electrical installation consists of three generators giving three-phase current at 10,000 volts, with a fourth similar machine held in reserve, each unit being formed of a 750-h.p. turbine direct-coupled with an alternating-current machine of corresponding size. In addition there is a storage battery plant of 2,000 ampere-hours capacity which works through a rotary converter, forward or backward, as the case may be, upon the circuit. In the city of Madrid there is a sub-station where the tension of the three-phase circuit is lowered from 10,000 to 3,575 volts, at which pressure it is distributed through the city. We understand from our Spanish contemporary, *Revista de Obras Publicas*, that the prices charged are 2d. for lighting and 1d. for motive power, which are about one-fifth of the figures previously in vogue for current delivered from stations located in the city of Madrid itself.

Variation of E.M.F. of the Daniell Cell.—The current number of the *Journal* of the Chemical Society has a short abstract of a paper by Mr. J. Chaudier on the variation of E.M.F. and the temperature coefficient of the Daniel cell with the concentration of the sulphate of zinc. The E.M.F. of the cell was determined when the concentration of the zinc sulphate varied from 0 to 200 per 100 of water, and the temperature coefficient was found at each concentration, the solution of copper sulphate being saturated throughout. It was ascertained that with increasing concentration of the zinc sulphate, the E.M.F. at first increases, reaching a maximum of 1·1368 when the concentration of the zinc sulphate is 0·5, after which it decreases, being 1·0902 for the saturated solution. The temperature coefficient is negative for the low concentrations, becomes positive at about 0·5 per cent., and again negative at from 7 to 8 per cent. When the concentration of the zinc sulphate is either of these values, the E.M.F. of the Daniel cell is independent of temperature. It also follows that the variation of the heat of the reaction with dilution varies in a corresponding way.

Measuring Coefficients of Self-Induction.—A few weeks back Mr. Paul Janet described before the French Academy an extremely neat method for measuring small coefficients of self-induction by the use of Mr. Duddell's singing arc. If around a direct-current arc a shunt circuit is constructed having a self-induction and capacity, respectively L and C, under certain conditions of burning the arc gives out a sound or musical note having the period $T = 2\pi\sqrt{C L}$. By measuring with a hot-wire ammeter the current in the derived circuit, and with a voltmeter of the same construction, the E.M.F. at the terminals of the self-induction coil, and by neglecting the resistance of the coil itself, and the self-induction of the remainder of the circuit, the current is $I = \frac{U}{L\omega}$. We already have $\omega = \frac{2\pi}{T}$, and by eliminating the terms for the period of vibration between these three equations, the formula $L = \frac{U^2 C}{I^2}$ results. This permits of calculating the self-induction by means of the purely electrical measures of capacity, voltage, and current without requiring to measure the vibration period of the sound produced by the arc. Self-induction coefficients as small as 0·001 henry, it is said, may be measured with accuracy and precision by this means.

Institution "Journal."—Volume 31, part 4, of the *Journal* of the Institution of Electrical Engineers is now being circulated. Among other things, it contains the following papers read this session either before the parent Institution or some of the local sections: "Researches on the Electrical Conductivity and Magnetic Properties of Upwards of 100 Different Alloys of Iron," by Prof. W. F. Barrett, F.R.S.; three papers on the subject of "Electric Shock," by Major-General Webber, Mr. F. B. Aspinall, and Mr. A. P. Trotter respectively; "Some Notes on Electrical Engineering Practice in Europe and America," by Mr. John Denham (Cape Town Section); "Practical Notes on Continuous-Current Distributing Mains," by Mr. J. C. A. Ward (Glasgow Section); "Surface-Contact Systems of Electric Traction," by Mr. W. Kingsland

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(Birmingham Section); "The Supply of Electricity in Bulk," by Mr. H. A. Earle (Manchester Section); and the inaugural address of the chairman (Prof. W. F. Barrett) of the Dublin Section in December last. This issue of the *Journal* also publishes the following original communications: "A General Formula for Regular Armature Windings," and "A Method of Studying Armature Windings by Means of Winding Diagrams," by Mr. David Robertson.

Lord Kelvin in the States.—From reports reaching this country Lord Kelvin is having a most enthusiastic welcome in America. On the 21st ult. he was the guest of the evening at a reception given in his honour by the American Institute of Electrical Engineers, the American Association for the Advancement of Science, and sister societies at Columbia University. All the principal representatives of science and engineering in the States were there, and addresses of welcome were delivered by, amongst others, Dr. F. B. Crocker, of Columbia University, and Prof. Elihu Thomson on behalf of the American Institute of Electrical Engineers. Lord Kelvin made a very interesting speech in reply. Referring to the work of Mr. Cyrus W. Field, "the father of the cable enterprise," he told of the trials and difficulties encountered in laying the first Atlantic cables, from the date of the first attempt to the successful conclusion of the work in 1866. Lord Kelvin also spoke of the advancement of science in recent years, and particularly of wireless telegraphy, which, in his estimation, was interesting and valuable, but would not be a competitor of the cables. Speaking finally of the Niagara power transmission, the veteran scientist ventured the prediction that it would be considered more beautiful some day to see all the water of the great cataract turning turbine wheels than to see it thundering over the cliff—an untamed waste of power. The conclusion of Lord Kelvin's remarks was greeted by loud applause, and the usual round of presentations was then made.

Three-Phase Four-Wire Systems.—Mr. Peter Junkerfeld read a paper before the Chicago Electrical Association last month on the "Application of Four-Wire Three-Phase Systems in Reconstructing and Modernising Central Stations." From an abstract of the same in the *Electrical World*, it seems that the Chicago Edison Company was one of the first to adopt this method of primary high-tension distribution for its outlying districts. The voltage used on this system is 4,000 between any two outside legs of the three-phase circuit. A fourth or neutral wire is run, which gives 2,300 volts between any of the outside wires and the neutral. When large motors are to be run, the transformers for the motors are connected delta-fashion to the outside legs of the circuit; the distribution, as far as the motors are concerned, is, therefore, 4,000 volts. For lighting circuits the three 2,300-volt single-phase circuits offered by the Y-connected three-phase system are utilised. The various single-phase lighting feeders are balanced between the three legs of the circuit. The distribution of these single-phase light circuits among the three-phase is done at sub-stations, at which each lighting feeder is provided by switches, whereby it can be thrown on to different phases. The system is said to have the advantage of giving the standard voltage for alternating-current single-phase lighting, while at the same time supplying larger motors at a higher voltage. Motors of less than 5 h.p., when not starting under load, are of the single-phase type. We gather that it has not been found difficult to maintain a balance between the three legs of the circuit.

Automatic Telephone System.—The American Patent Office have recently granted letters patent to Messrs. J. J. Brownrigg and J. K. Norstrom for an automatic telephone system, the chief claim for which is that it is simple and efficient, and entirely avoids any intricate and complex mechanism. Briefly, the system operates as follows: Circuit connections are automatically completed from any subscriber's station to the line wires of the other subscribers of the system by means of a movable contact operating over the terminal contacts of the line wires of the various subscribers. The movement of this movable contact in one direction, which results in the completion of the desired circuit connection, is effected by gravity. The movement in the opposite direction is positive, and accomplishes the restoration of the contact to initial or normal position. Electric currents are employed for the purpose merely of controlling such movements, and not to affect them. From an illustration of the arrangement given in our contemporary, the *Western Electrician*, we see that the movable contact is restored to initial or normal position positively and uniformly from a common source of power, each switchboard of the entire system being supplied with the air, gas, hydraulic or other pressure, or operating medium from the same source. By employing such an operating medium the inventors claim not only to avoid complex mechanism, but to produce an exceedingly simple and inexpensive central-station equipment. Instead of having a separate switchboard for each subscriber, one switchboard may be adapted, by suitable circuit connections, for the use of two or more subscribers, but in practice the inventors would prefer to employ a separate switchboard for each subscriber.

Liquid Chlorine Accumulator.—An Italian inventor named Pisca has devised an extraordinary type of accumulator, which depends for its action upon the chemical phenomena developed between zinc and liquefied chlorine. The reaction between zinc and this liquid has been applied already to the construction of primary batteries, but not hitherto to those of a secondary type. The apparatus in question is said to unite all the other qualities of accumulators with an E.M.F. and capacity superior to that of other types, and a higher efficiency. From a short description of the arrangement in the New York *Electrical Review*, which is taken from an Italian contemporary, we gather that the cell resembles a hermetically sealed battery. In a cylindrical glass jar fitted with a flange around its mouth is placed a disc of zinc, from which a rod projects out through a hermetically sealed opening in the bottom of the jar. The cover of the jar is of ebonite cemented on, and this carries a threaded rod of carbon, which passes down and makes contact with a carbon plate suspended a short distance above the zinc disc. Where the rod passes through the ebonite lid it is fitted with a conical screw thread, which makes a gastight joint. In the cover is also a hollow chamber closed with a threaded plug, and in this the liquid chlorine is introduced. To facilitate the action of the cell and increase its conductivity, a little alcohol or ether is added to the liquid, these carrying in solution zinc chloride. In operation the chlorine attacks the zinc with a formation of chloride, which is dissolved in the liquid. When the solution has been fully saturated, the cell may be recharged in the usual way, the chloride being decomposed, the gas returning to its liquid state, and metallic zinc being deposited upon the disc in the bottom of the jar.

Electrical Instruction in Indiana.—The annual prospectus of the Rose Polytechnic Institute, which has been established at Terre Haute, Indiana, now for more than 20 years, has just reached us. From this we see that the subject of electrical engineering is receiving that careful attention which its increasing inportance in the past

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few years calls for. The management are to be congratulated on the magnificent electrical equipment which is now installed at the institute, care having been taken to keep pace with the demands of times. Included in the electrical plant are a 50-h.p. compound engine, with a range of speed from 200 to 2,500 revolutions per minute on the dynamo shaft; a 36-kw. alternating-current Westinghouse dynamo complete, with transformers of from 250 to 2,500 watts capacity of various voltages and manufactures, arranged for experimental work; a model lighting plant of 250 lamps; a 4,000-watt 110-volt compound-wound dynamo specially arranged for experimental work; and a 25,000-watt 500-volt generator for the operation of several motors. A special testing and standardised laboratory is also provided. In this room a valuable and unique series of Lord Kelvin's standard electrical balances is mounted in a manner convenient for regular standardising or calibration work. These balances have exceptionally long ranges, and are guaranteed by certificates from Lord Kelvin as being equally suitable for the measurement of continuous and alternating currents or potentials. In a word, the electrical equipment at the Rose Polytechnic is such as will enable the attack of almost any problem in electrical engineering, and throughout the three years' course the students are instructed in these investigations.

Electrical Legislation.—In our last issue we gave the report of the committee of the Institution of Electrical Engineers appointed to enquire into the influence of electrical legislation in this country on the progress of the industry. The recommendations of the committee were given by us in full, but we had not then before us the complete report, including the evidence of the various witnesses examined by the committee. This evidence has now been published, and may be obtained from the secretary of the Institution for 2s. 6d. We would advise all electrical engineers who have interest in this matter to get the volume and to peruse the evidence given. At first glance it seems to us that the committee were not well advised in the selection of witnesses to appear before them. Thus out of nine gentlemen examined, eight were distinctly in favour of electrical undertakings being carried out by private enterprise, while only Alderman Pearson, of Bristol, was heard on the other side. This would naturally tend to the evidence being biassed in one direction, but it will be seen in looking through the questions asked the witnesses by members of the committee that the result is not misleading. For instance, the cross-examination of Mr. A. A. Campbell Swinton by Mr. W. M. Mordey clearly brings out that the manufacturing supremacy of America, so far as electrical engineering is concerned, has not been achieved with any financial success. We trust that the outcome of the enquiry, and the further action now to be taken, will be that the Board of Trade will be more ready to dispense with the consent of a local authority when it is seen that this consent is withheld on obstructive grounds only, or that the local authority by reason of its area and, perhaps, small population is unable to economically carry out the work which the company proposes to do.

Royal Institution. — The annual meeting of the members of the above institution was held on the afternoon of the 1st inst., Sir James Crichton-Browne in the chair. The annual report of the Committee of Visitors for the year 1901, testifying to the continued prosperity and efficient management of the institution was read and adopted, and the report on the Davy-Faraday Research Laboratory of the Royal Institution, which accompanied it, was also presented. It was stated that 44 new members were elected in 1901. The following gentlemen were unanimously elected as officers for the ensuing year: president—the Duke of Northumberland; treasurer—Sir James Crichton-Browne; secretary—Sir William Crookes; managers—the Right Hon. Lord Alverstone, Sir James Blyth, Bart,. Sir Frederick Bramwell, Bart., Dr. Thomas Buzzard, Dr. Donald Hood, Sir Francis Laking, Mr. George Matthey, Dr. Ludwig Mond, Dr. Hugo Muller, Mr. Edward Pollock, Sir Owen Roberts, Sir Felix Semon, the Right Hon. Sir James Stirling, Mr. John I. Thornycroft, and Mr. James Wimshurst. Visitors—Dr. Henry E. Armstrong, Dr. Charles Edward Beevor, Mr. John B. Broun-Morison, Mr. Francis Elgar, Mr. Francis Gaskell, Dr. Dundas Grant, Lord Greenock, Mr. Maures Horner, Sir Henry Irving, Mr. Wilson Noble, Mr. W. R. Pidgeon, Mr. Arthur Rigg, Mr. W. S. Squire, Mr. Harold Swithinbank, and Mr. Charles Wightman. At a general monthly meeting of the institution held on the 6th inst., under the presidency of the Duke of Northumberland, Dr. Alfred Hillier, Mr. Sydney Lupton, Mr. Carl F. von Siemens, and Mrs. C. F. von Siemens were elected members. The special thanks of the members were returned to Sir Thomas Sanderson, G.C.B., K.C.M.G., for a donation of £5. 5s. to the fund for the promotion of experimental research at low temperatures. The chairman announced that his Grace the president had nominated the following vice-presidents for the ensuing year: the Right Hon. Lord Alverstone, Sir Frederick Bramwell, Dr. Donald Hood, Mr. George Matthey, Dr. Ludwig Mond, the Right Hon. Sir James Stirling, Sir James Crichton-Browne, and Sir William Crookes.

Electric Searchlight for Field Service. — The *Scientific American* for the 19th ult. illustrates a simple form of electric searchlight which the Second Signal Corps of the New York National Guard are adopting for service in the field. As shown in the engraving, a locomobile is employed both for transportation and for producing the power to run an electric generator, which is located in a trailer attached to the rear axle. When it is desired to use the searchlight, the rear wheels of the motorcar are jacked up by tilting a supporting block against the rear axle and pushing the vehicle back on to it, thus raising the rear wheels about 2in. off the ground. The tongue of the trailer is now secured to the right end of the block, and a brass rod attaches the body of the trailer to the left end, thus ensuring a rigid connection and a perfect alignment of the generator pulley and the driving wheels. The generator is a 1-kw. engine of the Sprague type. It is provided with a 3½in. pulley, which is driven by a belt from the right rear wheel of the locomobile. It is necessary, of course, to couple together the differential gear on the rear axle, but this is easily effected, for the locomobile is of an early type, in which the differential gear is not encased. Boltholes are provided in the large bevel gears, through which bolts are inserted to clamp together the rear axle sections into an integral driving shaft, one wheel serving as a balance wheel for the other, which drives the generator pulley. Power is thus generated to run a 50-volt 10-ampere lamp. A marine projector of the Bogue make is used, having a 7in. Mangin mirror and projecting a beam of 8,000 c.p. The current generated can also be used in working the Ardois system of signals. It takes an incredibly short time to rig up the machine for action. Four men are employed to handle the apparatus, two of them being seated on the trailer while the machine is on the road. The trailer, aside from containing the dynamo and searchlight, has a large chest at the rear, in which emergency tools of all descriptions are carried. We understand from our contemporary that the

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searchlight has been subjected to tests which have showed it can be very advantageously used in the field, especially from an elevated position.

Electro-Chemical Polarisation.—The current number of the *Journal* of the Franklin Institute prints an interesting paper by Reed, in which he first reviews the widely differing definitions of polarisation given by numerous authors. He points out that polarisation is a phenomenon accompanying some kind of change in the condition of an electro-chemical cell due to the passage of an electric current. The inevitable effect of the passage of a current is to exhaust or destroy the chemical condition or composition of the cell as it was originally composed, and to produce a cell of different composition having different E.M.F., resistance, or concentration. There is an intimate connection between the progressive electro-chemical changes in a cell and its progressive polarisation, which points to the conclusion that polarisation is most correctly defined as a progressive change in the composition and E.M.F. of an electro-chemical system necessitated by the progressive exhaustion of one or more of the electro-chemical reagents. All of the so-called phenomena of polarisation are merely phenomena due to electro-chemical exhaustion—that is, phenomena due to the change of substitution of a new electro-chemical system for a preceding one. The author next examines the intimate relation between the energy evolved or absorbed in electro-chemical reaction and the phenomena of polarisation. As an example, he mentions the Daniell cell; while it gives current, the quantity of the copper sulphate is continually diminishing, while the quantity of zinc sulphate is continually increasing As the current increases, the original asymmetrical system is progressively converted into a symmetrical system. During this change there is a simultaneous progressive change of the E.M.F. When the amount of copper sulphate has decreased so much that it is insufficient to transmit the current, hydrogen will be deposited instead of copper, as water is more easily decomposed than zinc sulphate. The selective tendency of a current to be transmitted by a compound requiring the minimum absorption of maximum evolution of electrical energy in preference to other equally accessible compounds, is termed by the author the law of maximum electrogenesis. The recognition of this law makes it evident that in every case the phenomena of polarisation are merely phenomena of electro-chemical exhaustion.

Electrical Trade Questions.—Mr. R. Percy Sellon, the chairman of the Electrical Trade Section of the London Chamber of Commerce, has forwarded to us an extract from the annual report of the Chamber for the year 1901 relating to the work of that section. Reviewing the state of the electrical industry in the past year, the report makes reference to a number of important questions which have come before the Electrical Trade Section during that period. The first announcement of importance is that a committee of the section is still taking joint action with the Tramways and Light Railways Association on the question of "earth returns" as opposed to the action of gas and water companies in endeavouring to upset the settlement of the Parliamentary Joint Committee in regard to the matter. In February last year the section appointed an "Electrical Power Mains Regulations" Committee to consider whether and what modifications were desirable in the existing Board of Trade rules affecting electric power supply and transmission, and the result of their deliberations was the conclusion that an effort should be made to procure some modification of those rules. Accordingly, six recommendations were submitted to the Board of Trade representing the views of the section on the subject. In regard to the work of the Electrical Power Bills Committee, the case of the Lancashire Tramways Bill, in which parliamentary powers were refused to authorise the company to distribute electrical energy in the districts between Liverpool and Manchester, is cited as constituting an important precedent in the interests of Power Bills. The report next refers to the appointment of a sub-committee, consisting of the chairman and Major-General Webber, to represent the views of the section with regard to the inclusion of electrical stations in the Factory and Workshop Act, but as this matter was fully explained by Major-General Webber himself before the Institution of Electrical Engineers a few weeks back, it is unnecessary to do more than mention it. In conclusion, reference is made to the proposal of the Board of Trade to reduce the maximum price of electrical energy from 8d. to 6d. per unit, which proposal was eventually withdrawn. Other matters considered by the section during the year included interruption of telegraphic communication, private Bill procedure, and the appointment of the Board of Trade Departmental Committee on Light Railway and Tramway Legislation.

European and American Practice.—The members of the Cape Town Local Section of the Institution at one of their meetings this session were presented with some valuable notes on electrical engineering practice in Europe and America by Mr. John Denham on his return from a tour of inspection through the principal industrial cities of those continents. The author's remarks on the Nernst lamp which he saw in Berlin are interesting. There appeared to him to be quite a difference of opinion about the peculiarities of the lamp. In Berlin he was told it would work on an alternating or direct current circuit, and that its life was between 200 and 300 hours, with an efficiency of 1·4 to 1·5 watts per candle-power. On the other hand, in London he got the information that the life of the Nernst lamp was not determined, but that it was about the same as an ordinary incandescent lamp. He was further told that it would not work on an alternating circuit, and that when used with a direct current its polarity must not be altered once it was started up. Turning to central-station practice, it is interesting to note that, whether the power station be for lighting or power purposes, the generators are usually of three-phase both in America and Germany, 25 cycles and 6,600 volts being the standard practice. There is very little difference, he observes, between the generators built by the Westinghouse, the General Electric, or the German companies. They all have stationary armature with solid copper bar conductors and revolving field magnets. The shapes of the armature slots vary slightly, some being oval and others with parallel sides, in which case the conductor is held in with wooden wedges. The Germans prefer narrow armatures of large diameter, the Americans wider and smaller. The switches for dealing with high-pressure and heavy currents are of the oil-submerged pattern, operated either by compressed air or by motors. Three-core paper-insulated cables are favoured for underground work up to 11,000 volts. It is not unusual to find transformers in use which step down from 11,000 to 350 volts so as to give 550-600 volts direct current through rotaries for tram services. Mr. Denham remarks towards the end of his paper on the small number of men who are employed in the running of large stations in America, and also on the youth of the engineers in charge; and he mentions incidentally that the engineer in charge of the great Niagara power station, the overhead lines, and the various sub-stations is certainly under 40 years of age

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THE ELECTRIC CONSTRUCTION COMPANY'S WORKS.

The publication of descriptions of large new electrical manufacturing works, of which so many have recently been erected in England, is apt to make the casual reader forget that there are a number of old-established firms in this country possessing up-to-date factories. Amongst these the Electric Construction Company holds a leading position. Its works at Bushbury, Wolverhampton, were erected in 1892 for the sole purpose of making electrical machinery, and at that time they were unique in that respect. The works were designed on a plan which cannot be improved upon even now, and the machinery in them has been altered and added to from time to time, so that the equipment at the present time leaves nothing to be desired. A history of the large contracts which the firm has carried out would fill the present issue of our journal, but we propose only to say that the firm is equally noted for its direct-current, alternating, and three-phase machinery. In each class it has turned out machines of large output, but it was realised about a year ago that to make these economically a new shop equipped with larger tools was needed. This workshop we were invited to inspect last week, and found that it was equipped with all the tools required for handling the large units of plant which traction and power distribution schemes require at the present day. To give our readers some idea of this new department in the Electric Construction Company's works we reproduce four photographs, the

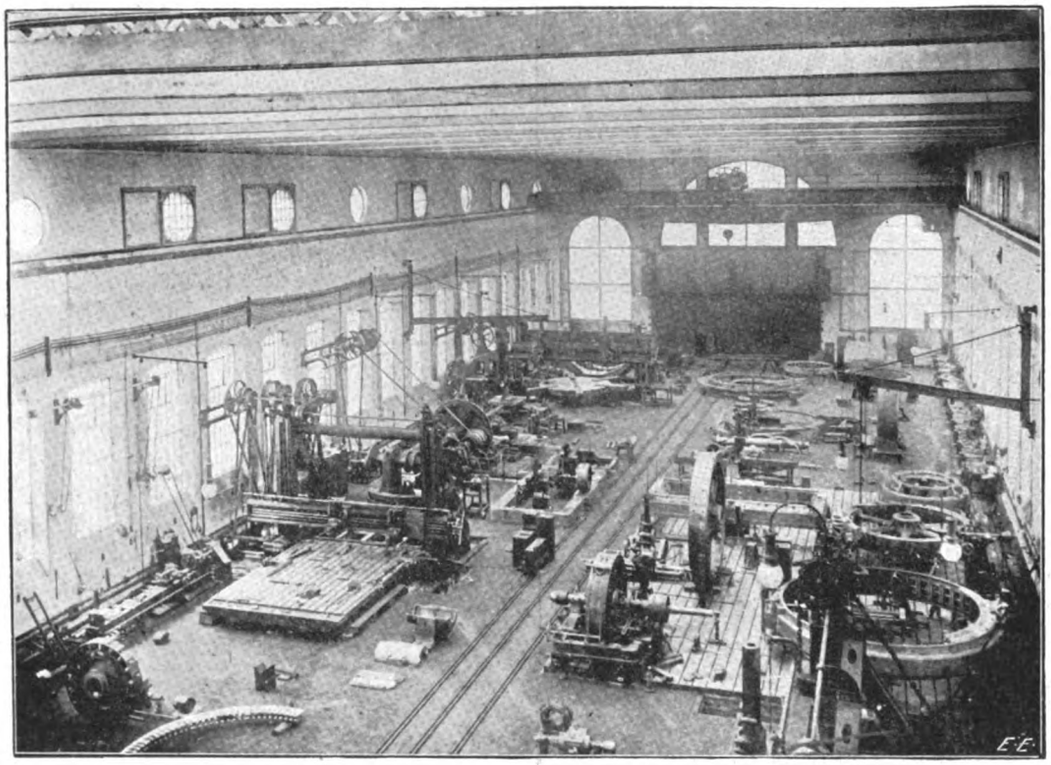

FIG. 1.—View of the New Shop of the Electric Construction Company for Large Dynamo Work.

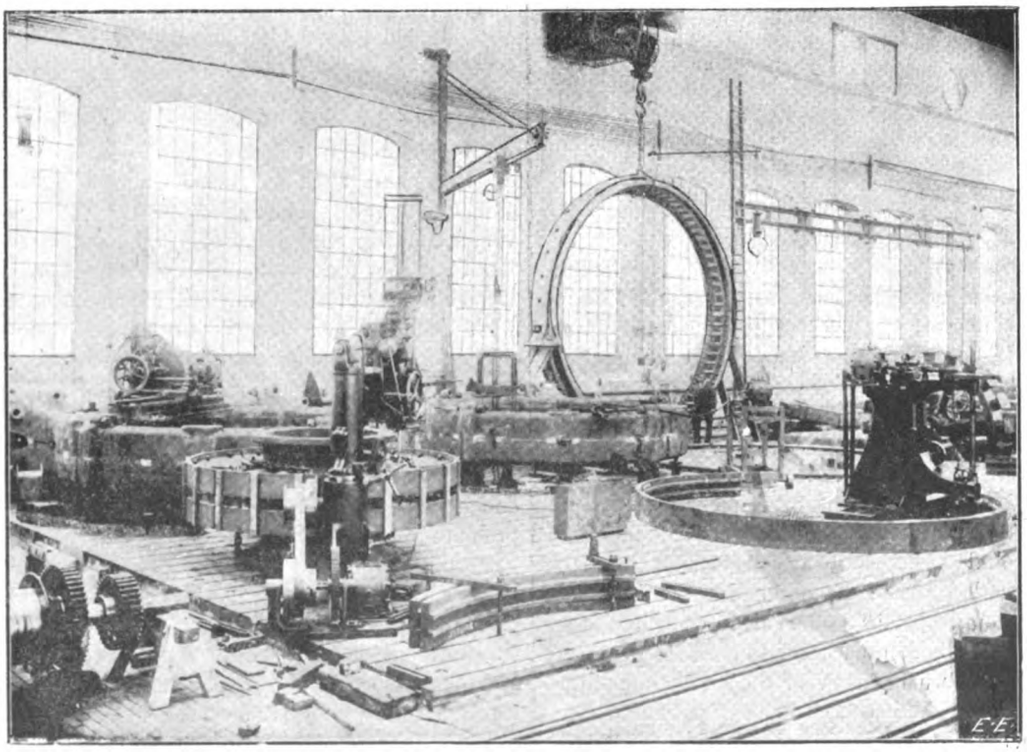

FIG. 2. Large Face Plate for Erecting Large Machines and for Supporting them while in course of Machining by Portable Tools.

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first of which (Fig. 1) gives a view of the whole of the shop, but in consequence of the large size of the same, the photograph as reproduced hardly gives a correct idea of its dimensions. In looking at this photograph, it must be remembered that the shop is 80ft. broad, this large breadth being spanned by two electrical cranes. On one of these there are two independent lifting crabs, while the other crane is equipped with a single crab. With these two cranes 60 tons can be lifted at the same time and moved about the shop. In the manufacture of these large direct-current and polyphase machines a few large tools are absolutely necessary, but the engineers of the Electric Construction Company have recognised the fact that the heavy establishment charges on these can frequently be avoided by the use of portable tools, which can be moved about from one part of a large casting to the other. In order, however, that accurate work may be done in this way, the castings must be supported on a face-plate, on which these portable tools can be stood. In the shop above mentioned, this requirement has been met by the laying down of a true surface plate 50ft. long by about 35ft. broad. This can be seen in Fig. 1, and an enlarged view of it is also shown in Fig. 2. In this latter illustration a variety of heavy castings are to be seen on the surface plate in course of being operated on by portable electric drilling and boring machines. The firm also make

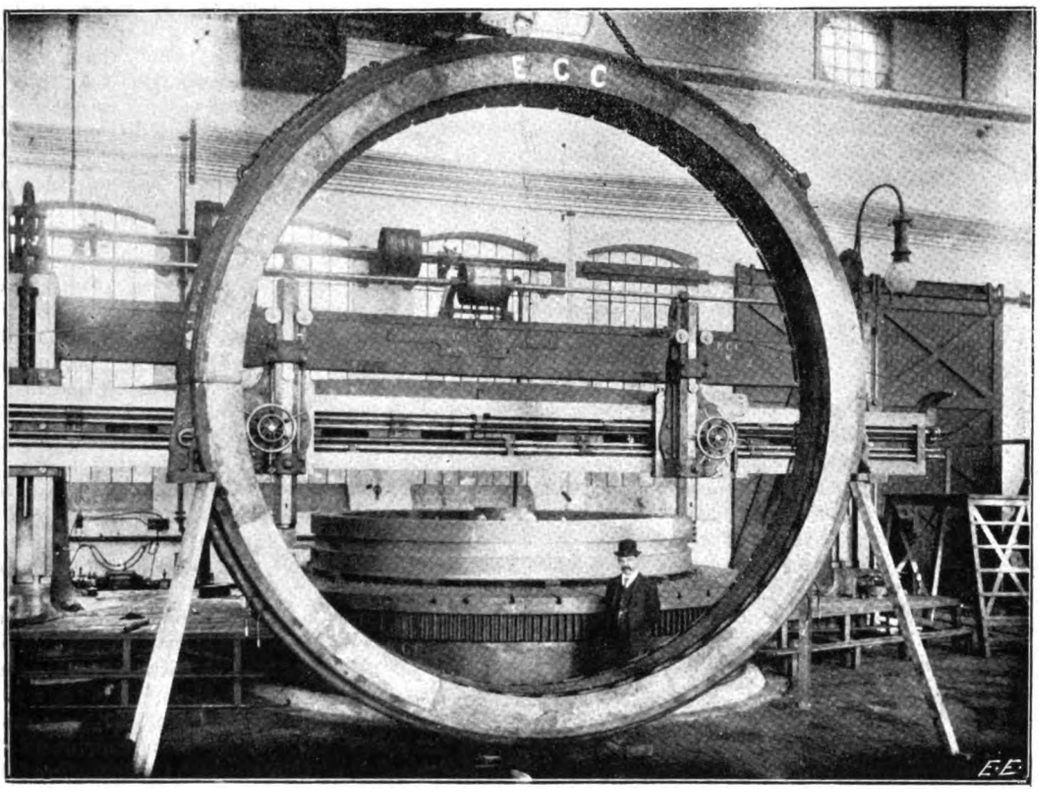

FIG. 3.—View of 32ft. Boring Mill, with Armature of 600-kw. Two-phase Alternator for Sheffield in the foreground.

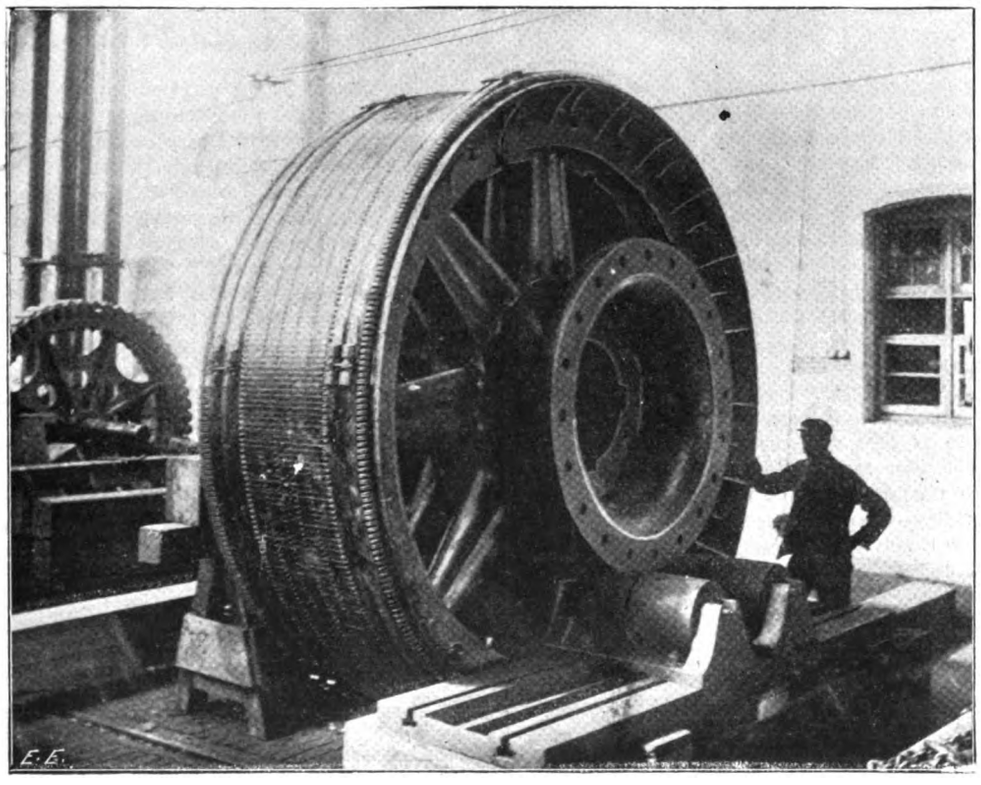

FIG. 4.—Armature of 800-kw. Slow-speed Traction Generator.

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extensive use of pneumatic tools, which are exceedingly handy when any chipping work has to be done. The electric tools are driven by three-phase motors, and are supplied by means of flexible conductors from wall plugs placed at convenient intervals along the walls of the shop. In Fig. 3 we give a view of the large horizontal boring mill erected in this department, which is capable of dealing with rings up to 32ft. in diameter. In the front of the mill will be seen the frame casting of a large alternator which has been machined in it. It may here be mentioned that the castings used by the company are all obtained from their own foundry at the Bushbury works, and we remarked on the excellent finish obtained on these castings. The original designer of these works took a very great interest in the foundry, and the reputation he obtained for the firm as the producer of highly-finished castings has been well maintained. The other large tools in the department deserving of special mention are the large planing machine, which can deal with a bedplate 18ft. long by 12ft. wide, and a large radial drill for boring rings up to 20ft. in diameter from the floor level. There is also another horizontal boring mill, which can deal with 20ft. rings and thus relieve the larger machine from the medium size work, while a few large lathes complete the list. It is noteworthy that the whole of the tools in this department have independent motors for driving them. This is, of course, the most economical way of doing the work, but in this case one is also struck by the absence of counter-shafting and by the wonderfully clear head-room which this absence gives for moving about the large castings by means of the electrical overhead cranes.

At the time of our visit some interesting work was in progress on some large alternators for the Leeds Corporation, which were being rewound so as to convert the machines from single-phase to two-phase working. The machines were originally designed by the firm so that this change could be economically carried out when required. In these machines, as in the others made by the company, the armature coils are wound by hand, and tubes of insulating material placed inside the tunnels of the iron armature core. These tubes project a sufficient way beyond the core at each end as to prevent any surface leakage trouble, and they give a perfect insulation between the core and the high-voltage winding. With these machines of large output the number of turns required in each tube is comparatively few, and the work of threading the wires through the tube and forming them to the right shape at the end is an exceedingly simple matter. Of course, this system would not meet with the old specification requirement that a coil could be quickly replaced in case of breakdown, but, as we have frequently pointed out, it meets the spirit of the requirement by effectually preventing the breaking down of a coil, and hence the need for replacement. The design of replaceable alternator coils has only too frequently resulted in a bad machine being obtained from a mechanical point of view, with the result of frequent breakdowns through mechanical strains on the insulation. The two new three-phase machines, also for Leeds, which are now going through the shop will have an output of 1,650 kilo-volt-amperes, and are expected to work at a power factor of ·8. These machines will run at 200 revolutions, and will give a frequency of 50 complete periods per second. We understand one of these machines is to be coupled to a Willans engine and the other to an engine made by Messrs. Belliss and Morcom. The revolving field-magnet system of these machines will weigh about 25 tons. In the design of these three-phase alternators great care has been taken to keep down the armature reactions, which frequently result in a large inductive drop. According to the specification, if one phase of the machine only is fully loaded, the drop of voltage in it is only to be 3 per cent. of the voltage of the unloaded phases when working on a non-inductive load. It will be seen that with machines with these good regulating qualities, there is no need to run a fourth neutral wire in order to get the pressure on the lamps practically constant for a varying distribution of load between the three phases.

Direct-current machines of large outputs are also being put through the shops of the company at the present time. In Fig. 4 we show the armature of an 800-kw. slow-speed traction generator in course of completion. The design of these machines is such that the commutating axis is not varied with alterations in load, so that the brushes are always kept in fixed positions. In winding the field magnets of these large machines, a somewhat novel procedure is adopted in order to reduce the length of the magnet poles, and consequently the diameter of the whole machine. With a given excitation, this decrease in length can only be effected by increasing the depth of the exciting coil. An increase of depth in this is apt to give trouble, as the heat on the inner layers becomes excessive owing to its having to pass through so many layers of copper and insulation before getting to the outside. Instead, therefore, of winding with an uniform depth, the Electric Construction Company's designers have designed what may be termed a corrugated winding, which offers a much larger cooling surface than usual for a given mean depth of copper. This corrugated effect is produced by winding more layers in one part of the magnet coil than in the other. These increased layers rise up in a V section, and are prevented from slipping out of position by being tied in to the layers immediately below them at frequent intervals. The armature conductors of these machines, as of all the smaller dynamos and motors for direct-current working made by the firm, are former-wound, and we were pleased to see the excellent organisation of this department of the works. The bulk of the labour in the department is done by girls, even to the placing of the coils into position on the armatures and fields of the smaller machines. We regret that the space at our disposal prevents us giving a full description of the older portions of the works and their modern equipments, but we need only say that we saw at work examples of all the latest types of automatic tools, and of the machines which with unskilled supervision are able to turn out repetition work at a cheap rate. The general conclusion of the matter is that the Electric Construction Company are fully prepared to meet competition from whatever direction it may come.

FORMERS AND FORMER-WINDING.

BY F. W. DAVIES.

I. General Remarks.

Former-winding, as is well known, is that method of field-magnet or armature winding in which the coils, instead of being wound either upon bobbins (in the case of a field magnet) or directly upon the core (in the case of an armature), are formed upon a block or frame of some description before being assembled in their respective places.

This method of winding has been steadily coming into favour for the past few years, and is now recognised by all electrical engineers as first-class practice. Ten years ago formed coils were practically unknown in this country. Numerous patents have been taken out at various times for different methods of forming wire-wound armature coils, and also for different kinds of end connections for bar-wound armatures. One of the first former-windings for wire-wound armatures to come into actual use was the evolute winding, invented by Mr. Eickemeyer, which is largely used at the present time by the owners of the patent in this country (Messrs. T. Parker and Co., Limited). Several patents have been taken out for the well-known barrel type of armature winding, and also for a variety of former-windings of somewhat similar design, but partaking more or less of the evolute style of winding. These latter may, not inaptly, be described as bastard windings. A few of the windings which have been patented resemble hand-winding, and are wound in sets—a set consisting of three or four coils, according to the number of sections in the armature. It would seem that in this case a different shape has to be given to each coil, or at least to each set of coils. This is obviously a disadvantage, as the use of differently-shaped coils on an armature complicates the winding, besides involving extra expense in manufacture. Almost every conceivable way of shaping the coils seems to have received the consideration of inventors. Some of the methods which have been brought out are now obsolete, and some will in all

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probability become so ere long, for the law of "the survival of the fittest" holds good in this as in all else.

Throughout the whole range of dynamo and motor design and manufacture, there is no feature more distinctively modern than former-winding. It is not many years since it first came into prominence, but it is now firmly established in the "public opinion" of electrical engineering, and it has undoubtedly come to stay. There are very few firms of any repute who have not adopted former-winding for the armatures of small and medium sized machines. The larger sizes, except when for high-tension work, are usually bar-wound; and bar winding may rightly be regarded as a species of former-winding. In the United States, especially, are the merits of former-winding recognised. For the armatures of tramway motors it is in practically universal use in that country. It is applicable to alternators, dynamos, and continuous-current motors; but it is on drum-wound continuous-current armatures with toothed cores that its advantages are most apparent. The field-magnet coils of most alternators may be wound on formers of similar construction to those used for continuous-current machines. The armature coils, too, of many alternators are precisely the same, in so far as the method of winding them is concerned, as those used for a continuous-current machine. Other alternators, which are manufactured under royalty, require special formers and jigs for the building up of the armature, a description of these, however, being outside the scope of the present series of articles. Former-wound field-magnet coils are very rarely used for dynamos, but in protected and enclosed motors their use is fairly common. In the choice of the type of former-winding for a given type of machine, there is practically a unanimity of opinion among the leading manufacturers. This unanimity tends to show that the types of winding in use are the best fitted for their respective purposes.

Notwithstanding the uniformity of practice in regard to the type of winding used, there is not such a uniformity in the construction of the formers themselves. Other points in design have been fully dealt with by electrical writers, but very little information regarding the construction and use of formers has been published. The methods used by individual manufacturers seem to be regarded somewhat in the light of trade secrets. One result of this is that the formers in use in various winding shops are of somewhat different construction. A winder, on commencing work at a fresh shop, frequently finds that the methods in use there are new to him. This difficulty occurs more or less in all classes of electrical work, but not to the extent that it does in matters pertaining to winding. That this want of uniformity is a disadvantage goes without saying. A little time spent in the consideration of this subject will be well repaid, for efficient winding is of primary importance. Nothing that will be said in these articles can do much towards rendering former-winding more popular; nor, indeed, are they written with that intention, it being too late in the day for that. It is proposed merely to describe a few of the formers and former-windings in use, and to discuss their uses and merits, or demerits, as the case may be. As in every other detail of the design of dynamo-electric machines, experience will sometimes lead the designer to make slight modifications for special cases. In empirical matters the ultimate appeal should always be made to experience.

The chief advantage attending the use of a former-wound field-magnet coil lies in the fact that, in the event of a fault developing in any of the inner layers of wire in such a coil, it is not necessary to unwind the whole of it in order to repair the fault, as would be the case if the coil were wound on a bobbin. However, as already mentioned, field-magnet coils are not often former-wound, except for motors of the protected and enclosed types, as the mechanical protection afforded to the coils by bobbins is considered by many engineers to be desirable.

Along with the introduction of former-wound armature coils, there has been of late years a general tendency towards the use of toothed cores, particularly toothed drum cores. One cannot but notice the great extent to which the toothed core co-exists with former-winding. Indeed, it is probable that neither of these features would have been adopted to the extent it has, were it not for the fact that each has tended to popularise the other. When a former-winding is used, it is of great advantage to use a toothed-drum core, on account of the greater facilities such a core offers for assembling the coils in position. Only those who have had experience in former-winding can fully appreciate the increased difficulty there is in assembling the formed coils in position on a plain drum core, as compared with a toothed core. Hence, when a former-winding is used, it is advisable, whenever practicable, to use a toothed core of the drum type. Conversely, when a toothed core is used the former-winding is preferable to hand-winding. This is on account of the difficulty of maintaining good insulation at the ends of the slots where the bend in the wire occurs, if the armature is hand-wound. Former-winding for armatures possesses many other important advantages over hand-winding. For instance, a faulty coil may be easily and quickly replaced without rewinding any of the other coils. True, it is necessary to partially remove a certain number of coils in order to take out the faulty one, but this is, comparatively speaking, a small matter. Then again, it is possible to insulate each coil separately, and, coils with the full potential difference between them not coming into such close proximity in the end windings, the risk of a breakdown from short-circuits is very much less. Besides which, a former-wound armature has a far neater appearance than a hand-wound one. Lastly, and this is, perhaps, the greatest advantage of all—certainly it is as far as efficiency is concerned—it is necessarily in perfect balance, both electrically and mechanically. An ordinary hand-wound drum armature with a plain core is sometimes seriously at fault in this respect unless coils which are connected to opposite bars of the commutator are wound at the same time, or else a "symmetrical" winding is used. A case in which a hand-wound armature was very much out of balance, electrically, came under the writer's notice quite recently. The core was of the plain drum type, and the method of winding the armature was that every alternate coil was wound first, this being done all round the armature until all the coils were put on. This is a simple, though bad, method, and one that is common for small armatures. It was wound for 200 volts. On making a special test of the voltages on two halves of the winding it was found that there was a difference of several volts, which was quite sufficient to cause serious heating of the armature, besides tending to cause sparking at the brushes. It may be mentioned, in passing, that this defect would not have been so marked had a toothed core been used, as the stray field at the ends of the armature would in that case have been considerably less; the said field, in conjunction with the unsymmetrical end windings, being the cause of the armature being out of balance.

It will be useful to give a general classification of the principal types of formers in use. For field-magnet coils they may be said to be of two kinds—the simple block former, consisting merely of a block of hard wood of slightly larger section than the magnet core; and the divided block former, which is made up of several wedge-shaped pieces of hard wood and provided with flanges. Armature-coil formers may be regarded as belonging to one of the two main classes—the ring and the drum. Each of these, again, may be sub-classified, as wire-wound and bar-wound, according to the material used for the conductors. Ring armatures with wire winding are seldom former-wound. When they are, the coils are wound on a former similar to an ordinary magnet-coil former, and are then slipped over the armature core, which must be built up in two or more sections, as subsequently described. When bar-wound the bars must be of special shape. The former-windings used for wire-wound drum armatures are of three kinds—namely, the evolute, the bastard, and the barrel. The formers for each of these types of winding may in their turn be either of the block type, in which the coils are usually wound in an undeveloped form in the first instance, and then worked into the required shape upon the former; or of the frame type, upon which the operations of winding and forming are performed simultaneously. Formers for bar-wound drums come under the head of either the evolute or the barrel type, and are usually of the block variety. The significance of the foregoing classification

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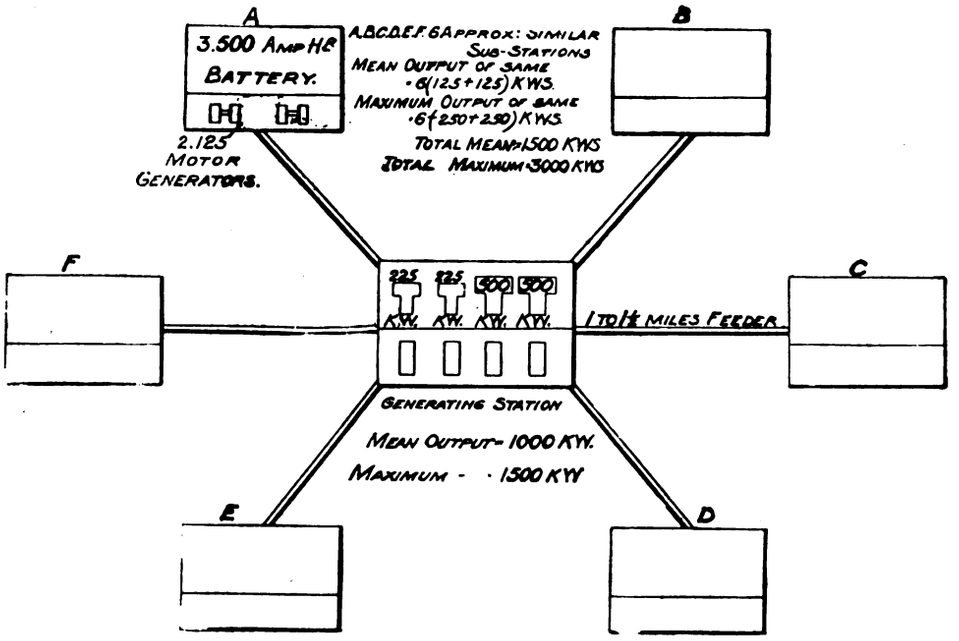
will be more apparent when the various formers are dealt with.

(To be continued.)

THE SUPPLY OF ELECTRICITY BY DIRECT CURRENT.

BY J. F. MOORE.

Every item that contributes to the stability and economy of electric supply is, of course, of great importance to every electrical engineer. Take the case of the supply of a town of something like 150,000 inhabitants by a generating supply at 220 or 500 volts and its subsequent distribution. In these days short and crisp information is necessary, and by the proper reading, the diagram herewith will, I feel sure, be sufficient to explain the general principle that I wish to make prominent—viz., storage in the right place and at the right time. You will see that by the steady running (and consequent high load factor) of some 1,000 kw. it is easily possible to deal with a maximum load of some 3,000 kw. The radius of supply—some two miles—is considerable, and is usually sufficient for most towns of the size taken.



Advantages.—(1) Stability of supply; (2) short-circuits on feeders liable to cause total extinction rendered comparatively safe; (3) easier location of faults; (4) very high load factor; (5) batteries at the proper position for economy; (6) batteries to take some 10 or 12 hours to charge at times of light load, so keeping a steady load at the station; (7) plain two-wire system throughout; (8) less risk of breakdown due to lower pressures.

From the above one sees the function that the main feeders play in the supply by the adoption of 220-500 volt or three phase, as the difference in first cost is practically dependent on main feeders. The same is applicable to tramways.

Costs.—Taking the example as per diagram, and working out costs for same, at a generating pressure of 500 volts, we have:

Main Station.		*Six Sub-Stations.*	
Buildings, Machinery, Main feeders, Professional services and incidentals,	= £48,000.	Buildings Batteries, Motor-generators, Feeders and mains, Meters, etc.,	Total, £144,000; £24,000 each.

Capital Expenditure, £192,000.

Board of Trade units used per annum by consumers = 4,000,000.
Maximum load observed, 3,000 kw.

B.T.U. supplied by battery	1,250,000	Efficiency of battery 65 %.
B.T.U. supplied to battery	1,923,000	
B.T.U. supplied by motor-generators	2,750,000	Efficiency of M.G. 80 %.
Total B.T.U. supplied to motor-generators	5,850,000 units generated.	

Works Cost (Consumers' Units).	d.
Coal (5lb.) per unit	·25
Oils, etc.....	·05
Repairs, etc.	·07
Wages	·15
Management	·09
Sinking fund and interest ..	·90
Total cost	1·51

Coal Consumption per Unit generated. Table.		
Load factor,	10 %	10lb.
,,	25 %	5lb.
,,	50 %	4lb.
,,	75 %	3·5lb.
,,	100 %	3lb.

INSTITUTION OF CIVIL ENGINEERS.

At a special meeting of the institution on the 23rd ult., Mr. Charles Hawksley, president, in the chair, the tenth "James Forrest" lecture was delivered by Sir William Roberts-Austen, K.C.B., F.R.S., Hon.M.I.C.E., the subject being "The Relations between Metallurgy and Engineering."

The lecturer stated that this was the subject with which the council had requested him to deal in his lecture, but it must not for a moment be imagined that the metallurgic art was not included in the wide range covered by the institution, which had from its earliest days given prominence to the work of metallurgists. He quoted Mr. P. G. Bidder, who in his presidential address to the institution delivered in 1860 said "that if he were called upon to define the object and scope of the profession of civil engineer he would say that it was 'to take up the results discovered by the abstract men of science and to apply them practically for the commercial advantage of the world at large, and to diffuse their beneficent influence among all classes of his fellow-citizens.'" He hoped to be able to show that metallurgists practising an industrial art had helped the engineer to do this, and in evidence that such was the case he quoted from the presidential address of Sir John Fowler words to the effect that engineers had been more assisted by members of the institution and by distinguished men of science generally in relation to iron and steel than as regarded any other material. It was in connection with iron and steel that the illustrations of the lecture would be mainly given. It might at first be thought that the relations between metallurgists and engineers, which had become so close and enduring, arose quite simply from common interest. The case was, however, far from being so simple; communication between those who extracted metals from their ores and adapted them for the use of the engineers, who actually employed metals in construction, was seldom, at the outset, quite direct. The relations with which the lecture dealt had been strangely stimulated by the intervention of men who, in many cases, were neither engineers nor metallurgists, but were men whose lives had been devoted to abstract science. Such men recognised the

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value of certain metals and alloys for definite uses, they investigated their mechanical properties, and proclaimed their merits to engineers. The intervener then disappeared, leaving behind some coefficient or constant bearing his name by which he was gratefully remembered. As an instance, Galileo's estimation of the tensile strength of copper cylinders and Young's determination of the rigidity of steel (which had resulted in Young's modulus) were cited.

It was not easy to fix the period in industrial history at which the metallurgist began to give the engineer material assistance. If in this country Stonehenge were taken as a starting point, the architect-engineer who designed that crowning example of neolithic art could not have received any assistance from the metallurgist. That stately structure arose from the plain at a time when bronze tools were known, but were not in general use, and this period had recently been fixed by Mr. Gowland at about 2,000 B.C. In another phase of engineering work it was known that Rome, in the days of her occupation of this country, trusted to the metallurgists of our island to supply the lead which was so extensively used in the Eternal City. The fourth-century wrought-iron column, discovered in India, and the girders and beams of the Orissa temples, rendered it necessary to exercise great caution as to the period at which iron was used in construction. Such magnificent efforts as those given were, however, not maintained, and no widespread or continuous records of the metallurgists' contributions to early constructive work could be presented. On the other hand, the civil engineer had, to quote the charter of the institution, "advanced mechanical science and directed the great sources of power in Nature for the use and convenience of man," for ages before the metallurgists rendered more than incidental service. As examples of great engineering works into the construction of which no metal entered, the lecturer referred to, and gave illustrations of, the primitive cantilever bridges of pine trees used to cross mountain torrents in Savoy. The interesting thirteenth-century cantilever bridge made up of 20ft. beams given in the note-book of Villars de Honnecourt was also shown, as was a bascule bridge of the Middle Ages. The dome of Milan Cathedral, as designed by Leonardo di Vinci, the great Tuscan painter, engineer, and architect, was also referred to as an example of a structure in which metal was not used. The employment of cast iron from the time of Queen Elizabeth to the present day was then dealt with, and the proposed cast-iron bridge of 600ft. single span, by Telford and Douglas, was referred to, and it was pointed out that in the nineteenth century metallurgists, by creating the age of steel, more than atoned for their somewhat tardy and intermittent efforts to supply engineers with suitable materials.

As regarded the use of cast iron and malleable iron, the influence of Watt in developing the steam-engine was traced, and it was admitted that the necessity for pumping water out of mines was the main factor in the evolution of the steam-engine, and, in turn, the development of British metallurgy of iron and steel dated from the time when the steam-engine of Watt enabled air to be readily pumped into the blast furnace employed for the production of cast iron. It was then pointed out that more than half of the last century had elapsed before the "age of steel" began, and that towards the end of the century great attention was devoted to considerations connected with the molecular structure and properties of steel, and to enforcing the action of carbon, the element which gave steel its properties, by the addition of other elements than carbon in very small proportions. With regard to the slow growth of confidence in the qualities of steel, the opinion of successive presidents of the institution, as expressed in their addresses, was quoted; Sir John Hawkshaw, Sir John Fowler, Sir Frederick Bramwell, Mr. W. H. Barlow, Lord Armstrong, and Sir George Bruce being specially alluded to. In 1887, when Sir George Bruce delivered his address, the merits of steel had at last received recognition, and, as regards the crowning triumph of the age of steel—the Forth Bridge—Sir George exultingly exclaimed: "At the Menai Bridge, the total quantity of iron was 11,468 tons; at the Forth Bridge, there will be 50,000 tons of steel and iron." No one had done more than Sir Benjamin Baker to insist on the importance of phenomena which engineers used to consider "mysterious" in connection with the behaviour of steel, and his warnings and example were at last being regarded and followed. The lecturer pointed out that when metallurgists gave engineers mild steel, they provided a cinder-free solid solution of iron and carbon. All subsequent advance had been due to the recognition of this fact, and to the gradual study of the properties of metallic solid solutions. Sir John Hawkshaw, in his presidential address to the institution, delivered in 1862, had said that if the strength of iron could be doubled, the advantages might be equal to the discovery of a new metal more valuable than iron had ever been. The lecturer contended that this was exactly what metallurgists had done with regard to steel. By suitable thermal treatment, and by suitable additions of comparatively rare metals, they had doubled the strength of steel as it was known in its early days. The nature of solid solutions was then explained, and the importance of allotropic modifications of iron was dwelt upon, this portion of the subject being illustrated by some difficult experiments. The question was then asked, Could the past molecular history of a mass of steel be traced by microscopic examination of the solid metal? Some very beautiful experiments by M. Osmond, Mr. Stead, and others were appealed to in evidence of the possibility of this. It was then demonstrated that solid metals might even reveal, by their structure, the vibrations to which they had been subjected, and Sir Benjamin Baker had constantly insisted on the importance of such vibrations. In making this clear, Vincent's experiments on the beautiful wave-structure that might be imparted to the surface of mercury by the aid of a vibrating tuning fork were then exhibited, and it was demonstrated that the surface of solid lead which had been subjected to similar vibrations possessed a similar structure to the vibrating surface of mercury.

Finally, with regard to the efforts metallurgists were making to study the influence of rare metals on iron and other metals, the reducing power of aluminium on metallic oxides was shown. Very high temperatures of 3,000deg. C. and over were attained, and brilliant light was produced during the reduction of chromium, cobalt, nickel, and other metals from their oxides.

In conclusion, the lecturer appealed to the new Alexander III. Bridge at Paris as showing the need for the careful measurement of high temperatures in connection with the treatment of large masses of steel. In the construction of the bridge 2,200 tons of cast steel had been employed, and a peculiar molecular structure was imparted to the steel by rapidly cooling it in air from a temperature of 1,000deg. C. to 600deg. C. This gave the metal certain mechanical properties which it would not otherwise have possessed. With reference to the aid given by metallurgists to engineers in connection with ordnance, reference was made to the address delivered by Mr. T. Hawksley, the father of the president, in 1872. He said that "in no way" other than by the study of such questions "could the Institution" of Civil Engineers "serve its country better, or better promote, in the interests of peace, the advancement of practical science and its application, if events should order, to the purposes of protective warfare." The use of copper, aluminium, and other metals in electrical engineering was referred to, and the lecture ended with an appeal for the more extended study of the physical properties of metals.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers

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to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

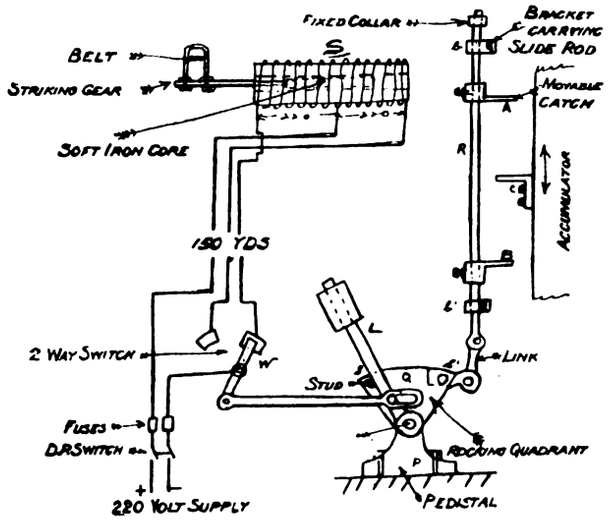
479. I have seen on a high-tension alternating switchboard an instrument indicating power factor, but can find in no text-book a description of its mechanism, and I should like it explained.

480. Describe, with sketches and diagram of connections, a good type of series-parallel controller for electric overhead travelling crane.—W. H.

ANSWERS.

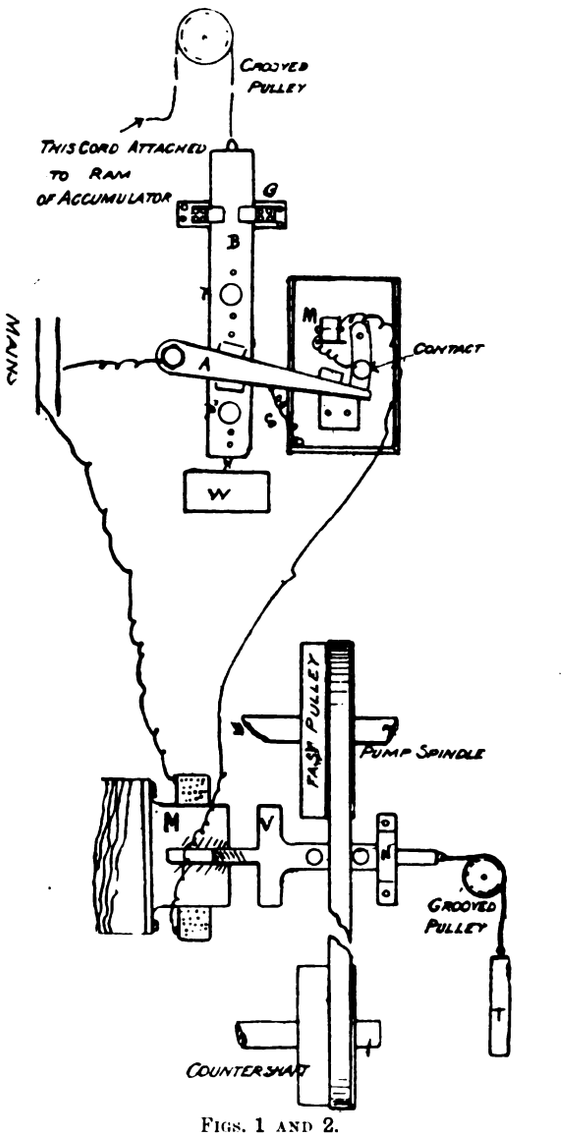
Question No. 473.—There is in a shipyard here a hydraulic accumulator worked by three pumps driven by a gas-engine. The distance between the accumulator and the pumps is approximately 150 yards. The accumulator formerly automatically stopped and started the pumps as required, there being levers on the side of the tower which opened or closed valves at different positions. These valves were connected with hydraulic striking gear on each pump. The small pipes from the valves on the accumulator to the striking gear on the pumps have been a considerable source of trouble during frost. Is there any satisfactory method of working the striking gear electrically and controlling it automatically from the accumulator tower? There is electric power at 220 volts available.

Best Answer to No. 473 (*awarded* 10*s.*).—This result could be attained in several ways more or less expensive.



The accompanying rough sketch shows an arrangement which if worked out might be useful: A fine-wire solenoid, S, with core, to which is attached the striking gear, and would be fitted with the necessary stops to prevent the belt being pulled too far either way. The solenoid would be wound as shown, which would necessitate three wires being carried to the two-way switch, W, which would be operated by weighted lever, L, which would swing between studs, *s s'*, on rocking quadrant, Q. This quadrant could be supported by two pedestals carrying shaft, and connected with a link to slide rod, R, which would be mounted on side frame of accumulator, and free to move up and down through brackets, *b b'*. This slide rod would carry two adjustable catches, A and B, and another catch, C, fixed on accumulator weight, which would engage with A and B at top and bottom, and in this way operate two-way switch, W, which controls the two windings on solenoid. Of course, at voltage stated in question—viz., 220 volts—a non-inductive resistance would possibly be necessary to be connected to two-way switch, W, to take up the spark. A little more expensive arrangement would be to fire out the gas-engine and use an electric motor, whose starter could be operated in a similar way by a solenoid with a single winding and fitted with a dash-pot brake, so that the arm of starter would not be pulled over too quickly, and replace two-way switch with a double-pole one.—J. D. A.

Answer to No. 473 (*awarded* 5*s.*).—We presume that the engine is always running whenever there is occasion to run the pumps, then by applying the following method "M. K. R." would have an efficient apparatus for controlling the pumps, which would not be incapacitated by inclement weather. An arrangement similar to the one here described has come under the writer's notice, and has worked very well for a long time without a hitch. Two contrivances are necessary, one situate near the accumulator and the other in the pump-room. We will first of all consider the arrangement worked by the accumulator, or, rather, by the rise and fall of the ram. In Fig. 1 is a switch which is connected to the ram by means of a steel wire, which passes over a grooved pulley, the rise and fall of which (the ram) stops and starts the pumps. The action of the switch is as follows: Suppose the ram to be falling, then the bar, B (Fig. 1), would rise, being guided by guide blocks, G, and the pin, P', would force the switch arm, A, on to contact. Immediately contact is made, the pumps are started by an arrangement to be considered shortly,



FIGS. 1 AND 2.

and the small magnet, M (in series with M, Fig. 2), grips the arm and holds it there until the ram has risen sufficiently, when the bar, B, in descending forces the arm from M by means of pin, P; a quick break being ensured by the spring, S. It will be seen from Fig. 1 that the pins, P, P', can be adjusted—*i.e.*, screwed into different holes—by means of which the desired rise and fall of the ram can be attained. Two vulcanised-fibre blocks must be screwed to A, where the pins touch, to prevent leakage of current.

We will now consider the arrangement fixed in the pump-room (Fig. 2). A powerful magnet is provided and firmly bolted to a beam or other handy timber. When the current is switched on to this magnet by means of switch (in Fig. 1), it powerfully attracts the mass of iron, V, to which is attached the usual fork arrangement for shifting belts from the loose to the fast pulley. Hence, as soon as V or the armature is drawn to M, the belt is shifted to the

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fast pulley on the pump spindle. The belt is held in this position until enough water has been pumped, when the switch is knocked off, and the belt is restored to its original position by the action of the weight, T. The armature is suitably supported at either end, as can be seen from Fig. 2. A shoulder on the fork arm, which catches against the bearing, N, prevents the weight, T, from pulling the belt over too far.—W. F. SAUNDERS.

Question No. 474.—Two dynamos on test, one 75 kw. and the other 150 kw., both identically of the same four-pole type (and by the same makers), except the larger machine has a pole ring, the smaller has not; they are both fully loaded up on artificial load. The full load is then switched off the 150-kw. machine without so much as a spark being observed at the commutator; the 75-kw. machine is tested in the same way, and immediately the brushes spark violently, and before the lead can be shifted the machine had flashed over—this test was tried repeatedly, and every time the machine flashed over. What is the cause of this, and how can the machine be remedied to pass the test successfully?

Best Answer to No. 474 (*awarded* 10*s.*).—Briefly stated, the condition necessary for sparkless commutation is that at the moment when the coil passes from under the brush there shall be flowing in it a current equal in sense and magnitude to the current flowing in the series of coils which it is about to joint. In order that such a condition may obtain, the coil must be short-circuited in a field of sufficient strength to generate in the coil an E.M.F. capable of causing such a current to flow. Two factors have to be taken into consideration: (1) as the load in amperes is increased, a greater reversing field is required; (2) the greater the current generated, the greater will be the distortion of the magnetic field due to the armature reactions, and the reversing field will be proportionately weakened. For both these reasons an increased lead is required with an increased load, and if the machine is run on light load with the brushes in the position for full load, or *vice versâ*, sparking will be set up. The amount of sparking will depend upon amount by which the value of the angle of lead varies from the right value for the particular load. With a 75-kw. generator, however, flashing should not occur, although there might be excessive sparking with any load if the brushes are anywhere between the true positions for no load and full load. As proof of this the writer might say he once, for a special purpose, reduced the E.M.F. of a 50-kw. generator from 230 to 150 volts simply by altering the position of the brushes. The generator was run in this way for 20 minutes, and while there was excessive sparking, no other damage was done.

In order to obtain fixity of lead, or one position of the brushes for all loads, various devices have been contrived. One of these devices is the employment of the pole-ring. The theory of this arrangement is outside the scope of the present answer, but it may be said to prevent any great distortion of the field. From what has been said before it is hardly likely that the omission of this ring causes the trouble, although it may give rise to some sparking. There are some illnesses which a doctor can prescribe for if he is told the symptoms, but there are others for which he would not prescribe unless he himself diagonised the patient. So with dynamos—peculiarities in behaviour may arise which an expert will readily explain, but there are others which the wise man will not care to pronounce definitely upon unless he himself has examined the machines under the given circumstances. This may be classified as one where it would be advisable to have the machine inspected by an expert. From the data given the writer thinks the phenomenon is entirely due to self-induction of the compound turns.

From Lenz's law, we know that self-induction prevents a growing current from immediately attaining its full value, and maintains a dying current for an appreciable time. If, however, the circuit forms a spiral with an iron core, the effect of the collapsing of the magnetic field due to the stoppage of the current will give rise to a high E M.F This is seen in the case of the ordinary medical coil. Now, when the current is suddenly broken the current in the series winding is stopped, and a high self-induced E.M.F. is created, which experience has shown over and over again will readily flash from brush to brush. It may be contended that if this be the cause the same result will obtain with the larger generator. This is not necessarily the case, although the two machines are said to be identical. Will "R. M." guarantee that the induction is the same in each case? It may be that with the larger generator the fields are practically saturated by the shunt turns, and only moderately magnetised by the shunt in the case of the smaller machine. If so, the self-induction of the series turns would be enormous. The larger machine may be connected up with a long shunt, which would offer a path for the induced current, and the smaller machine with a short shunt, which would offer no relief path. Again, is "R. M." certain of his connections? Is he sure that in stopping the current of the 75-kw. machine he does not break his shunt? We are told that, with the exception of the pole-ring, the machines are identical. Now, the machines must be most badly designed if it is the omission of this which makes the difference, so that this may be left out of consideration, and the fault put down to self-induction, which we know often causes flashing over.

Now for the cure. If the fault is due to the breaking of the shunt current, the shunt must be permanently connected, so that it cannot be broken. If it is due, as is probably the case, to the breaking of the current in the series turns, an improvement can be made by coupling the two ends of the series together through a low resistance, or, in other words, putting a low-resistance device of sufficient carrying capacity in parallel with the compound turns, thus offering a ready path for the induced current. It is easy to see whether the above explanation is correct. Let "R. M." run his machine at full load with the brushes in the right position. Now, without altering the brushes during the experiment, let him gradually reduce the load to zero by steps, say, of 20 kw. at a time. If no flashing occurs, it is evident it is not due to the omission of the pole-ring, which is employed only for commutation purposes. Let him then put in the parallel resistance and try breaking the full load again, and the writer thinks he will find that the difficulty is overcome.

A similar result was experienced some time ago with a traction generator in a large tramway station. There were six circuits and all the circuit breakers were set open too high; the result was that they never opened, but at times the main circuit breaker, which was set rather low, did so on many occasions, and in every case flashing occurred. The writer had all the circuit breakers readjusted, the smaller ones set lower, and the main higher. Afterwards three branch circuit breakers could open instantaneously without flashing. This machine could not stand the whole load being suddenly thrown off; a parallel device for the compounding was inserted later, and while it greatly improved matters, it did not entirely do away with the flashing when the full load was cut off, although it reduced it so far as only to slightly mark the commutator.—M.

Answer to No. 474 (*awarded* 7*s.* 6*d.*).—This is certainly a rather unusual case, and the inference is that the "pole-ring" which is fitted to the 150-kw. generator had greatly improved the commutation, at any rate, so far as running with fixed brushes is concerned. By "pole-ring," I presume, is meant that the pole-shoes consist of a solid ring of iron fixed to each pole, and concentric with the armature, having holes cast through it at the interpolar spaces in order to keep down the flux leakage from pole to pole to a reasonable figure. I do not think, however, that this arrangement can be good in any way as regards commutation, and if the big machine is so much better than the other for running with fixed brushes, it is not because of the "pole-ring," but in spite of it.

Let us examine the causes which produce good commutation, especially with regard to fixed brush position. In order that there may be *no* sparking whatever, the current in the commuted coil must be completely reversed by the time that it has "passed under the brush," and in order to do this we must have the following conditions fulfilled: (1) If the coil is in the neutral position—*i.e.*, is in *no* field except that due to the induction flux—the inductance of the coil must be such that the reactance voltage it produces must not be too great to prevent the current from being completely reversed during the time

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the coil is being commutated. (2) If the coil is in a reversing field, the voltage set up in the coil by this field tends to help commutation by opposing the reactance voltage; hence in this case we may add the volts set up by the reversing field to the maximum permissible reactance voltage calculated for case (1). (3) If the coil is in an anti-reversing field, the voltage set up in the coil tends to cause the current to persist in the same direction, so helping the self-induction, and we must, therefore, subtract it from the maximum permissible reactance voltage calculated for Case 1.

Mr. Hobart, in a very interesting paper read at the Engineering Congress at Glasgow last year (see *Electrical Engineer*, Sept. 27, 1901) gives the following formulæ for reactance voltage, neglecting external fields—*i.e.*, Case 1:

$$R.V. = 2\pi n L C \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where C = normal current per bar—*i.e.*, current per circuit;
L = coefficient of self-induction;
n = periodicity of commutation.

Now the time a commutator part takes to pass under the brush is equal to $\frac{60 \times w}{\pi R D}$, where w = width of brush in inches, R = revolutions per minute, and D = diameter of commutator in inches. Now, Mr. Hobart reckons that the current in changing from, say + maximum to − maximum describes a *half* period of a sine curve, and since he takes his n to be the periodicity of this sine curve, it will be just half the value of the true time of commutation given above. Hence $n = \frac{60 \times w}{2\pi R D}$. The other terms in his R.V. formulæ are 2π, and this is again because of his sine-wave supposition.

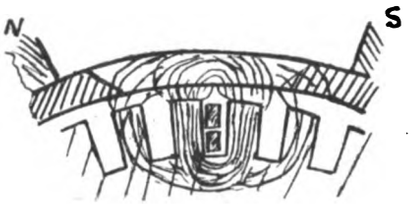

Fig. 1.

In his paper he says that a R.V. of 4 means good commutation, while 6 is an outside figure. We may, therefore, write

$$2\pi n L C = 2\pi \times \frac{60 \times w}{2\pi \times R \times D} \times L \times C \text{ must be less than 6,}$$

or,
$$\frac{w \times L \times C}{R \times D} \text{ must be less than } \cdot 1 \quad . \quad . \quad . \quad (2)$$

Turning now to our machine fitted with a pole-ring, we see that, owing to the fact there is iron just above the coil being commuted, the flux path round the coil is greatly decreased in reluctance (see Fig. 1). This, of course, means more lines per ampere per centimetre length linked with the coil, and hence a much greater value for L in equation (2), which is bad. Hence we see that commutation with the brushes in *any* position is made worse by a pole-ring. We will now see how a pole-ring affects running with a fixed position of brushes. If we take flux distribution curves of a dynamo on open circuit and full load, we shall get something like those shown in Fig. 2. Here we see that the full-load curve has moved forward owing to the armature reaction, which sets up a cross flux additive to the magnet flux on one side of the pole and subtractive on the other. The difference between the open-circuit and full-load curves would, if plotted, give us the armature cross flux. From these curves we see that if we keep our brushes at the neutral position, $x\,x$ (which is the no-field position on open circuit), they will be in a heavy anti-reversing field when the load comes on. If we can shift them about, so as to always keep them in a no-field or reversing field, things are fairly easy, but if we have to keep them in the same position for all loads it is rather harder, and we must make a compromise by putting them in some position, y, between the open-circuit and full-load curves. Here we have a fairly heavy reversing field on open circuit, and a slight anti-reversing field on full load. If we were to try and get them in a reversing field on full load, say at z, we should probably find that the coil would be over-commutated on open circuit, and so cause sparking, the effect of this being that the E.M.F. sets up a circulating current in the short-circuited coil, so causing an excessive current density in the brushes, and, hence, sparking. Now the further the full-load curve shifts forward the greater will be the fields on both open circuit and full load, and the more difficult it will be to run with fixed brushes. Here, again, the effect of the pole-ring is bad, since it makes the reluctance of the path taken by the

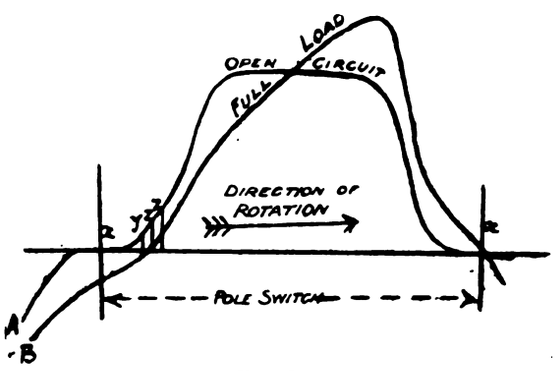

Fig. 2

cross flux less (see Fig. 3), so producing more cross flux, and hence a greater shifting forward of the full-load curve. Not only does it do this, but it also causes a greater fringing out of the flux into the interpolar space, so causing the commutating zone to become narrower.

What must really, I think, be the case is that the sparking constants (apart from the pole-ring) are much worse on the 75-kw. than on the 150-kw. machine, and it would be worth while to look into this. In order to use Mr. Hobart's rule, we can get a fairly good value for L by taking 4 lines per centimetre of coil in slot and ·8 lines per centimetre of end connections, and dividing the total by 10^{-8} to bring it to henries. This should be multiplied by the (turns per coil)^2 and by the number of commutator bars under the brush, and by $\frac{\text{poles}}{2}$ if a wave or series-wound armature. If double wound, L should be multiplied by 2. The reactance voltage for the machine should be worked out, and will probably be found to be more than 6; if so, the only way to cure it will be to rewind the armature with a winding which will reduce one or more of the terms in the R.V. so as to get it below 6.

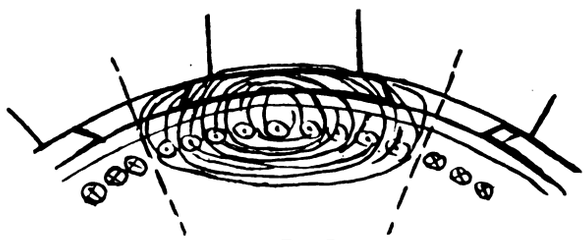

Fig. 3.

This may perhaps be done by (1) using a lap-wound armature instead of a wave-wound; (2) reducing the turns per coil and increasing the commutator bars; (3) altering the width of the brush; (4) using a carbon brush of high contact resistance.—T. Square.

Answer to No. 474 (*awarded* 7*s.* 6*d.*).—We may assume that the machines are for the same voltage and speed, and that they are both fitted with similar carbon brushes. It is not quite clear what is meant by a "pole-ring," but probably this refers to the well-known practice of fitting a thin iron ring or cylinder within the bore of the magnets, connecting all the poles together by forming a magnetic shunt of more or less reluctance. If this is so, it would probably account for the difference in the behaviour of the two machines, as the principal effect of such a ring is to minimise the distortion due to armature reaction, and so reduce the amount of brush shifting for changes in load. The cross-section of the iron ring is made quite small relatively to the area of magnet pole, so that as soon as the machine

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becomes excited the iron bridges between the poles, which practically act as the horns of the machine, become highly saturated. At the same time they produce a very well graduated fringe of magnetism at each pole-tip.

Suppose the position of the conductor in the fringe for sparkless running at full load is found. As the load is reduced to zero the strength of the fringe will become greater, due to the absence of the armature cross and back ampere-turns, but the amount of this strengthening will be very much less with the iron ring than without it, for in the former case a length of saturated iron forms part of the magnetic circuit of the fringe, and so prevents any decided increase in magnetic density with increased ampere-turns; whilst in the latter case this saturated iron is replaced by air, in which, of course, the density is practically proportional to the ampere-turns. If, then, such a pole-ring (Fig. 1) is fitted on the larger machine and not on the smaller one, it would certainly be advisable to fit one on the latter, as it would at least greatly reduce the sparking with change of load, even if it did not entirely prevent it. The magnets should be bored out about $\frac{3}{4}$in. larger in diameter, and a cast-iron cylinder about $\frac{3}{8}$in. thick and as long axially as the armature core, and having an internal diameter equal to the present bore of the magnets, should be fitted and screwed to the magnets. In order to reduce the leakage from pole to pole, the cylinder may be partly cut away between the poles, as at A (Fig. 1), leaving only two strips an inch or two wide at the sides. The insertion of the cylinder will probably necessitate a slight increase

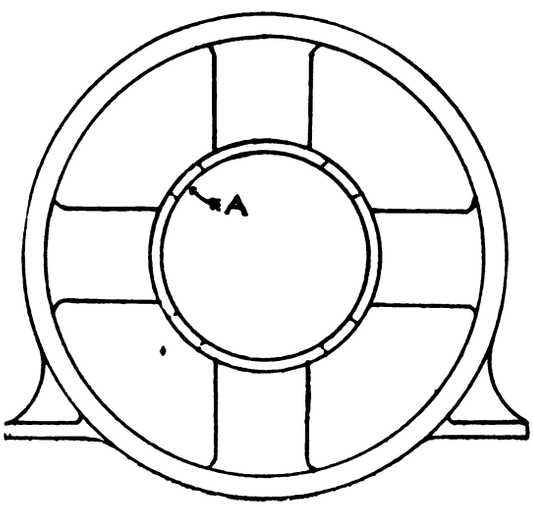

FIG. 1.

in the field excitation, or, if preferred, a slight increase in speed. It is, of course, quite conceivable that, even after the cylinder has been fitted, the smaller machine may not work so well as the larger one, for the possibility of changing from full load to no load with fixed brushes is largely dependent on the inherent sparklessness of the armature winding—*i.e.*, on the lowness of the reactance voltage per section.

The reactance voltage for a given type of machine at a given speed is directly proportional to the square of the number of turns per section and to the current per conductor, besides being more or less influenced by the length of armature core parallel to the shaft, the width of brushes, and the width of the commutator segments. Thus, suppose the 75-kw. machine has an armature core some 25 per cent. less in diameter than, and of the same length as, that of the 150-kw. machine. The number of conductors on the smaller machine for the same voltage, speed, and flux density would then have to be about 33 per cent. greater than the number on the larger machine, and, for equal reactance voltages, the product of (turns per section)^2 by current must be the same so that, calling the turns per section 1 in the larger machine, the number for the smaller machine must not exceed $\sqrt{\frac{1 \times 150}{75}} = 1{\cdot}41$. This means that the number of commutator segments for the small machine should = number of commutator segments for large machine $\times \frac{1{\cdot}33}{1{\cdot}41} = 94$ per cent. of the number of commutator parts on the larger machine. If, on inspection, it were found that the number of segments on the small machine were decidedly less than 94 per cent. of those on the larger machine, it would point to the want of sufficient commutator parts as the cause of the trouble. It would not be possible to remedy this defect on the finished machine, so that recourse must be had to some simpler cure, such as the pole-ring mentioned above, or the following device, which has often been successfully employed to permit a fixed position of brushes to all loads. It consists in cutting a deep slot about $\frac{1}{4}$in. wide up the centre of each pole

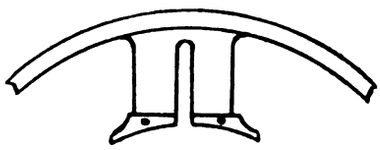

FIG. 2.

(Fig. 2). This greatly reduces distortion of the field from the leading to the trailing horn, by causing the trailing part of each pole to become more or less saturated as soon as any appreciable difference in the flux from the two horns is set up by the armature cross ampere-turns.—Q.

POWER TRANSMISSION SCHEMES IN AUSTRALIA.

Before the Australasian Chamber of Commerce and the Australian Club on Wednesday, Mr. James Stirling, Government geologist of Victoria, gave an abstract of a most comprehensive and exhaustive paper, accompanied by numerous diagrams and illustrations of the coal resources of Australia. The importance of the supply may be gauged that a low estimate of the various Government geologists put the visible supply of coal, equal to the best English, but not to the best Welsh steam coal, at 240,000 million tons against 146,000 millions—the estimated visible supply of the United Kingdom. What is of more special interest to our readers at the present moment is that active interest is being shown to put into execution the recommendations contained in a report presented some time ago to the Minister of Mines of Victoria by Mr. H. C. Jenkins, A.R.S.M., Government metallurgist. The report dealt with the utilisation of brown coal upon the spot where it is mined as a source of power for transmission to a distance by electrical means, with special reference to the transmission from Gippsland to Melbourne. In this report it is set forth that most suitable plant would consist of producers, boilers, direct-acting engines, and large alternating dynamos generating polyphase currents at about 2,500 volts. The central point of dynamo would be earthed, and the current would be transmitted by means of "step-up" transformers and bare wires. Mr. Jenkins came to the conclusion that even with as high a potential as 10,000 volts the interest and depreciation charges, each of 5 per cent., of the copper cables would be much greater than the cost of carrying the fuel by railway at 1d. per ton per mile, and that it would be necessary to transmit at about 25,000 volts before the operation would be economical. Transmission at 25,000 volts is, however, scarcely beyond the experimental stage as yet, although a few installations are in use employing as high a potential as this. Where black coal costs 5d. per ton per mile, or brown coal or wood would cost 2½d. for road carriage, as in mountainous districts, with bad roads, such an operation as the subject matter of the report would be economical at a potential of 10,000 volts. The report goes on to say that the transmission of the energy in the electrical form would have to be cheaper than the transport of the fuel in the solid or gaseous form before being burnt, or it would be better to have the electrical plant at the spot where the electrical energy is required. It is evident, upon the most cursory examination of the matter, that for transmission to a great distance the cost of the copper in the connecting leads is the one factor whose value is so large as to outweigh all others. The most economical use of the copper involves transmission at the highest possible voltage, so as to reduce the numerical value of the current as much as possible. The complete plant would comprise (1) gas-producers and recovery plant for by-products; (2) boilers; (3) steam-engines, or steam turbines, or gas engines; (4) alternators coupled direct to engines; (5) step-up transformers; (6) three-wire line at high potential; (7) step-down transformers. The engines and dynamos employed would be of large size—say, from 1,000 kw. to 2,500 kw. There would, indeed, be precedent for using 5,000-kw. machines, but these latter are large, and there is the question of spare plant to be always kept in view. When the units are very large, such as when 5,000-kw. machines are adopted, the cost of a single spare machine becomes unduly great. If, however, a capacity of 25,000 kw. was contemplated in making an installation, large machines such as 5,000 kw. would be in place, particularly if there were a steady load to meet. The engines would be direct-acting, and would be either of the reciprocating or turbine type. Both types give good results in practice when used coupled direct to the dynamos. Gas-engines could be adopted, but the running, though good enough for purposes of power, is not always steady enough for lighting purposes. Gas-engines are now being built as large as 1,500 h.p. for use with producer gas, and would use about 2lb. of Victorian brown coal per

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horse-power per hour. The three-phase alternators would give currents at 2,500 volts as a maximum potential from that of the earth, and 50 to 90 alternations per second. Such machines have now been long outside the experimental stage of use, and are regularly built by electrical engineering firms. The transmission would be by three-phase alternating currents of much higher potential than those from the machines. The currents from the machines would be raised to this higher potential by "step-up" transformers at the power station and reconverted into alternating currents at lower potential again, or into continuous currents, as desired, by means of suitable transformers at the delivery end. The distance to which current can be economically transmitted depends largely upon the cost of the leads and necessary apparatus connected with them, such as, for instance, the transformers, the interest and maintenance costs on which must not exceed the cost of carriage of the fuel to the other end of the line. To a less degree it depends upon the relative cost of the land and buildings for generating stations at the two ends respectively, and upon difference in cost for labour, it being always presumed that the power is desired to be delivered in the electrical rather than in any other form. The necessity for keeping the numerical value of the current low in order to reduce the losses in the wires due to heating compels a very high potential to be adopted, and experimental lines at potentials as high as 40,000 volts have been tried. It is found, however, on a line 2½ miles long at Telluride, Colorado, that 50,000 volts gave rise to much loss of energy, owing to the air itself tending at that stress to act as a partial conductor. It has since been demonstrated by experiments at still higher potentials that this is the case. The line (55 miles) was finally used at 40,000 volts.

Such is the scheme proposed by the Government, and in face of the great local interest shown, there is every likelihood of something being done in the near future. There is decidedly a good chance for English firms to benefit the colony and themselves by assisting in carrying the matter through.

PHYSICAL SOCIETY.

At the ordinary meeting of the society held on April 25, 1902, Prof. S. P. Thompson, president, in the chair,

Dr. Dawson Turner exhibited and described **"A Mechanical Break for Induction Coils."** The use of induction coils in the production of Röntgen rays and in wireless telegraphy had made the construction of a suitable break a matter of importance. The ordinary break was unsuitable, because of the wearing away at the point of contact, and there were objections to the use of mercurial breaks. The portable mechanical break which was shown by Dr. Turner consisted of two metallic rollers with their axes parallel, and kept in contact by a spring. One of the rollers had a cam attached to its spindle, and could be made to rotate by means of a small electric motor. Once in each revolution the cam separated the rollers, thus making the break, and at the same time causing the second roller, which rides loose upon its axis, to turn about one-eighth of a revolution. As soon as the cam had passed, the rollers were brought into contact by the spring, and the next break occurred at a different place. The wearing was thus distributed evenly over a large surface. The break was placed in a box containing alcohol or petroleum, and worked best when rotating rapidly. An objection to the arrangement was the noise it made when working. Some experiments were then shown on the discharge of electrified bodies by ultra-violet light. A disadvantage of the electric arc when used to furnish ultra-violet light for use in medicine was that the light was accompanied by heat, so that it was necessary to shield the patient from the heat without interfering with the passage of the light. A condenser spark between iron electrodes was useful, because it gave a large amount of ultra-violet radiation without much heat. Dr. Turner showed that this light was capable of discharging bodies whether positively or negatively electrified. He then showed that glass and mica were opaque to the radiation, while pure rock salt was transparent.

Mr. Wilson Noble exhibited a mechanical break similar to the one already shown. A roller and a disc, with their axes parallel, were placed in contact and made to rotate in the same direction by a motor. Longitudinal slots were cut upon the surfaces of both, and the break occurred when a slot in the roller came opposite a slot in the disc. Since the two were moving in opposite directions at their point of contact the break was very sudden. To vary the length of the break without altering the rate of rotation, the slot in the roller was wider at one end than the other, and the disc could be placed so as to touch the roller at any point of its length.

The **Chairman** said he knew of no metal which would withstand continual sparking without wearing, and suggested that breaks should be so designed that the parts affected by the sparking could be easily replaced. He asked if there was any difference in the wear of the two rollers? Referring to an experiment shown by Dr. Turner, in which ultra-violet light discharged a positively electrified body much quicker than a negatively electrified one, he asked if that would be the case if the apparatus were surrounded by an earthed metallic screen?

Mr. Watson suggested that the wearing of the edges in Mr. Wilson Noble's break might be lessened by filling the cavities with slate.

Mr. Duddell said that the worst substance for making contact pieces was carbon. Then came zinc, brass, and copper, with platinum best. These were the results in air, but the effects in liquids were different. With rapidly-moving contacts all metals were equally good, but in ordinary coils the contact pieces moved slowly.

Prof. Everett said it was interesting that rock salt, which was very transparent to long waves, should also be transparent to very short waves.

Dr. Dawson Turner said that if the experiment referred to by the chairman had been performed inside an earthed metallic screen, the negatively electrified body would have been more quickly discharged.

Mr. R. S. Whipple exhibited **"A Temperature Indicator for use with Platinum Thermometers, in which Readings are Automatically Reduced to the Gas Scale."** The instrument was very similar to the well-known Callendar and Griffith's temperature indicator, with the exception that it was so arranged that the readings obtained were automatically reduced to the gas scale, thus avoiding the necessity of applying a correction. It consisted of a simple Wheatstone's bridge with equal ratio arms, the other arms being the thermometer and a long helical bridge wire, together with the compensating leads. A travelling contact was moved round the wire until a balance was obtained. The bridge wire was wound on an ebonite drum, on the outer surface of which a helix had been cut. The contact piece, which was connected electrically with the galvanometer, was carried from the inside of a cylinder fixed to a shaft. A white celluloid tube, on which the scale was divided, was fixed to the outer surface of the cylinder. A screw of the same pitch as the helix on the ebonite drum was cut on the shaft, so that by rotating the shaft the contact was caused to travel along the bridge wire, and at the same time the scale was carried past an index placed above it. The scale had been so constructed that the reading at the index gave directly the temperature of the thermometer reduced to the gas scale. The instruments read from 0deg. to 1,400deg. C.

Dr. Chree asked the following questions: Was not the instrument so constructed restricted to platinum thermometers of wire having a given specified value of δ; if so, what was this value? Did the helical wire balance the entire resistance of this thermometer or only the excess above the resistance at 0deg. C.; and could the instrument measure temperatures below 0deg. C.? What error was likely to come in when measuring temperatures up to 1,000deg. C. from changes in the resistance of the helical wire under the variations of atmospheric temperature to which it would be exposed in ordinary use? Would not there be some wear between the wire and the contact piece?

Dr. Harker asked what were the limits of the value of δ for wires now supplied for commercial purposes? He thought that the accumulation of dust between the contact piece and the wire, due to continual scraping, was a more serious objection than the wearing away of the wire.

Mr. Whipple said the scale was calculated for a value of $\delta = 1{\cdot}5$. The value of δ seldom exceeded 1·52, and wire could be obtained with $\delta = 1{\cdot}5$. The instrument shown was made to read from 0deg. C., but could be easily arranged to read below 0deg. C. The wearing between the contact piece and bridge wire was very slight.

The society then adjourned until May 9.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the ordinary general meeting of the Institution on April 24 the following were the candidates balloted for:

Members.—H. Dowson, Midland Junction, Western Australia; J. Hissink, 122, Charing Cross-road, W.C.; F. A. Newington, 4, Osborne-terrace, Edinburgh.

Associate Members.—W. J. W. Bullock, 22, Deanery-road, Stratford, E.; H. C. Caldwell, Electricity Works, Broadheath, Altrincham; W. J. Head, 23, Percy-avenue, Whitley Bay, Northumberland; E. M. Hollingsworth, Prescot-road, St. Helens, Lancs.; W. S. J. A. Jones, Electricity Works, South Shore-road, Gateshead; E. Marples, The Garth, Hoylake, Cheshire; G. H. P. Morgan, Corporation Electric Light Works, Belfast; P. S. Thompson, 763, Rochdale-road, Queen's Park, Manchester; A. R. Tudman, Ennerdale, Colwyn Bay.

Associates.—G. H. Carter, Electric Light and Power Station, Heckmondwike, Yorks; A. H. Chisholm, 143, Southwark Park-road, Bermondsey, S.E.; A. R. Craddock, Canterbury-road, Christchurch, New Zealand; W. Fletcher, Ovingham House, Beech-grove, Whickham, R.S.O.; A. W. Greville, 46, Farringdon-street, E.C.; G. H. Hardwick, 85, Brighton-grove, Newcastle-on-Tyne; J. Josephs, Wellington Hotel, Old Charlton, Kent; W. Lang, 82, Marchmont-crescent, Edinburgh; A. M. Simpson, The Hawthorns, Hurst-grove, Bedford; K. O. Swan, 20, Granville-street, Gateshead-on-Tyne.

Student.—W. J. Proctor, 64, Clarendon-road, Walthamstow.

At the ordinary general meeting on May 1 the candidates balloted for were as follows:

Members.—S. H. Holden, 24, Arthur-road, Erdington, Birmingham; C. J. Sutherland, Guildhall, Worcester.

Associate Members.—J. M. Austin, 11, Emperor's-gate, S.W.; A. R. Bell, Uxbridge and District Electric Supply Company, Limited; F. A. Bond, 9, Childebert-road, Balham, S.W.; T. C. Hement, Hereford-street, Christchurch, New Zealand.

Associates.—C. B. Burdon, 139, Queen Victoria-street, E.C.; H. Dean, 5, Eades-street, Pendleton, Manchester, C. H. Ellison, 13, Queen Anne's-road, York; V. Graff, 22, Lansdowne-road, Aldershot; W. Henderson, 5, Blythswood-drive, Paisley; E. Long, 71, Shrewsbury-street, Old Trafford, Manchester; H. S. Marsden, Mile Ash, Derby; W. Mead, 12, Lucy-street, Broughton, Manchester; W. T. Meier, Carlswerk, Mulheim-a/Rhein; G. A. Neild, Arc Works, Chelmsford; H. B. Sale, 23, St. Bede's-terrace, Sunderland; E. A. Shaw, 8, Albert-road, Mowbray, Cape Town, S.A.; C. W. Webster, 28, Priesthorpe, Bingley, Yorks; T. Wray, 20, Dragon-terrace, Harrogate.

Students.—J. Aspin, 52, Norfolk-road, Seven Kings, Essex; R. L. Davies, Glenderwyn, Chorlton-cum-Hardy; J. H. Forster, 5, Haldane-terrace, Newcastle-on-Tyne; A. R. Harris, The Meadows, Betchworth, Surrey; H. M. Lawson, Boscombehurst, Bournemouth; H. S. Street, Civil Engineering College, Sibpur, Calcutta.

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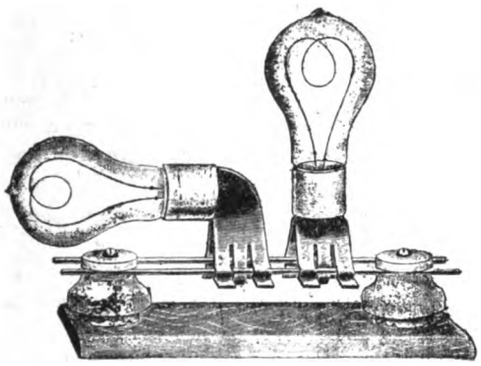
TRADE NOTICES AND NOVELTIES.

"Cremorne" Illumination Lamps.

The accompanying illustration shows the arrangement of the electric illuminating lamps and system of wiring introduced by Messrs. Falk, Stadelmann, and Co., Limited, "Veritas" Lamp Works, Farringdon-road, London, E.C. This system is called the "Cremorne," and gains interest in view of the approaching Coronation festivities. For the purpose of outlining buildings, windows, etc., common wood battens about 2in. by ¾in. are used, to which patent insulators are loosely screwed 18in. apart or thereabouts. The copper or galvanised iron wire, which is preferably stout for reasons of rigidity, is laid through the grooves provided in the insulators, the whole being then firmly tightened up. After the battens are thus fitted, they are attached to the building to be illuminated, and the wires connected to the supply. The lamps are then



clipped on to the wires by means of the patent spring socket, as closely together as desired. Among the advantages claimed by the above firm for the "Cremorne" illumination lamps in connection with their patent system of wiring are the following: exceptionally low cost for labour, the same being stated to work out at about one-tenth that of the ordinary methods of wiring; rapidity with which a temporary installation can be erected; economy of materials, since the same can be used over and over again; and the flexibility of the system, which enables the rearrangement of the lamps at will. A selection of special Coronation devices is shown in a circular recently issued by the firm. While from a list of testimonials separately published, it is evident that the "Cremorne" system has already found considerable favour among central-station engineers.

Wilson's Automatic Time Switch.

We have received from the General Electric Company, Limited, Queen Victoria-street, London, E.C., a copy of their circular No. M 1,003, dealing with the Wilson automatic time switch. This switch, we are told, has been designed with a view to overcoming the defects of the maximum demand system. It enables electric supply undertakers to adjust consumers' rebates in proportion solely to the number of units consumed outside the peak period, and not in proportion to the total number of hours over which their consumption are spread. The following further advantages are claimed: the meter shows a direct indication of price to be charged; no complicated

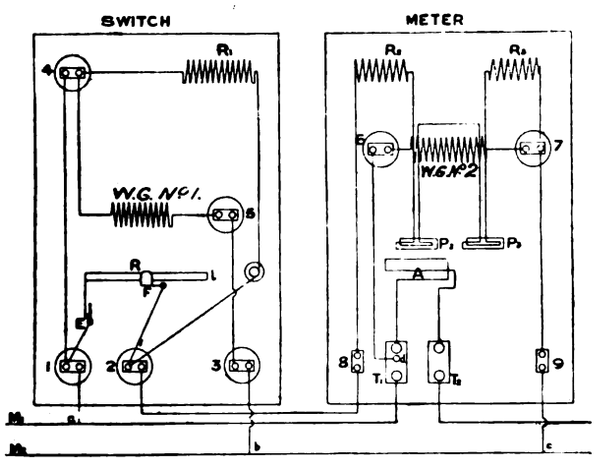


FIG. 1.

system of discount is necessary; the consumer can see when his high rate is being charged; hours of change of period can be varied with facility; values of high and low rate can be varied with ease; the instrument can be placed anywhere, and it is the only means of avoiding the overlapping of the lighting and motor loads. So far as the construction of the switch is concerned, we gather from the circular in question, from which the accompanying illustrations are reproduced, that it consists essentially of an electrically-driven pendulum clock, which beats normal time and which actuates a relay. The function of this relay is to insert a resistance, R_1 (see Fig. 1), into the shunt circuit of the meter during the low-rate period, and also to keep this resistance short-circuited during the period of high rate. The insertion of R_1 will make the meter "slow." It should be mentioned that this resistance is placed inside the meter it controls, not in the time switch, so that any time switch may be used for any meter. Let the shunt resistance of the meter be Q, and suppose the high-rate charge to be n times that of the low rate, then R_1 must be equal to $(n-1)$ Q. Fig. 1 is a diagram of connections showing the switch coupled with an Aron meter. M_1 and M_2 are the supply mains, of which M_1 is taken into the meter at terminals, T_1 and T_2, thus allowing the current to pass through the main coil, A, of the meter. W.G. No. 1 and W.G. No. 2 are the winding gears for the switch and meter respectively, and are connected across the mains, but only taking current when the clocks require to be wound up, consuming, therefore, a negligible amount of energy. The shunt circuit of the meter is connected to the two terminals, 8 and 9, and consists of resistances, R_2 and R_3, as well as the two solenoid pendulums, P_2 and P_3. Terminals 8 and 2 are connected electrically, and terminals 1 and 9 are joined to the mains at a and c respectively. R is the relay which is actuated by the clock, and owing to the position of lever, l, the shunt current must pass through R_1, and the meter will be "slow." During the period of high rate the lever, l, makes contact with E, causing R_1 to be short-circuited. The shunt current will then pass from 1 to E through l and F to 2, and thence to the meter, which will then register correctly. Fig. 2 is a front view of the time switch with the door open. P_1 is the pendulum beating half-seconds, and by means of lifting or lowering weight, W, the clock can be adjusted so as not to lose or gain more than two or three minutes per month. When moving the apparatus the pendulum should be clamped by means of a screw, which fits into hole, H. Of the five dials shown in the illustration, the middle one indicates normal time, S is a seconds dial, and K indicates day and night, according to whether the hand points on the white or black side of the dial. Daytime is reckoned from 6 a.m. to 6 p.m. The two dials, N and D, below the time dial indicate the time when the periods of high or low rates begin and end. The high-rate period begins at the time indicated on dial

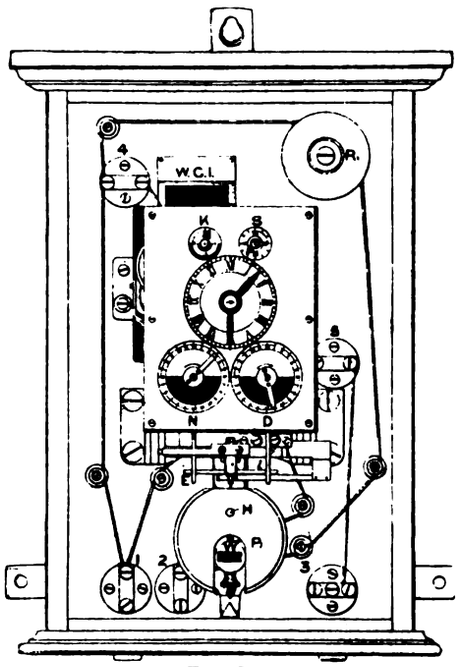


FIG. 2.

N, and ends at the time indicated on D. These dials are half white and half black, for the purpose of distinguishing between day and night. In Fig. 2 the pointer of dial N is set at 3 p.m., and that of dial D at 11 p.m. The high-rate period is therefore from 3 p.m. to 11 p.m., and the low-rate period extends from 11 p.m. till 3 p.m. As an example, a consumer is taken who uses 10 kw. day and night, the prices charged being 8d. between 7 p.m. and 9 p.m. and 2d. for the remainder. In this case the resistance $R_1 = 3$ Q, and the meter will register from 7 p.m. to 9 p.m. an amount equal to $10 \times 2 = 20$ B.T. units, and from 9 p.m. to 7 p.m. $10 \times 22/4 = 55$ B.T. units, the total charge per day $= (20 + 55) \times 8$d. $=$ £2. 10s. The switch is contained in an oak case, the over-all dimensions being 14½in. × 10⅜in. wide × 7⅜in. deep. The clock has sufficient reserve power to work for a period of 36 hours if the current is switched off.

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Overhead Linesman, Burnley Corporation Tramways. Full particulars may be obtained from Mr. R. Birkett, borough electrical engineer, Electricity Supply Works, Burnley.

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CONTINUITY OF POLICY.

The committee-rooms of the Houses of Parliament are perhaps, the last places to which one would look for a continuity of policy, in view of the fact that the composition of committees dealing with any particular subject varies from year to year. It is true that the members of the parliamentary Bar are much in evidence at this time of the year, and that their knowledge of past decisions is of great value to the committees before whom they appear. We never yet found, however, a leading member of the parliamentary Bar who could not bring forward precedent and weighty argument for whichever side of a case he happens to be retained. We, therefore, must conclude that it is to the committees themselves that we must look for any continuity in the decisions given from year to year. These committees are composed largely of men who are in the midst of a successful business career, and we see every desire on their part to treat the matters brought before them from a commercial standpoint. At the present time the London areas are practically the only ones in the United Kingdom in which there is any competition as far as electric lighting is concerned. It is true that there are two separate electric lighting companies in Newcastle-on-Tyne, but they do not supply in competition, as the city was divided up for them into two separate areas. In London the case is otherwise, and only two years ago a new electric lighting order was granted to enable the Charing Cross and Strand Electric Lighting Company to compete in the city of London. In certain municipal areas there are often three or four companies supplying electricity, and, as a rule, there are frequently two with rights to lay mains in each street. It will be seen from this that competition between electric lighting companies has been considered the right thing by parliamentary committees. When, however, a local authority wishes to compete in an area supplied by only one company, the decision of numerous committees has always been against the proposal, and although there is no written law on the subject, the numerous decisions in this direction tend to become a fixed policy. During the present year there have been two refusals to grant powers which would allow competition between a municipal undertaking and one owned by an electric lighting company or companies. The first of these decisions was given by the Board of Trade in the case of an application by the Chiswick Urban District Council for power to do their own street-lighting by electricity, and to supply to themselves any electrical energy for power purposes they might require at different parts of their area. The previous electric lighting order for the Chiswick area was originally granted to the Council in question, and was transferred by them to the present company. This fact may have been an additional reason why the Board of Trade refused to pass the application of the Chiswick Council on to Parliament for consideration. The second case referred to above is that of the London County Council's Electric Supply Bill, which succeeded in passing a second reading in the House of Commons, although personally opposed by Mr. Gerald Balfour. This Bill was thrown out in committee at the end of last week, and in this way unfair competition between the London County Council and the London electric lighting companies has been avoided for the time being. The main lines of the Bill were certainly novel, and they appeal strongly to the individual who believes in municipalisation at any cost. Such impatient individuals are not prepared to wait until the expiration of the London electric lighting orders, when

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the local authorities will be able to acquire the plant and mains of the companies at the then value, as many tramways have already been acquired. Instead of this they advocate the immediate purchase by agreement, as is being done by the St. Marylebone Metropolitan Borough Council. The difficulty then arises that a council can only purchase that portion of a large company's undertakings which is within their area. They also have to purchase at valuation under the Lands Clauses Act, which allows of goodwill. The result can only be that they give an unduly high price for plant and mains which to them may be almost valueless, owing to the arrangements not being such as will work in economically from a local supply station. How far the unremunerative capital outlay on the purchase of the undertaking will render the municipalisation of it useless, can only be determined for each individual district. The Bill of the London County Council which was thrown out by the committee had for its object the avoidance of this partial buying up of an electric lighting undertaking. One clause of the Bill provided that the London County Council could, with the consent of the majority of the local authorities interested, purchase the whole of the company's works supplying the areas of these authorities. The working of the scheme after purchase hardly affects us here, but we understand that the London County Council proposed to supply in bulk to the local authorities, who would retail the electricity. This would at once enable competition to be set up between private enterprise and an undertaking financed by the ratepayers, and we are pleased to see that the present committee has prevented this. The electric lighting companies of London, taken as a whole, have been well managed, and the competition between them has kept the cost of electrical energy reasonable. It will be quite time for the London County Council to consider the supply of electricity in bulk to the individual authorities, or the buying up of the companies' suburban stations designed for the purpose, when the life of the electric lighting orders has more nearly expired.

REVIEWS.

Dynamos, Motors, Alternators, and Rotary Converters. By GISBERT KAPP. Messrs. Biggs and Co., 139-140, Salisbury-court, Fleet-street, E.C. Price, 10s. 6d.

This book, which is really a revised edition of one by the same author, entitled "Dynamos, Alternators, and Transformers," published by the same firm two years ago, contains a vast amount of new matter. This volume has been translated from the third German edition of the above-mentioned book by Mr. Harold H. Simmons. This fact alone reminds us that the best writer on the above subjects which we have had in England, now from his position in Berlin issues his original work in the German language. Mr. Kapp's style of treating electrical subjects is well known to all electrical engineers, many of whom owe their technical success to the insight into the principles of design given in his books. The absence of long mathematical investigations and the use of graphical methods wherever possible make his works available to the practical man. In this respect the revised edition now before us is no exception to his earlier works, although it deals with more advanced, and hence with more intricate, problems in electrical designs. In dealing with these, the author is careful to point out in a number of instances how he has been able to avoid more complicated formulæ by making approximations and neglecting small effects which do not prevent the accuracy of the result obtained being well within the requirements of practice. This method of simplification is quite a legitimate one, and conduces to ease in design. The most important additions which this volume contains beyond the matter in the book, "Dynamos, Alternators, and Transformers," previously issued, are briefly the following: The treatment as to the cause of sparking in direct-current dynamos is much more full, and the question of predetermining sparking limit in design is most carefully gone into. We remember a quotation by a well-known American designer, that any fool could design an alternator, but that it took a good engineer to make a satisfactory direct-current dynamo. The magnetic leakage and the distribution of flux in the magnetic circuits of large machines is also gone into much more thoroughly in the present volume. Armature windings of the most used description are also well considered, while the practical requirements as to armature reactions in both alternators and direct-current dynamos are amply treated. The new chapters on subjects which were not treated in the original edition cover three distinct branches of the subject. The first of these is the design of multiphase motors working on the rotating field principle. For this purpose a theory of these asynchronous motors is given, together with typical calculations for ascertaining the proportions of the same when designing. In this department practical methods are extensively used. The second new departure deals with rotary converters for changing one form of electrical energy into another. While this subject is most carefully gone into mathematically, there is given at the end of the chapter some most useful conclusions, which will be of great service to the electrical engineer who wishes to make use of such apparatus without designing it himself. The other new feature spoken of above is a chapter dealing with the hunting of alternators working in parallel. In view of the present knowledge on the subject it would be more correct to say that the chapter deals with the hunting of prime movers driving alternators working in parallel, as it is exceedingly seldom that the blame for the hunting can be laid on the alternator. With this brief notice we commend the work to our readers as one which they cannot afford to leave unread.

The New Volumes of the Encyclopædia Britannica. Vol. 1 (being vol. xxv. of the completed work). Adam and Charles Black, Edinburgh and London; *The Times*, Printing House-square. 1902.

Last Friday saw the publication of the first of the new volumes of the "Encyclopædia Britannica," constituting, in combination with the existing volumes of the ninth edition, the tenth edition of that work, and also supplying a new distinctive and independent library of reference dealing with recent events and developments. There will be 11 of these new volumes, mainly constructed upon lines so as to bring up to date the information contained in the previous edition. At the same time, they will be able to rank by themselves as the most comprehensive work upon the history, scientific achievements, and statistics of the last 20 years, an epoch which in incidents, as well as in scientific and commercial progress, stands unsurpassed if compared with any similar short period in the world's history.

Infinitely more attention has been paid to biographies, and the fact that the edition, which is to be completed within a year, comes just after the completion of the last census of most civilised nations, will make it a work of reference sufficient to last for this generation. A boon is promised at the end of the last volume in an elaborate index, containing 600,000 entries, with sub-divisions under each heading, which will make the use of the work a pleasure instead of an obstacle race over cross entries.

The nine volumes will contain 10,000 articles by 1,000 contributors—the best to be got, not only in the United Kingdom, but in the whole world—and 150 full plates of superfine excellence, if the illustration representing Sir H. H. Johnston's Okapi, as supplied in the preliminary prospectus, is to be taken as a fair sample. There will also be 125 coloured maps and 2,300 other illustrations.

Of the former we have an example in a map of Central Africa, which was a blank in our schooldays, and which now represents such a close conglomeration of entries that, if it were not for the excellent printing of the copy before us, nothing but examination with a microscope would assist the enquirer. The rest of the illustrations, paper, printing, etc., are all in conformity with the highest publishing standard.

The contents of vol. i. give a fair idea of the scope of the whole undertaking. In these days of specialisation we

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need only point out a few of the articles which will most interest our readers.

They will find 20 columns on "Atmospheric Electricity," by Dr. Charles Cree, and will admire the bibliographical notice at the end of the same, where the various English, American, German, and French authorities are enumerated which are quoted in the article. Another eight columns are allotted to "Æther," by Dr. Larmour; Lord Rayleigh contributes an article on "Argon," six columns—a lecture in itself; Dr. E. Gosse has one on "The French Academy;" Mr. W. Hibbert discusses "Accumulators"; Prof. V. B. Lewes, "Acetylene"; Prof. G. Lunge, of Zürich, is the authority on "Acid and Alkali Manufacture." A whole text-book (84 columns) is supplied on "Algebra and Algebraic Forms" for those who wish to refresh their memories, the first by G. B. Mathews, and the other by Major P. A. Macmahon, both, needless to mention, Fs.R.S Sir W. C. Roberts-Austen deals with "Alloys," and Signor E. Ristori with "Aluminium."

Amongst the articles promised we find a number allotted to electric industrial developments, supply, lighting, traction, welding, electro-metallurgy, electromagnet, electro-chemistry, dynamo, magnetism, magneto-optics, power transmission, transformers, motorcars, municipal enterprise, strength of materials, telephony, and wireless telegraphy. Besides which there is a series of articles under the heading of "Electricity" by J. A. Fleming, F.R.S., Pender professor of electrical engineering, University College, London; Louis Duncan, late president of the American Institute of Electrical Engineers; W. C. D. Whetham, F.R.S., Fellow of Trinity College, Cambridge; E. Garcke, M.I.E.E.; W. G. McMillan, late lecturer on metallurgy, Mason College, Birmingham; and J. J. Thomson, F.R.S., professor of experimental physics, Cambridge. These articles are arranged as follows: I., Electric Conduction; II., Electrolytic Conduction; III., Electric Current; IV., Electric Units; V., Electric Discharge through Gases; VI., Electric Waves.

AN IDYLL OF ENGINAMING.

At the recent Municipal Opening Ceremony in M********, the generating sets were christened respectively: "Mary Gertrude," "Sarah Ann," and "Eliza."

'Twas morning, and the metered amps.
But slightly rocked the pointer vane;
The product of a score of lamps
And, maybe, of a leak or twain.
A dainty engine sweetly ran,
Of noiseless sound she had the gift,
And always looked so spick and span:
It was our Mary Gertrude's shift.

'Twas afternoon; disgusted stood
The engineman with spanner armed.
It would have shocked the unco' good,
It would a bargeman's soul have charmed,
To hear one engine's points portrayed,
The parts that ran hot, squeaked, and jammed,
If Certain Things that man obeyed,
Then Sarah Annie would be eternally uncomfortable.

'Twas eventide, the hour of peak,
And juice was wanted very bad,
The steam mains on the rollers creak,
The stokers shovel coal like mad.
"Run up Eliza!" yells the chief,
Just come upon the switchboard sheif;
The man in charge replies with grief,
"Eliza won't excite herself!"

'Twas night, the battery ran the show,
The chargeman lay in soft repose;
And all the engines in a row
Began to tell their joys and woes.
Sweet Mary Gertrude softly chid
Her sisters for their stupid games.
The twain replied, "We only did
"It to get even with our names.
"We'd rather far be Numbers than
"Be called 'Eliza,' 'Sarah Ann.'"

B. C. H. J.

FORTHCOMING EVENTS.

FRIDAY, MAY 9.

North-East Coast Institution of Engineers. — At 7.30 p.m. General meeting at Newcastle-upon-Tyne.

Physical Society. — At 5 p.m., ordinary meeting. Papers: "A Simple Electric Micrometer—Part I.," by Dr. P. E. Shaw; "The Conservation of Entropy," by Mr. J. A. Erskine; and "Rational Units of Electromagnetism," by Signor G. Giorgi.

SATURDAY, MAY 10.

Institution of Junior Engineers.—At 10 a.m., visit to the Great Eastern Railway Works, Stratford.

Institution of Electrical Engineers (Students' Section).—At 10 a.m., visit to the works of Messrs. Elliott Bros., Lewisham.

WEDNESDAY, MAY 14.

Institution of Electrical Engineers (Birmingham Section).—At 7.30 p.m., annual general meeting.

THURSDAY, MAY 15.

Institution of Electrical Engineers.—At 8 p.m., Society of Arts, extra meeting. Paper: "Electrical Traction on Steam Railways in Italy," by Prof. C. A. Carus-Wilson.

FRIDAY, MAY 16.

Institution of Mechanical Engineers.—Annual conversazione.

Royal Institution.—At 9 p.m., Sir Robert Ball on "The Nebular Theory."

TUBE BILLS IN PARLIAMENT.

LORD WINDSOR'S COMMITTEE.

FRIDAY, MAY 2.

The Select Committee of the House of Lords presided over by Lord Windsor resumed their enquiry into the Brompton and Piccadilly-circus scheme.

Sir James Szlumper, engineer of the authorised Brompton and Piccadilly-circus Railway, under further cross-examination, stated that as originally laid out the junction line between Piccadilly-circus and Charing Cross Station showed a 3½-chain curve in the neighbourhood of the approach to the station. It was now proposed, subject to the approval of the committee, to convert that into a 4½-chain curve. The trains would have to slacken their speed in taking that curve because of the approach to the station. He did not regard such a curve as a source of danger. Their limits of deviation would allow them to go within 8ft. of the Baker-street and Waterloo Railway in Northumberland-avenue, but he was willing to bind himself not to go nearer to that railway than he was really compelled to do. He was not aware that as the result of the construction of the Baker-street Railway the pavement in front of the Hôtel Métropole had sunk ¾in. The outside work of the tunnel of the Piccadilly line as at present laid out was 27ft. from the wall of St. George's Hospital. If it was possible to get further away than that, they would do so.

Mr. Balfour Browne, K.C., on behalf of the Piccadilly and City and combined companies, handed in the filled-up Bill and estimates asked for by the committee, showing exactly what was relied upon and what was abandoned in the amalgamated scheme. He also handed in a copy of the agreements as to through fares.

Sir A. Binnie, consulting engineer, said he had very carefully considered the present proposal, which fulfilled the requirement that tube railways should facilitate communication between the thickly-populated centres of London and the surrounding suburban areas. From South Kensington to Piccadilly-circus the works were already authorised and commenced, and, the Great Northern and Strand Railway being also authorised, the only remaining link in the system was the small piece, under a mile in length, of the extension from Piccadilly-circus to join the Great Northern and Strand at Little Queen-street, Holborn. He considered that the proposal was one of the best which had ever been suggested for dealing with the complicated question of the London traffic.

Mr. Chapman, chief electrical engineer to the District Railway Company and the present group of tube railways, with 27 years' experience of the operation of electric railways in America, estimated the electrical equipment of the seven miles of lines proposed under the Bill at £460,000, £237,000 of which was for rolling-stock. The estimated cost of the generating station at Lots-road, Fulham, was £1,250,000, of which £850,000 was for machinery. It was proposed to work the railways on the modified multiple system. The signals would be on the block system, worked by compressed air governed by electricity. The cars proposed to be used were almost exactly the same as those which had been experimented with by Lord Rayleigh's committee, and which reduced the vibration by one-fifth. The speed would be 16 miles an hour. With stations at intervals of a mile, it would be possible to run 20 miles an hour. The seating capacity of the trains run over the District and the proposed tube railways was 124,392,000 passengers a year. A curve of 3½ chains on a gradient of 1 in 60 was quite safe. He did not see why trains should not be run at one-minute intervals.

Mr. Hayes Fisher, M.P., gave evidence in support of the Fulham extension.

Sir Henry Oakley, a director of the Great Northern Railway, said that at present there was no connection between their King's Cross terminus and the west and central parts of London, but they had obtained one by their arrangement with the Brompton and Piccadilly-circus Company, who had taken over the Great Northern and Strand Railway. That company would construct and work the line to Fins-

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bury Park, where the suburban traffic of the Great Northern converged, and through which they passed about 30,000,000 passengers a year. The Great Northern and City and the Great Northern and Strand Railways would have underground stations below the terminus of the Great Northern Railway at King's Cross.

Mr. C. Pearson, surveyor, estimated the cost of the land required for the four extension railways contemplated under the Bill at £212,935.

The committee adjourned.

MONDAY, MAY 5.

The Select Committee presided over by Lord Windsor resumed consideration of the Brompton and Piccadilly-circus scheme.

Sir J. Wolfe-Barry, consulting engineer to the Metropolitan and the District Railways, said the route proposed by the Brompton and Piccadilly-circus Railway, coupled with its extension and connections, was a thoroughly good one and served a better third-class neighbourhood than any of the competing or parallel schemes. The proposed route between Hammersmith and the City was as short as any of the competing schemes, and was best calculated to serve the demand for facilities between the East and West and North and South of London. For an expenditure of something under £300,000 the Brompton and Piccadilly-circus Company could, by constructing the junction railway to Charing Cross, give a through route to the City, instead of the expenditure of £15,000,000 or £16,000,000 proposed by the Piccadilly and City combined companies. The competition proposed to be set up by the construction of the new line of the Piccadilly and City combined companies would be most disastrous to the District Company and to the authorised Brompton and Piccadilly-circus Railway, the works for which were now in progress. A further advantage of the Brompton and Piccadilly-circus scheme was that it utilised authorised capital, and was therefore most economical. The Lots-road generating station would serve not only the District Railway Company, but also the Brompton and Piccadilly-circus, Charing Cross, Euston, and Hampstead, and Baker-street and Waterloo Railways. On the question of vibration, the witness stated that the unborne-spring weight of the trains should be got as low as possible, and the rails should be laid deep. In any case, he did not think curves had anything to do with the question. He thought Parliament made a mistake in sanctioning the Central London tunnel with a gauge of 11½ft. He was in favour of a larger tunnel, so that the rolling-stock of the ordinary railway companies might be interchanged. He considered that the tube of the Brompton and Piccadilly-circus Railway was sufficiently large to enable the recommendations of Lord Rayleigh's Committee to be given effect to. He was dead against the suggested emergency platform on either side of the train. It would, in his opinion, constitute simply another element of danger in the case of an accident. Passengers should, in such circumstances, be enabled to leave the train and walk away on the floor of the tunnel.

This concluded the case for the Brompton and Piccadilly-circus Railway, and the committee proceeded to consider the proposed extensions of the Central London Railway.

Mr. FitsGerald, K.C., for the promoters, after describing the existing line of the Central London, six miles long, said it was worked on the shuttle system, and it was found that owing to loss of time by terminal shunting the larger service required at busy times could not be given. Additional facilities were necessary in the public interest, and the directors had decided to promote this Bill, which would give the Central London a closed circuit. The proposed new line would start from Shepherd's Bush, come down to Hammersmith, pass along Kensington and Addison roads, Kensington High-street, past the Albert Hall, on through Knightsbridge and Hyde Park-corner, thence under the edge of the Green Park to Piccadilly-circus, thence across Leicester-square it went down to Charing Cross, passing along under the Strand and Fleet-street to Ludgate-circus. It then made a detour by Thames-street to Cannon-street, and thence by St. Mary-axe to Liverpool-street, and so back to the original terminus. This line would be about 8½ miles long. Every opportunity was taken to effect exchanges with other lines at the different stations. If the line was taken as a whole it would be found that practically every centre of traffic in London was served by it, that it could be rapidly and simply worked without junctions and without points. It was proposed on the new line to continue the system now in force and to have one single uniform fare for the whole circuit, the fare remaining at 2d. The existing tunnel was 11ft. 6in. in diameter, but if the Board of Trade desired it the new extensions would be made 12ft. or even 13ft. in diameter. He was authorised to state that the City Corporation approved of the company's scheme, and as for the County Council, in its report on all the schemes before the committee it had reported favourably in respect of these proposals.

Sir Henry Oakley, chairman of the Central London Railway, gave evidence in support of the statement, and added that the new capital the company was seeking under the present Bill was £3,000,000 of share capital, with borrowing powers of £1,000,000.

The committee adjourned.

TUESDAY, MAY 6.

The committee resumed their consideration of the proposed extensions of the Central London Railway.

Sir H. Oakley, cross-examined, said that his Board was advised that there would be no difficulty in raising the capital required for the extensions at par. He did not think that that capital could be separated from the old capital. The estimated expenditure on the extensions was £4,151,000. Works and land would take nearly £3,000,000, and for lifts and rolling-stock another £900,000 would be required. The cost of construction came out at £470,000 a mile, as compared with £579,000 for the existing line, but the difference was accounted for by the fact that the construction could be looked after more closely and more was known about it. It was true that the proposed line was nowhere more than six furlongs distant from the existing line, but even in spite of the "tube" the traffic along Piccadilly was greater than by Oxford-street. The figures were for the Oxford-street route: at Marble Arch, 10,974 vehicles and 21,080 pedestrians in a day of 12 hours, from 8 a.m. to 8 p.m.; at Oxford-circus the figures were 12,331 and 54,100; at Holborn-bars 14,301 and 59,455. On the Piccadilly route the figures were: at Knightsbridge 18,874 and 37,036; at Piccadilly-circus 12,501 and 52,930; and in the Strand 11,927 and 56,927. That proved the larger stream of traffic by the more southern route. Re-examined, witness stated that his scheme was carefully planned to avoid congestion in the City, and was so far successful as to obtain the approval of the Corporation.

Sir B. Baker, engineer to the Central London, said he had also been engineer to the pioneer tube line, the South London. The idea was purely British, and had been carried through by British capital, and it was only when shares went to a premium, and the capabilities of the system were proved, that the Americans sought to come in. He then described the proposed new extensions in detail.

In cross-examination, witness said that the new line in the City would be in the clay. As a rule, the subsidences had occurred along old water-courses, and they were mostly due, not to the tubes, but to the shafts and subways at the stations. As to the Bank of England, its clause in the original Central London Act could be given to it again by this Bill, but the promoters would rather have it put on them by the committee than grant it of their own accord. There was no special reason for giving the Bank of England clause to St. George's Hospital.

The committee adjourned.

WEDNESDAY, MAY 7.

The enquiry into the proposals for the extension of the Central London Railway was resumed.

Sir B. Baker, under further cross-examination, admitted that in the original prospectus of the company it was stated that the line was to be worked as a local line and would seek no extension.

The **Chairman,** after consultation with his colleagues, said: Before you go on it would be convenient that the committee should state that having been considering, in conjunction with Lord Ribblesdale's Committee and the Chairman of Committees, the question of a compensation clause, have arrived at this conclusion: that they are inclined to consider the advisability of inserting a general clause giving a limited period, possibly two years, after the opening of the railways, during which all questions of damage arising from construction or working should be referred to a special tribunal or to an arbitrator. If the promoters agreed to such a clause the proceedings might be materially shortened, but the committee reserves to itself the right of imposing on the promoters such special clauses as, in their opinion, may be necessary for the protection of particular buildings. I would point out that the committee leave the actual terms of such a clause open; they say "possibly two years," but that is a question on which naturally something might be said. The committee have not in their minds any intention of referring these matters to a court of law, but they suggest a special tribunal or arbitrator. Lastly, I would suggest that counsel should consider this, and if they can bring up a clause on which promoters and opponents can agree we shall be glad to consider it.

Mr. Pember, K.C., thought that would not be difficult; once the principle was agreed on, the agents could draw the clause. He could not see why some special clause of the kind should not also be agreed on for special buildings, and then the only question would be which special buildings should be scheduled.

Mr. Parshall, electrical adviser to the Central London, said there had been no electrical failure on the line since it started. Plans had recently been approved by the Board of Trade for new rolling-stock which was fireproof, and had a motor to the front and end cars, thus doing away with the locomotives—the great cause of vibration. The new expenditure on the power-house would be £83,000, on steam plant £115,000, on electrical generation and distribution £150,000, on passenger stations and 60 lifts £187,500, and on 28 new trains £258,000.

Mr. Vigers, surveyor and valuer, said that he had made the estimate for the land and easements required for the Central London extension, and it amounted to £873,000.

Further evidence having been given in support of the scheme, the case closed. The opposition to the North-East London and City and North-East Suburban proposed railways was then taken.

Lord Claud Hamilton, chairman of the Great Eastern Railway Company, said his company had made alterations in the seating capacity of their rolling-stock for the purpose of accommodating the traffic on their suburban lines, and were considering the possibility o electrifying these lines. When that was done they would be able to give an improved service and meet the demands of the traffic.

The committee shortly afterwards adjourned.

LORD RIBBLESDALE'S COMMITTEE.

THURSDAY, MAY 1.

The newly-formed Select Committee of the House of Lords of which Lord Ribblesdale is chairman began consideration of a group of Bills also promoted with the object of providing underground railway communication in London.

The first scheme taken was embodied in three Bills, and provided for a system of tubular railways connecting Hampstead and other outlying northern districts with the centre of London at Charing Cross.

Mr. Littler, K.C., for the promoters, said the line was authorised in 1893, and an extension of time had since been granted. In the present Bill an extension of the line was proposed from an interchange station to Highgate-hill, where the line would join the now authorised light railway of the County Council of Middlesex. Then it was proposed to extend communication to Golders Hill, again coupling with

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the county of Middlesex tramway system. The promoters placed themselves in the hands of the Board of Trade as to the size of the tubes, but would prefer tubes of 13ft. The station at Charing Cross would be in Adelaide-street, at the back of St. Martin's Church, with a subway into the South-Eastern terminus. The Edgware extension was not a part of this scheme, but the promoters of that line, too, desired to pass under Hampstead Heath. The routes varied slightly, but they ran in the same direction, and the promoters would be prepared to accept the decision of the committee as between the two routes, but it was a *sine qua non* that the promoters of the present Bill should have control of the tubes from end to end. There was no petition attacking directly the area proposed to be supplied. The convenience was admitted. The promoters had power under various Acts to raise for No. 1 line £1,800,000 by shares and £600,000 by debentures; for No. 2 line, £450,000 by shares and £150,000 by debentures; and for No. 3 line, £300,000 by shares and £100,000 by debentures. The promoters, however, had five millions provided for the proposed schemes. Turning to petitions against the Bill, he contended that as the line would pass 260ft. below the surface in London clay at the top of Hampstead hill, there could not possibly be any injury caused by vibration to Lord Iveagh's property there. There was a petition from the Hampstead Heath Protection Society, which objected to the passage under the heath. The surface of the heath would not be interfered with in any way, and the authority that took care of the public interest in that open space had raised no objection to this part of the proposal. The Mayor and Corporation of Hampstead were in favour of the Bill, and he challenged the right of this self-constituted society to a *locus standi*.

The committee decided not to allow a *locus* to the society.

Mr. W. R. Galbraith, C.E., then gave the engineering details of the proposals, and expressed the opinion that Lord Iveagh's property and Messrs. Shoolbred's premises would in no way suffer injury, and he supported this opinion by reference to the results of the construction of the Waterloo and Baker-street line.

Mr. Arnold White, member of the Hampstead Corporation, said the proposed communication was much needed at Hampstead.

Mr. Johnson, town clerk of Hampstead, gave evidence on behalf of the Corporation in favour of the Bill, and strongly so from the point of view of providing houses for the working classes on land near Golders Hill.

Mr. Perks, M.P., chairman of the District Railway, and **Mr. C. T. Yerkes** also gave evidence in support of the scheme.

Before the committee adjourned it was announced by counsel that practically an arrangement had been arrived at with the promoters of the Hampstead and Edgware line by which an end-on junction at Golders Hill would be constructed.

The committee adjourned.

FRIDAY, MAY 2.

Lord Ribblesdale's Committee resumed consideration of the Charing Cross, Euston, and Hampstead Railway Bills.

Mr. Shaw confirmed counsel's statement of the previous day on behalf of the Hampstead and Edgware line, that its promoters would be satisfied with the arrangement which would give them an end-on junction with the Charing Cross Railway.

Mr W. R. Galbraith, C.E., the engineer of the line, gave further evidence in reference to the claims of frontagers.

The **Chairman** said the case of Messrs. Shoolbred raised the whole question of frontagers along any line of tube railways.

Mr. Galbraith said his experience was that when the line was once made, structural injury was not caused by vibration. In regard to a protective clause of a uniform character, he feared that out of 1,500 frontagers a vibration clause might be taken advantage of by some litigious persons, and unfounded claims would be raised.

In cross-examination by Lord R. Cecil, K.C., the witness admitted that protective clauses were often inserted in Bills through promoters being anxious to satisfy opposition, and these clauses often led to misunderstandings.

Lord R. Cecil, K.C., addressing the committee, urged that special clauses should be inserted for the protection of Messrs. Shoolbred's property, which was built on a foundation of water-logged gravel.

After hearing **Mr. Freeman, K.C.**, for the promoters, the committee declared the preamble of the three Bills proved, and that they were not prepared to impose special clauses on the promoters.

The Edgware and Hampstead Bill was then considered, and **Mr. Davidson**, responsible engineer for the line, having formally proved the estimates, the committee declared the preamble proved, the **Chairman** adding that these decisions were given on the understanding that the arrangements referred to in the course of proceeding as to the junction of lines would be faithfully carried out.

The Islington and Euston Railway Bill was next considered.

Mr. Freeman, K.C., opened the case for the promoters. The proposal was for a short extension from the Angel at Islington under Pentonville-road, passing King's Cross, to Euston-square, of about one mile five furlongs. It was but a short line, but important in that it provided connection between several of the great railway companies. The line would have the ordinary double tubes and would be subject to the ordinary conditions. The diameter of the tubes would be 11ft. 6in., with enlargements at the station. It was proposed to charge a uniform rate of 2d. a mile, with a clause to secure that workmen's trains should be run night and morning at a return fare of 1d. The capital to be raised was £420,000 by the issue of ordinary and preference shares, and the borrowing powers proposed were for £140,000. The estimate for works was £387,653, leaving a sum of less than £30,000 for contingencies. The line would be 109ft. below the surface at the Angel, rising at easy gradients to 70ft. near Euston, all in London clay. A footway would provide safe exit for passengers in the event of a train breaking down. Each train would consist of a locomotive and four cars, the whole not exceeding 40 tons in weight, the engine weighing 13½ tons. It was contemplated to run a 2½ minutes' service during the busier hours. The only opposition to it came from the Metropolitan Railway Company and the London County Council, and the petition of the latter was in favour of a more stringent clause with regard to workmen's trains, and this was a matter for discussion on clauses. The Metropolitan Railway Company feared the competition of the traffic between King's Cross.

Mr. J. Harrison, general manager of the North-Western Railway Company, expressed his opinion that the proposed line would tend to develop traffic on the North-Western Railway.

Mr. W. Forbes, general manager of the London, Brighton, and South Coast Railway, spoke of the want of facilities for passengers to their London Bridge Station getting to the northern termini.

Sir B. Baker, C.E., acting engineer for the line, who prepared the estimates, said he was sure the work could be carried out, and would prove a valuable addition to the existing line.

Mr. Blair, C.E., engineer and surveyor for the borough of St. Pancras, and **Mr. A. C. Morton**, members of the Streets Committee of the City Corporation, also gave evidence in support of the scheme.

The clauses of the Hampstead and Edgware Bills having been adjusted, the committee adjourned.

MONDAY, MAY 5.

Lord Ribblesdale's Committee resumed their sittings, when the consideration of the clauses of the Charing Cross, Euston, and Hampstead Bill was proceeded with. In the majority of cases agreements were arrived at between the promoters and the parties appearing. It was arranged, however, that the question of damage from vibration should stand over, in view of the fact that the other Lords' committee dealing with tube railways would also have to consider that subject. Lord Ribblesdale intimated that though he must not be taken as speaking with any authority, his impression was that some "model clause" for protecting the interests of those affected by tube railways would probably be drawn up for insertion in all Tube Railway Bills. A series of clauses proposed by the London County Council was next considered. The committee refused to sanction a provision requiring the company to give up the frontage of a piece of land in the Strand in order that that thoroughfare might be widened. A clause empowering the County Council to veto the erection of unsightly hoardings by the company was approved, as also was a provision that there should be no interference of any kind with the surface of Hampstead Heath without the consent of the County Council. It was decided that the powers conferred by the Act should lapse if the company did not within 12 months of the passing of the Act obtain a certificate from the Board of Trade that they had made a *bond fide* commencement of the undertaking. A provision was agreed to as the result of which employers will be able to purchase workman's tickets in bulk for distribution among their employés. A clause was also inserted making the provision as to workmen's trains, including the 1d. return fare, applicable to the whole of the combined line.

The further consideration of clauses was adjourned, and Mr. J. Mathieson, general manager of the Midland Railway Company, having given evidence in favour of the extension of the City and South London Railway from the Angel to Euston, the committee adjourned.

TUESDAY, MAY 6.

The proposed extension of the City and South London Railway was further considered.

Mr. Ellis, general manager of the Metropolitan Railway Company, expressed the view that there was not sufficient traffic between Islington and Euston to justify the proposed extension. The distance between Islington and Euston was very short, and he hardly thought that passengers would walk to a station, descend by a lift, wait for a train, and ascend by a lift at the other end of their journey when they could step into an omnibus and travel the whole distance for 1d. In cross-examination, he said he knew that evidence had been given by representatives of the North-Western, Great Northern, and Midland lines in favour of the Bill, but those companies naturally welcomed any greater facilities for their passengers.

Sir J. Wolfe Barry, consulting engineer to the Metropolitan Railway, considered that if the extension to Euston were authorised, it would be a very logical demand that the City and South London line should be linked on to the Baker-street and Waterloo line at Baker-street. In that case there would be a parallel competitive route with the Metropolitan Railway between Moorgate-street and Paddington.

The committee decided that the preamble of the Islington and Euston Bill authorising the extension was not proved, and the measure was, therefore, rejected.

Mr. Balfour Browne, K.C., then opened the case for the promoters of the City and Crystal Palace Railway Bill, which seeks parliamentary sanction for the construction of a tube from Cannon-street to the Crystal Palace. At Penge the railway would come to the surface, and be connected with the system of tramways which was to be in the hands of the British Electric Traction Company in that part of London. The line would be seven miles long, and would commence at Queen-street, close to Cannon-street, where a junction could be made with the North-East Suburban Railway. The other stations proposed were Borough High-street, New Kent-road, Trafalgar-road, Peckham High-street, Rye Common, Dulwich Park, Lordship-lane, Sydenham, and Penge.

Mr. Dalrymple Hay, C.E., gave evidence bearing out counsel's statement, and the committee adjourned.

WEDNESDAY, MAY 7.

The committee resumed consideration of the City and Crystal Palace scheme.

The **Chairman**, at the outset, made an announcement similar to Lord Windsor's statement as to the insertion of a general clause in all the Bills for the protection of house property on the lines of route from damage due to vibratory causes.

Mr. Galbraith, C.E., said that the estimates of the City and Crystal

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Palace line were based on experience in construction of similar work. Half the distance would be through London clay and through the water-bearing strata. Experience at Greenwich and elsewhere led him to anticipate that working under compressed air would dispose of all difficulty. The witness, continuing, said the margin allowed between capital and estimates seemed to him reasonable. The raising of the money was no part of his business as consulting engineer, a position he had undertaken out of friendship to Mr. Hay.

The **Chairman** suggested that it was little good going on with engineering evidence until the promoters had satisfied the committee on the financial side of their proposals.

Mr. Gluckstein, of Salmon and Gluckstein, expressed an opinion that the financial side of the scheme was sound, and said he was prepared to take financial interest in it. He confessed he had not gone into the figures, but on general grounds he had formed an opinion that the line would pay.

In answer to the Chairman, **Lord R. Cecil, K.C.,** explained that the capital of £4,600,000 would be reduced by the interest for borrowing to £4,550,000; the estimated expenditure on works and lands was £2,964,041; equipment, £653,500; leaving, after certain necessary expenses, a balance of £48,860 to cover contingencies.

Mr. Garcke, managing director of the British Electric Traction Company, thought the scheme was a valuable one, and he would advise his company to assist it financially. He had looked at the estimates of expenditure, and saw nothing improper in them. Six per cent. for expense of financing was not unreasonable.

The **Chairman,** referring to further evidence given, said the committee would prefer to have evidence from witnesses whose knowledge of these matters extended further back than a fortnight. It appeared to him that, so far, nobody seemed to know anybody else or had troubled to make enquiries.

Sir C. Rivers Wilson, chairman of the British Electric Traction Company, remarked that he thought the scheme would be successful, though he spoke with some hesitation as to financial results. He considered the line would be of advantage to the system of tramways worked by his company, a system which they hoped largely to extend in the neighbourhood of Croydon. From what he had learned, he thought there would not be the slightest difficulty in raising the capital. He had had the proposals under consideration within the last two or three months.

Mr. Schenk, chairman of the Crystal Palace Company, said he had subscribed £1,000 towards preliminary expenses, and would be prepared to give substantial assistance. Estimating that the line would carry 40 million passengers annually at an average fare of 2d., he calculated that the line should pay 4 per cent.

The committee adjourned.

NEW COMPANIES REGISTERED.

Autolite, Limited.—Capital, £25,000. Objects: to acquire the inventions of W. P. Warren relating to the generation and use of acetylene gas, and to carry on the business of gas and electrical engineers, etc.

General Motorcar Company, Limited. — Capital, £1,000. Objects: to carry on the business of manufacturers of and dealers in motors and automobiles, electricians, suppliers of electricity, electrical and mechanical engineers, etc.

London Electrical Syndicate, Limited.—Capital, £2,000. Objects: to adopt an agreement with G. B. Pushmuller for the acquisition of certain patents relating to improvements in relation to galvanic batteries, and to carry on the general business of electricians and electrical engineers, manufacturers of cells, wires, cables, batteries, etc.

Messrs. H. R. Powell, Limited.—Capital, £3,500. Objects: to carry on the businesses of auctioneers, sanitary, electrical, and general engineers and contractors.

Rosario Electric Company, Limited. — Capital, £120,000. Objects: to adopt an agreement made by this company with the City Safe and Deposit Company, Limited, and to carry on in the Argentine Republic or elsewhere the business of producers and suppliers of electricity; as electricians and electrical engineers; to construct and maintain rail and tramroads, telegraph and telephone systems, etc.

BARNSLEY ELECTRICITY WORKS.

The following is an abstract of the second annual report of Mr. S. E. Bastow, borough electrical engineer, on the working of the Barnsley electricity department for the year ended March 31 last:

Steady progress has been made in all departments. New plant has been added and the mains have been considerably extended, whilst the original plant and mains have been maintained in a condition of high efficiency. Contrasting the works completed on March 3, 1901, and the same at the present date, the following increases have been made: 1901, engines 625 h.p., 175 temporary horse-power—1902, 1,225 h.p.; boilers, 3—5; mains, 7 miles—9 miles; public arc lamps, 15—27; consumers connected, 209—280; equivalent in 8-c.p. lamps connected, 14,825 - 22,183. The number of consumers now waiting to be connected is 10, with an equivalent lamp connection of 1,600, so that the total applied for is 23,783 lamps of 8 c.p. Motors connected, 41 of 190 h.p.; motors on order, 8 of 100 h.p. On March 31, 1901, your borrowing powers were limited to £28,500, and during the past year sanction has been obtained for an increase of £20,000, bringing the total borrowing power to £48,500. The capital expenditure during the year has amounted to £9,747. 17s. 9d., distributed as follows: machinery, £6,234. 4s. 8d.; mains and services, £1,450. 13s.; buildings, £1,487. 14s. 5d.; meters, £222. 8s. 5d.; accumulators, 5s. 6d.; instruments, £343. 4s. 8d.; general establishment charges, £9. 7s. 1d., leaving unexhausted borrowing power to the extent of £4,536. 19s. 7d.; £2,509 of this amount is ear-marked for contracts now running. Turning to the revenue for the year, a very satisfactory increase in the sale of current is observed, amounting to 52 per cent. of last year's total sales, and the total revenue has increased £812. 5s. 11½d., notwithstanding the fact that concessions were made to consumers last year, which have had the effect of reducing the average revenue per unit from 4·48d. to 3·54d. A striking decrease in works costs is noticeable, exceeding my anticipation in this direction. The price of coal has averaged 40 per cent. less than last year, and whilst the total units sold have increased over 52 per cent., the coal bill has decreased by £127. 0s. 6d. The bill for oil, waste, and water has remained stationary, and satisfactory decreases per unit sold in this and other items are shown. The increase in the item rents, rates, and taxes is due to the fact that we were not rated during our first year's working, and in general establishment charges the increase is due to law and other charges in opposing electric schemes before Parliament. In works cost per unit a decrease of ·49d., or 34 per cent., has been effected, whilst in total costs the decrease has been smaller, amounting to ·11d. per unit, or 7 per cent., owing to the above-mentioned causes. The revenue account for the year is as follows:

Dr. *Revenue Account.*	£	s.	d.
Oil, waste, and water	101	15	2
Fuel	537	4	2
Wages	403	3	9
Management	319	1	5
Rents, rates, and taxes	345	13	11
Stationery	38	12	11
General establishment charges	167	17	3
Insurance	16	10	3
Repairs and maintenance	142	17	9
Bank interest	182	10	7
Interest and sinking fund on first loan	1,574	18	7
Interest and sinking fund on second loan	639	11	3
Balance (net profit)	168	10	3
	£4,638	7	3

Cr.	£	s.	d.
Balance, 1901	8	1	10
Sales	4,480	19	4
Fittings	149	6	1
	£4,638	7	3

The trading profit has amounted to £2,557. 8s. 10d., an increase of £306. 13s. 4d. on last year, and after bringing up the balance of £8. 1s. 10d. from last year's account and setting aside £2,397. 0s. 5d. for interest on and repayment of loans, £168. 10s. 3d. remains to be carried forward to next account. In view of the above very satisfactory results and the low costs achieved, I suggest that the flat rate of 4½d. per unit for lighting purposes should be reduced to 4d. The reduction adopted to the figures of the past year would mean a concession of £217.

LEGAL INTELLIGENCE.

ACTION FOR INFRINGEMENT.

A Fuse-Box Patent.

The case of the Reason Manufacturing Company, Limited, *v.* Ernest F. Moy, Limited, was heard in the Chancery Division of the High Court before Mr. Justice Byrne on the 21st ult. The action was brought for an injunction to restrain the defendants from infringing the plaintiffs' patent relating to "the construction and arrangement of electrical fuse or cut-out boxes or covers which automatically prevent access being obtained to more than one main at a time." The defence was that there was no subject matter in the patent.

Mr. Moulton, K.C., who appeared for the plaintiffs, explained that the object of the invention was to avoid short-circuits. Before the date of the patent it had been customary to use fuse boxes which, in order to avoid danger of short-circuiting, were made very deep, so as to have high sides and shallow lids. The boxes obtained safety, therefore, by making the fuses difficult of access. The patentee abandoned all that, and made his fuse box so that, instead of having high sides, it had practically no sides at all, and the lids were made very deep. By this means the fuses were readily accessible when the boxes were opened, and the patentee by the ingenious plan of mounting them back to back, so that only one lid could be opened at a time, solved the difficulty and avoided the danger of short-circuiting in use.

Mr. J. G. Lorrain, consulting engineer, gave evidence in support of the plaintiffs' case. He testified that prior to 1894 he knew of no efficient device which achieved the object of the patentee, and that this object was one much desired by electrical engineers. He construed the claims of the plaintiffs' specification as embracing both the construction and arrangement of fuse boxes. He had never seen a fuse box of this construction prior to the date of the specification. In his opinion the invention was new and useful, and he knew that it had been largely adopted.

Mr. James Swinburne, for the plaintiffs, said he regarded the invention as one of very great utility, and he looked upon it as a sufficient protection against the consequences of carelessness or negli-

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gence. He considered that the apparatus was ingenious, and involved invention, and that though there might be no novelty in making the boxes with hinged lids, he did not know of any similar box prior to the plaintiffs' invention.

Mr. Ernest F. Moy and **Mr. W. W. Beaumont** gave evidence for the defendants to the effect that there was no novelty in the idea of placing boxes so that only one could be opened at a time.

Mr. Justice Byrne gave judgment on the 23rd ult. In his opinion the construction and arrangement of these boxes was novel, and they were undeniably useful. The question which remained was whether there was sufficient invention to support a patent. The conclusion he had come to was that, although this was not a great invention, there was invention in the construction and arrangement of the boxes in question. He further decided that the invention did obviate the danger that was meant to be hit at. Under the circumstances, therefore, he granted the injunction asked for.

Judgment was accordingly entered for the plaintiffs, with costs.

BRITISH MOTOR TRACTION COMPANY.

In the Chancery Division on Tuesday Mr. C. Treswell applied to Mr. Justice Buckley for the compulsory winding up of the company. The petitioner was a creditor for £787, the amount of his taxed costs of an action brought against him by the company, which action was dismissed by Mr. Justice Farwell. It was now stated that an arrangement had been come to with certain persons connected with the company, by which the petitioner obtained security for his debt, and was willing to abandon his petition.

His Lordship accordingly allowed the petition to be dismissed.

WRONGFUL REMOVAL OF A TELEPHONE.

Judge G. Williams, of the Swansea County Court, heard a case last week in which Mr. J. B. Harris, a builder and contractor, of Llanelly, sued the National Telephone Company for £50, damages alleged to have been sustained in consequence of defendants depriving him of the use of a telephone which he had agreed to rent. The plaintiff's case was that while he was away his telephone was removed, and on enquiry he was informed that it was removed on instructions from plaintiff's brother, with whom he had quarrelled. Later on a representative of the company apologised for the removal of the telephone, and asked what compensation the plaintiff would require. Plaintiff declared that he had entered into a verbal agreement with a former manager of the company to have the telephone put in, and he had paid the rental. The defence was that the contract was signed by plaintiff's brother, and it was on his instructions that the instrument was removed.

His Honour said defendants could not resist judgment for some amount, though not anything like that claimed. They accepted the plaintiff's money, and gave him a receipt for it, and the way the defendants had acted was not a proper treatment. He gave judgment for plaintiffs for £20, with costs.

THE RIGHTS OF FREE WIRING.

An important action depending upon the construction to be put upon certain free wiring agreements was brought in the Canterbury County Court last week by the National Electric Free Wiring Company to recover £16 from the Canterbury Corporation for damages resulting from an alleged breach of contract.

Mr. Norman Craig explained that an agreement was come to between the Corporation and the Free Wiring Company on Oct. 19, 1898, and there was a further supplementary agreement entered into on June 19, 1899, between the Corporation, the Wiring Company, and the consumer (Mr. Wildman, then of the Rose Tap Inn, Rose-lane). The consumer remained in possession of the premises until the end of 1900, and paid on the basis of the agreement. A new tenant then came in. He declined to avail himself of the installation made by the Free Wiring Company, but, by his own contractor, wired and fitted the premises and called on the Corporation to supply energy to the installation. This the Corporation did. The Wiring Company contended that the Corporation continued to be bound to pay the minimum rent prescribed by the principal agreement. On Dec. 31, 1901, after previous notice to the Wiring Company and a request to them to remove the installation, the Corporation removed them, and now held the fittings at the disposal of the Wiring Company. The Wiring Company protested against this threatened action on the part of the Corporation, and instituted the present proceedings.

His Honour, in giving judgment, said the agreement with the Free Wiring Company could not be said to be very clear. Before the agreement was entered into the advisers of the Corporation suggested a proviso, which, if adopted by the company, would probably have put the matter at rest, because that proviso stipulated that in such a case as the present the wires and fittings should be removed, if required, by and at the expense and risk of the Wiring Company, and the Wiring Company should save harmless and keep indemnified the Corporation in respect of all claims for injuries or damage done in consequence of or in connection with such removal. The Wiring Company did not agree to that proposal, which would have rendered their undertaking an extremely hazardous one, but they modified the proviso, and that modification was accepted by the Corporation. The alteration read: "That in the event of a consumer being desirous of discontinuing the use of the electric light, the Wiring Company may, if they so desire, remove the wires and fittings from the premises of such consumer, but such removal shall be effected by and at the expense and risk of the Wiring Company." That gave the company the right to remove the wires as between themselves and the Corporation when desirous of doing so. The agreement between the consumer and the Corporation was supplementary, and it provided a mode of payment for the installation itself if the consumer desired to purchase it, and a mode of payment by way of interest on the capital expended by the company in putting in the installation. Then came a clause that "if the consumer, or other occupier for the time being, shal cease to take the supply of electrical energy from the Corporation, or shall neglect or refuse to pay for the use of the installation, the Corporation may enter and remove the installation at any time." It was contended that this clause gave them the right to move the installation as between the consumer and the Corporation. In his opinion it could not be said that the Corporation had the power to destroy the Wiring Company's property in that way. The agreement should be construed on the lines that the Corporation should do this after the Wiring Company had given consent, not otherwise. If they did this against the protest of the Wiring Company they must pay damages for so doing. He gave judgment for the plaintiffs for the amount claimed. With regard to the claim for rent, he ordered the Corporation to pay the minimum rent for the last quarter, from January to March 31, 5s. 6d., this making a total of damages £15 and rent 5s. 6d.

On the application of Mr. Norman Craig, his Honour gave leave to appeal.

TORQUAY ELECTRICITY WORKS.

The Smoke Nuisance.

A summons at the instance of the Torbay Yacht Club was heard against the Torquay Corporation on Monday for permitting a smoke nuisance at the electricity works on March 18 last.

Mr. Percy Pearce, who appeared for the defendants, said that everything was being done that possibly could be done to prevent anything savouring of a nuisance arising from the issue of smoke from the electric lighting station. He hoped the Corporation might be so successful as to prevent any nuisance in future. While the defendants did not desire to admit that anything in the nature of a legal nuisance had been created, yet, as those who were responsible for the prosecution told them they had suffered inconvenience in consequence of the works, defendants accepted their statement. He could only say on behalf of the defendants that they would continue in the future to do as they had done since the inconvenience had been brought to their notice. They felt that possibly complainants might have been justified to a certain extent in bringing the proceedings forward, but Mr. Carter, for the prosecution, relying on the assurance given, was prepared to withdraw the summons, defendants to pay the costs.

Mr. Carter said the proceedings were taken solely for the suppression of what his clients felt was a nuisance within the Act.

The **Chairman** said the magistrates were glad the matter had been arranged.

A BRADFORD COLLISION CASE.

At the Bradford County Court on Tuesday his Honour Judge Bompas and a jury were engaged in hearing the claim of Mr. J. Punt against the Bradford Corporation for £50 damages in respect of a tramway accident.

The accident in respect of which the claim was made took place on Jan. 9 last. It appeared that on the evening of that day the plaintiff was driving a horse attached to a flat cart down Bolton-road to Carnarvon-street from the direction of Eccleshill. As he crossed the line to the right into Carnarvon-street an electric car approached. The incline varies at this point, and it was said to be the practice of car-drivers to increase the speed in negotiating the hill. The plaintiff alleged that this was what happened on the evening in question. Before he could get clear of the lines the electric car crashed into the back of the cart, overturned it, and threw the plaintiff violently on to the causeway. He was 74 years of age, and the accident had very much affected his health. As a result of the accident he was often unable to sleep at night, he now suffered from occasional lapse of memory, and in other ways the shock to his nervous system had greatly damaged his general health.

Several witnesses gave evidence to the effect that the car was being driven at the rate of 10 miles an hour, that the driver gave no warning of his approach, and that if the car had continued at the usual speed the plaintiff would have got clear of the lines. The suggestion that the plaintiff was suffering from the effects of alcohol was denied.

In the result the jury were unable to agree and were discharged.

The case will now have to be tried before another jury.

NORWICH ELECTRIC TRAMWAYS.

In the Court of Appeal, consisting of Lords Justices Vaughan Williams, Romer, and Mathew, on Tuesday week, the defendants in the case of Rattee v. the Norwich Electric Tramways Company applied for judgment or a new trial of the action, which was heard before Mr. Justice Grantham and a special jury at Norwich.

It appeared that the action was one to recover damages for personal injuries by the alleged negligent driving of the defendants' servants. On April 27, 1901, the plaintiff was driving a horse and trap along the Newmarket-road, when one of the defendants' cars approached him at a rapid pace. The plaintiff's horse was frightened at the approach of the car and became restive, when the plaintiff held up his hand, and shouted to the driver of the car to stop until he could get past it. The plaintiff's horse and trap were not then upon the metals along which the tramcar was approaching. The driver of the car, in disregard of the plaintiff's signal and shouting, drove the car on without any stop or abatement of pace, whereupon the plaintiff's horse, when the car was close upon him, from fright swerved round, so that the trap came upon the tramway, the tramcar ran into it, and the plaintiff

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was thrown out and injured. At the trial the jury found a verdict for the plaintiff, with £854 damages. Hence the present appeal, on the ground, mainly, that the learned judge at the time misdirected the jury by implying that the driver was bound to stop merely because the plaintiff put up his hand.

Lord Justice Williams, in giving judgment, said that in his opinion the appeal failed. He could find no misdirection in the summing up of the judge below. It seemed to the Lord Justice to be clear that the jury meant by their verdict to find that the driver of the tramcar did see the plaintiff's signals and had his attention called to the plaintiff's shouting, and that he negligently went on in disregard of them. The real question, therefore, was this—whether, where the driver of a tramcar pursued such a course of conduct, the tramway company were in the position to say that an action could not be brought against them in respect of such negligence because their Act of Parliament authorised them to run tramcars on the highway. In his opinion there was no pretence for the proposition that, because the company were authorised to run tramcars on the highway, their drivers were exempted from the common law obligation to take reasonable care not to injure persons lawfully using the highway.

Lord Justice Romer and **Lord Justice Mathew** concurred, and the appeal was accordingly dismissed with costs.

COMPANIES' MEETINGS AND REPORTS

KIDDERMINSTER AND DISTRICT ELECTRIC LIGHTING AND TRACTION.

Mr. W. L. Madgen presided over the ordinary general meeting of the shareholders in this Company at Donington House on the 1st inst., and in moving the adoption of the report (which appeared in our last issue) remarked that substantial progress had been made in both departments of the Company's business during the past 12 months. Taking the electric supply department, which only commenced to connect customers in the autumn of the previous year, the receipts from the sale of current amounted to £2,747, as compared with £182 for the four months of 1900 during which the supply was available. At present the number of private consumers represented a demand upon the plant equivalent to 7,628 lamps of 8 c.p., as compared with 5,760 a year ago. While this might be taken as equal to the normal rate of progress in the first year of electric supply, the Board looked forward to more rapid growth in future. They had expended £15,148 during the year on capital account, including £9,893 on new machinery. Of the total capital of £77,000, £56,000 was invested in the Kidderminster and Stourbridge Electric Tramways Company, from which the Company received in dividends £2,240, as compared with £1,540 in the previous year.

Mr. J. S. Raworth seconded the motion, which was agreed to.

SUBMARINE CABLES TRUST.

The annual meeting of the shareholders was held on Tuesday at the offices, Electra House, Moorgate, the Marquis of Tweeddale presiding.

The **Chairman**, in moving the adoption of the report, stated that the revenue for the past year, including interest on deposit, amounted to £24,615, showing a decrease as compared with the figures of the previous year of £286. Of this falling off £80 was owing to the additional income tax on the various stocks and shares held by the Trust. A full statement was given in the accounts as to the redemption of certificates, and out of the surplus funds during the past year the trustees had been able to redeem 31 additional certificates by purchase in the market at a cost of £3,612. This made the total number of certificates cancelled 928, the Trust retaining the extra coupons, which he hoped would have a substantial value some day. The trustees had paid the two usual coupons of £3 each, and after transferring the amount spent in the redemption of the 31 certificates mentioned, there was a balance of £71 to be carried forward.

Sir J. Denison-Pender seconded the motion.

In answer to Mr. Fuller, the **Chairman** said that the present market value of the investments held by the Trust was £433,389, the surplus over the capital thus being £92,963. This made the value of their certificates about 128, as against the market price of 115.

The motion was agreed to unanimously.

WEST COAST OF AMERICA TELEGRAPH.

Sir J. Denison-Pender, presiding over the ordinary general meeting of this Company on Tuesday at Electra House, Moorgate, stated that the gross receipts for the year ended Dec. 31 last amounted to £32,106, as compared with £30,888 in 1900, £28,347 in 1899, and £25,080 in 1898. There had thus been a steady increase in the gross receipts, although the improvement last year as compared with 1900 was not so great as in the two preceding years. This, however, was attributable to the reductions in the tariff which were made in April of last year. The cost of repairs was much about the same. As for the last repair, 14 knots of new cable were taken out of stock, additional stock to replace it had to be sent out, and about 30 knots, which cost £3,000, had been dispatched. This item would come into the accounts of the current year. He had hoped to be able to tell the shareholders that the ship had not so far been called upon to do any work this year, but he regretted to announce that a message was received that morning stating that the Mollendo-Arica cable was interrupted, and the ship had already left to effect the repairs. He hoped they would be able to add something every year to the general reserve fund in order to replace the cables as they became too old to work. He concluded by formally moving the adoption of the report and accounts.

Sir A. J. Leppoc Cappel seconded the motion, which was carried unanimously.

CALCUTTA ELECTRIC SUPPLY.

The annual general meeting of the above Corporation was held at Winchester House on the 1st inst.

Colonel A. J. Filgate occupied the chair, and, in moving the adoption of the report and accounts (*vide* issue of 18th ult.), said the business continued to grow at a rapid rate, and was apparently likely to continue to expand largely for a considerable time. In order to meet this expansion the Company had to incur considerable expenditure, and their commitments for further outlay were also considerable. The total length of mains laid at the close of the year was 46 miles, as compared with 26 miles at the end of 1900. A considerable further addition of mains material was being sent out. It seemed probable that the growth of the business would necessitate the building of a third station at the north end of the city, and if the Company obtained the order for supplying Howrah, this might entail the erection of a fourth station on the western side of the Hugli. The Company received frequent demands for further extensions of mains. The gross revenue for the year amounted to £23,248, as compared with £11,147 in 1900, and the expenditure was £14,002, as compared with £8,252. To the net amount brought from the revenue account had to be added the balance from last year and the interest realised during the year, making the total £9,016. From Jan. 1 up to the 4th ult. the lamps and motors on the system showed an increase of the equivalent of 8,020 8-c.p. lamps, while the increase in the same period of 1901 was 7,106 8-c.p. lamps.

Mr. E. Boulnois, M.P., seconded the motion, which was adopted.

A final dividend for the half-year at the rate of 7 per cent. per annum, making, with the interim dividend, 6 per cent. for the year, was afterwards declared.

EASTERN EXTENSION, AUSTRALIA, AND CHINA TELEGRAPH.

The half-yearly meeting of the shareholders in the above Company was held on Wednesday at the River Plate House, Finsbury-circus, Sir J. Wolfe Barry in the chair.

In moving the adoption of the report, which appeared in our last issue, the **Chairman** reminded the shareholders that the gross revenue for the half-year to Dec. 31 last had been £324,000, showing a decrease as compared with that for the corresponding period of 1900 of £36,000, of which nearly £20,000 was due to traffic with Australasia and the remainder to traffic with China, Japan, and the Philippines. Unfortunately, the working and other expenses showed an increase last half-year as compared with those of the December half of 1900 of £15,000, of which about £6,000 was attributable to the increased cost of maintaining the cables, owing to circumstances over which the Company had had no control, and the balance was accounted for by the opening of new stations in connection with the Cape-Australian cable. As regarded the whole year, the gross revenue, as compared with that for 1900, showed a decrease of £3,500, while in the expenses there had been a total increase of £22,000. Since the close of the half-year the last section of their great enterprise connecting the Cape and Australia had been successfully laid, and the whole line had been opened for traffic. The line was, roundly, 7,600 nautical miles in length, and it passed in places at a depth of 3,400 fathoms of water, or about 700 fathoms deeper than the waters in which the Atlantic cables were submerged. Referring to probable further reductions of tariff, he said that if the standard revenue were maintained during the current year, the tariff would be further reduced next January to 2s. 6d., but in order to realise this reduction the Australian traffic would have to show much more vitality than it had done in the past few years. The first section—that between Australia and New Zealand—of the Pacific cable, belonging to the British and Colonial Governments, was opened for traffic last month, when competition was started with the Company's cables between Australia and New Zealand. The negotiations between the Federal Government and the Company for substituting a uniform agreement for the whole Commonwealth in place of the agreements with the four contracting States had not yet had any practical result, but they were told that when the Prime Minister, Mr. Barton, was in London next month he would further discuss the matter with them. Meanwhile, the higher rates were maintained in Victoria and Queensland, and the merchants in those States were agitating for their assimilation with the rates charged to the rest of the Commonwealth. The Chairman afterwards referred at some length to the final report of the Inter-Departmental Committee appointed by the Government to enquire into the question of tariffs and matters generally connected with cable communications. He remarked that the committee, from its constitution, must command universal respect. Speaking generally, he thought they might congratulate themselves on the committee's report. With reference to wireless telegraphy, at the meeting last January he addressed the shareholders of the Eastern Telegraph Company on the subject, and what he then stated was somewhat widely circulated. All that was necessary for him to add now was that since those remarks were made there had been no new development of any practical nature. He had nothing to withdraw from what he said at the meeting in question, and the views which he then expressed were, he thought, generally speaking, endorsed lately by Lord Kelvin in America.

Sir J. Denison-Pender seconded the motion, which was carried unanimously.

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MOTOR MANUFACTURING.

An extraordinary general meeting was held on the 1st inst. at Winchester House, Mr. R. W. Wallace, K.C., presiding, to consider a scheme for the future working of the Company.

The **Chairman** explained that the accounts showed that a loss had been made on the trading. That was owing partly to the absence of sufficient capital to keep the works going regularly, but it was also caused by inefficient management. One of the first things to be done was to cut down the inflated assets in the shape of patents and goodwill, and to put the management on a better footing. The cash value of the undertaking would then, including the new capital to be brought in, amount to between £70,000 and £80,000. The shareholders would, therefore, have the satisfaction of feeling that the nominal capital was the actual amount, and that any profit would be available for the payment of dividends. With regard to the business, the Company had certain approved types of vehicles for which they were getting orders. These types would be kept to, although improvements would, of course, be made in them from time to time. There were now £21,000 of orders in hand for their standard types. Having referred to the proposed scheme for reconstructing the Company with 5s. shares credited with 3s. paid up, he said it was thought that another effort should be made to try and turn the disastrous failures of the past into success in the future. He concluded by moving a resolution approving a provisional agreement for the sale of the undertaking to a new company.

Mr. Mark H. Buckea seconded the resolution.

After some discussion the resolution was carried with a few dissentients.

WILLANS AND ROBINSON.

A general meeting of the holders of the first mortgage debenture stock of this Company was held on Friday at the Westminster Palace Hotel to consider and, if thought fit, sanction and confirm an arrangement embodied in a provisional agreement, dated the 21st ult., and made between the Company, of the one part, and Robert S. McLaren, on behalf of all the holders of the said debenture stock of the other part, and to authorise the trustees (Lieutenant-General Sir Richard H. Sankey and Mr. Frederick Gordon) to concur with the Company in carrying the arrangement into effect. It was stated that the agreement provides, among other things, for the constitution of a new first mortgage debenture stock of the Company of £250,000 bearing 4 per cent. interest, and for the acceptance by the holders of the existing debenture stock of the new debenture stock at the rate of £105 of the latter for £100 of the former stock.

Mr. Mark Robinson formally proposed the resolution. The matter, he said, was well considered at the last general meeting, and it was approved, he thought he might say, without a dissentient voice.

Sir G. A. Clayton-East seconded the motion.

In answer to Mr. Rhodes Cobb, the **Chairman** stated that the present debenture stock was repayable at par in 1921, and it could be paid off at 105 in 1906. The reserve fund, which would form part of the security for the debenture stock which it was proposed to issue, would be invested entirely outside the business.

The motion was agreed to unanimously.

WESTERN TELEGRAPH.

The report of the directors for the half-year ended Dec. 31 last states that the revenue for this period amounted to £221,512 and the working expenses to £101,003. After providing £9,576 for debenture interest and sinking fund and £4,392 for income tax, there remains a balance of £106,541. To this is added the sum of £3,368 brought forward from June 30 last, making a total of £109,910. First and second interim dividends, amounting to £62,379, have been paid, and after transferring £40,000 to the general reserve fund and £2,300 to the maintenance ships' reserve fund, there remains a balance of £5,531, which is carried forward to the next account. The revenue includes £11,336 dividends upon the Company's investments in other telegraph companies.

WEST INDIA AND PANAMA TELEGRAPH.

The report of the directors for the six months to Dec. 31 last shows that there is an amount to credit of revenue of £25,243, against £24,300 for the corresponding half-year of 1900. The expenses have been £19,836, against £20,962, leaving a balance of £5,407, to which is added £2,529, interest on investments; and £6,512 brought from last account, making a total of £14,448, with which it is proposed to deal as follows: payment of 6s. per share on account of arrears of dividend on the first preference shares, £10,368; balance to current half-year's account, £4,079. This will leave in arrear the dividend on the first preference shares for the six months ended Dec. 31, and 18 months' dividend to the same date on the second preference shares.

PRIMITIVA GAS AND ELECTRIC LIGHTING COMPANY OF BUENOS AYRES.

The directors' report for 1901 states that the balance of revenue account for the year amounts to £80,444, and, after deducting interest (which will not be incurred again), London expenses, remuneration of local Board, and income tax, there remains a balance of net profit amounting to £67,305, which, after paying interest on debentures (£14,533), leaves a sum available for dividend of £52,771. Two dividends were paid for the past year of 2s. 6d. each, free of income tax, on the preference shares of the Company, absorbing £40,000, leaving £12,771, which the directors propose to carry forward to new account. During the year £45,191 has been expended on capital account.

MELTON MOWBRAY ELECTRIC LIGHT.

The report of the directors for the year ended Dec. 31 states that supply has been maintained during the year without interruption or failure; the works are running satisfactorily and efficiently. A contract for the public lighting of the district was entered into during the year, and the lighting has, it is believed, met with the approval of the residents. The number of lamps connected at the beginning of the year was equivalent to 2,002 8-c.p. lamps; this had increased to 4,111 by the end of the same, an increase of over 100 per cent., and 78 consumers were connected at that date. No interest has been paid during the year upon the loan capital which has been provided by Messrs. Edmundsons' Electricity Corporation, Limited. Ten thousand pounds in 5 per cent. debentures has been issued since the close of the year. The profit for the year shown by the balance sheet is £549. 6s. 4½d. The directors propose to wipe off the preliminary expenses, amounting to £86. 19s. 9d., and to carry the balance forward to the next account. Messrs. F. E. Gripper and S. C. Hobson, two of the directors, retire by rotation and being eligible, offer themselves for re-election.

Dr. Abstract of Revenue Account.	£	s.	d.
Generation of electricity	408	1	8
Distribution of electricity	27	1	2
Public lamps attendance, renewals, and repairs	36	8	0
Rates and taxes	18	18	9
Insurance	9	10	0
Management expenses	92	18	2
	592	17	9
Balance to net revenue	256	10	5
	£849	8	2

Cr.	£	s.	d.
Sale of current	740	6	2
Public lighting	41	7	9
Rentals of meters, etc.	24	1	5
Rental of motors and wires	43	12	10
	£849	8	2

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	8,050	0	0
Sundry creditors	18,485	6	0
Net revenue account—balance at credit thereof	549	6	4
	£27,084	12	4

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	23,807	12	2
Preliminary expenses	86	19	9
Sundry debtors for current supplied	522	5	5
Other debtors for wiring accounts	673	8	10
General stores in hand	18	13	9
Wiring stock in hand	808	9	5
Wiring work in progress	125	6	10
Office furniture	35	0	0
Cash at bankers	1,005	14	5
Cash in hand	1	1	9
	£27,084	12	4

Statement of Electricity Generated, Sold, etc.

Quantity generated in Board of Trade units		73,370
Quantity sold: Public lamps	11,371	43,742
Quantity sold: Private consumers by meter	32,371	
Quantity used on works		20,161
Total quantity accounted for		63,903
Quantity not accounted for		9,467
Total maximum supply demanded (kilowatts)		57·7

Number of public lamps: 5 arcs, 140 incandescents.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Edinburgh.—The Corporation invite tenders for annual supplies from May 15 for the electric supply department.

Alicante (Spain).—The Harbour Board require tenders for the supply of two movable cranes. Tenders by May 14.

Shanghai.—The last day for receiving tenders for the proposed municipal tramway and motor 'bus service is June 30.

Woolwich.—The Borough Council invite tenders for 10,000 pairs of arc lamp carbons and a 70-b.h.p. motor. Tenders by May 15.

Glamorgan.—Tenders are invited for wiring and fittings at Parc Gwyllt and Angelton Asylums, near Bridgend, Glamorgan. Tenders by May 31. Details in our advertisement columns.

Valparaiso.—The Municipality are inviting tenders for electric lighting and tramways. We understand that particulars may be obtained from the Chilian Consul. Tenders by Sept. 1.

Oldham.—The Electricity Committee invite tenders for supplying the cables, troughing, bitumen, and insulators comprised in contract No. 6. Tenders by May 20. Details in our advertisement columns.

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Brighton.—The Town Council invite tenders for the supply of 300 tons of steel girder tramrails. Specifications, etc., may be obtained from Mr. Thos. B. Holliday, tramways engineer, Lewes-road, Brighton. Tenders by June 9.

Bedford.—The Electricity Committee invite tenders for the supply and delivery of economisers. Specification, etc., can be obtained from the Borough Electrical Engineer, Cauldwell-road, Bedford. Tenders by May 17.

Glasgow.—The Corporation invite tenders for one economiser, with induced-draught fan, and condensing plant. Particulars may be obtained from Mr. W. A. Chamen, the engineer, 75, Waterloo-street, Glasgow. Tenders by June 7.

Bury (Lancs.).—The Electricity Committee invite tenders for the supply and erection of jet condenser and pumps. Specification, etc., may be obtained from Mr. S. J. Watson, engineer and manager, Electricity Works, Bury. Tenders by May 20.

Swansea.—The Public Library Committee invite tenders for the wiring and supplying of sundry fittings for an installation of electric light at the free library, art schools, and art gallery. Tenders by May 10. Details in our advertisement columns.

Coventry.—The Electric Light Committee invite tenders for the supply and erection of steam and water pipes and accessories. Particulars may be obtained from the Electrical Engineer's Office, Electricity Works, Coventry. Tenders by May 26.

Manchester.—The Corporation invite tenders for erection of four electricity sub-stations—viz., at Cheetham-hill, at Sherbourne-street, at Harpurhey, and at Openshaw. Particulars may be obtained from the City Surveyor, Town Hall. Tenders by 12th inst.

Stockport.—The Gas and Electricity Committee invite tenders for supply of one water-tube boiler for their electricity station at Millgate. Specifications, etc., may be obtained from the engineer, Mr. S. Meunier, Gas and Electricity Office, Portwood. Tenders by May 21.

Dewsbury.—The Corporation invite tenders for the supply, delivery, and erection of a traction switchboard. Specification, etc., may be obtained upon application to Mr. R. H. Campion, borough electrical engineer, Bradford-road, Dewsbury. Tenders by May 12.

Brighton.—The Town Council invite tenders for the supply of points, crossings, tiebars, bolts, and other fittings. Specifications, etc., may be obtained on application at the office of Mr. Thos. B. Holliday, tramways engineer, Lewes-road, Brighton. Tenders by June 9.

Blackburn.—The Guardians invite tenders for the carrying out of certain alterations and additions to the electrical fire-alarm installation at the workhouse. Specification, etc., may be obtained from Mr. F. C. Ruddle, architect and surveyor, Union Offices, Cardwell-place, Blackburn. Tenders by May 14.

Halesowen.—The Rural District Council have obtained orders under the Electric Lighting and Light Railways Acts for their district, and are prepared to receive offers for taking over the powers and liabilities of the orders or for carrying out the works required by the orders. Details in our advertisement columns.

Govan.—The Council invite tenders for fuse boxes for house services, meters (not electrolytic), demand indicators, manhole boxes and connections, and joint-boxes for armoured cables. Particulars may be obtained from Mr. J. Brown, resident electrical engineer, Electricity Works, Govan. Tenders by May 27.

Astrachan.—Erection of electric generating station and installation of public and private lighting, commencing with 150 arc and 6,000 incandescent lamps. Manufacturers who will undertake to finish the work within two years can obtain particulars from the Municipality. Agents will not be able to tender. Tenders by June 7-20.

Edinburgh.—The Town Council invite tenders for the wrought-iron pipework in connection with the electric lighting of the north-west extension of the City Chambers. Specification, etc., can be obtained at the office of the Resident Electrical Engineer, Electricity Supply Station, Dewar-place, Edinburgh. Tenders by May 17.

West Ham.—The Council invite tenders for two steel chimneys, four fans and engine for induced draught, all brickwork in connection with the flues, and economisers. Specification, etc., may be obtained from the borough electrical engineer, Mr. James K. Bock, Abbey Mills, West Ham. Tenders by May 13. Details in our advertisement columns.

Swindon.—The Corporation invite tenders for the supply, delivery, and erection at the electricity works, Swindon (Wilts), of 252 accumulator cells and accessories. Specification, etc., may be seen at the offices of the engineers, Messrs. Lacey, Clirehugh and Sillar, 78, King-street, Manchester, and at 2, Queen Anne's-gate, Westminster. Tenders by May 19. Details in our advertisement columns.

Belfast.—The Great Northern Railway (Ireland) invite tenders for the supply of one Otto Crossley high-speed gas-engine of 41 effective horse-power working load complete; also for one four-pole dynamo, with regulating resistance in shunt winding, giving an output of 420 amperes at 65 volts, complete with slide rails, delivered and fixed on foundations put in by the company. Firms tendering to state the price they will allow for one 7½ b.h.p. maximum gas-engine, made by Messrs. Crossley Bros. in 1894, and which will not be required when the new gas-engine has been erected. Tenders to be delivered to Mr. T. Morrison, secretary, Amiens-street Terminus, Dublin, by 10 a.m. on May 12.

RESULTS OF TENDERS.

Falkirk.—The tender of Belliss and Morcom for engines has been accepted by the Town Council.

Cheltenham.—The Town Council have accepted the tender of Johnson and Phillips for supply of arc lamp carbons, at £2. 1s. 3d. per 1,000.

Liverpool.—The Town Council have decided to purchase 30 additional cars from Dick, Kerr, and Co.

Dundee.—The Sanatorium Committee have accepted the tender of G. H. Nicoll and Co. for electric lighting, at £300.

Dundee.—The Tramway Committee have accepted the tender of Dick, Kerr, and Co. for a new triple-expansion engine and dynamo, at £6,215.

Islington.—The Borough Council have entrusted R. Carr and Co., of London, with the supply of 72 arc lamp columns required for Highbury arc lighting extensions.

Salford.—The Howard Conduit Company, Trafford Park, Manchester, have received from the Corporation the contract for 12 months' supply of asphalte troughing.

Barnstaple.—The following tenders have been received: St. Helen's Cable Company, laying cable through streets; Charteris Engineering Company, crane; Johnson and Phillips, artesian well.

Kingston.—The Town Council have accepted the following tenders: Henley's Telegraph Works Company, two miles of arc lighting cable, £70. 7s. 6d. per mile; Macfarlane and Co., 35 arc lamp standards, £11. 2s. 9d. each; Babcock and Wilcox, two chain grate stokers, £515.

Warrington.—The Town Council have accepted the following tenders in connection with the tramway extension: Bennie and Thompson, construction of the permanent way, £16,857; R. W. Blackwell and Co., construction of the overhead equipment, £2,736. The extensions include a tramway along Winwick-road to Longford, where the system will connect with the line of the South Lancashire Tramways Company shortly to be constructed.

Grimsby.—The Town Council have accepted the following tenders to the plans and specifications prepared by the borough electrical engineer, W. A. Vignoles: British Westinghouse Company, Limited, 220-kw. dynamo, direct-coupled to Belliss engine, £2,377: Britannia Company, Colchester, extension of switchboard and supply of motor boosters, £598; Tudor Accumulator Company, battery, £905; W. H. Allen and Co., Limited, condensing plant, cooling tower, etc., £1,748; Sir Hiram Maxim Electrical Engineering Company, Limited, pipework, £585; Stirling Boiler Company, Limited, water-tube boiler, with Erith underfeed automatic stoker, £1,151.

London County Council.—The County Council have received the following tenders for the supply, delivery, and laying of the high and low tension electric cables required in connection with the work of the reconstruction of the London County Council tramways:

(*a*) High-tension cables.

St. Helens Cable Company, Warrington	£31,454	12	6
Siemens Bros. and Co., Limited, Westminster (accepted)	31,743	17	6
Western Electric Company, Limited, North Woolwich	31,849	18	6
British Insulated Wire Company, Limited, Prescot, Lancs.	33,371	17	6
Callender's Cable Company, Limited, Victoria-embankment	34,782	6	8
W. T. Henley's Telegraph Works Company, Limited, Cannon-street	34,799	17	8
Land und See Kabel Werke Aktien Gesellschaft, Cologne	40,464	19	4

(*b*) Low-tension cables.

St. Helens Cable Company	47,298	5	0
British Insulated Wire Company, Limited (accepted)	49,499	12	6
Western Electric Company, Limited	49,964	6	8
Siemens Bros. and Co., Limited	50,523	5	0
Callender's Cable Company, Limited	54,293	11	8
W. T. Henley's Telegraph Works Company, Limited	54,303	6	8
Johnson and Phillips, Old Charlton, Kent	56,518	8	3
Land und See Kabel Werke Aktien Gesellschaft	61,478	5	4

BUSINESS NOTES.

TRACTION.

Pwllheli.—The new tramways in the town were opened on the 1st inst.

Appointment.—Mr. H. S. May has been appointed assistant tramway engineer to the Corporation of Blackpool.

Barnsley.—The work of constructing the tramway which will connect Barnsley and Worsborough is proceeding rapidly.

York.—The clauses relating to tramways and street improvements in the Corporation Bill before Parliament have been struck out.

Liverpool.—The Tramways Committee are obtaining competitive plans for the new central offices of the Corporation tramways department.

Torquay.—A suggestion for the introduction of steam or electric motor 'buses into the town has been referred to the Tramways Sub-Committee.

Spen Valley.—The light railway through the Spen Valley is expected to be running on the Ravensthorpe and Thornhill section on or before Coronation Day.

Maidstone.—The estimated cost of the proposed tramways in the borough, a resolution in favour of which was carried at the last Town Council meeting, is £22,150.

Exeter.—On Friday a deputation from the Exeter Corporation visited Wolverhampton for the purpose of inspecting the working of the Lorain system of electric traction.

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Cavehill and Whitewell Tramways Bill.—This Bill has been read a third time in the Lower House.

Lancaster.—Mr. Litten, of Salford, has been appointed clerk of works at Lancaster in connection with the tramway scheme.

Birkenhead.—The Tramways Committee have authorised the tramways manager to obtain a tank and the necessary electrical fittings for a watering-car to run upon the electrical tramlines.

Belgium.—The Belgian Government Railways Department is making experiments with a view to substituting electric traction for steam, for shunting and other operations within the limits of railway stations.

Darlington.—Messrs. Kennedy and Jenkin have been requested to prepare the necessary plans of the proposed light railways in order that they may be submitted to the Board of Trade for approval.

Rochdale.—The formal opening of the electric tramways has been fixed for the 22nd inst., subject to the sanction of the Board of Trade being received. The inspectors are expected to visit the town about the 15th.

Stourbridge.—The surveyor in his annual report states that the British Electric Traction Company are laying down the tramway from Stourbridge to Lye, and also along Enville-street and Bridgnorth-road to Wollaston.

Lexden.—The Rural District Council have agreed to support the light railway scheme of the promoters of the Southend, Colchester, Mersea, and Bradwell light railway, provided that safeguards are given to life and property.

Proposed Electric Railway to Dover.—The proposal for an electric railway from London to Dover includes branch lines to run through the Isle of Thanet to Ramsgate and Margate, on the one hand, and Folkestone on the other.

Scarborough.—Mr. J. W. Lowther, reporting to the House of Commons on the Scarborough Tramways Bill, states that the committee have examined the allegations of the preamble of the Bill, and have made the necessary amendments.

Darwen.—It was stated at the last meeting of the Town Council that the losses on the Hoddlesden section of the tramways for the past financial year amounted to over £341, and on the main section to £963. 16s. 7d. The opinion was expressed that the Council are still carrying the people at too low fares.

Glasgow.—The suggestion was made at the last meeting of the Corporation that the electric cars be provided with ambulance appliances. No action was taken. The general manager recommends a complete reorganisation of the staff in the tramway department, together with an increase of salary in most cases.

Bolton.—The annual financial statement regarding the working of the Corporation tramways shows a profit on revenue for the past year of £3,395, against £5,742 for the preceding 12 months. The causes contributing to the decrease include heavy expenditure in the relaying of the track and increased wages for the employés.

Leeds.—Mr. J. B. Hamilton (the new general manager of the Corporation tramways) took up his duties at Leeds this week. Since leaving Glasgow he has been to the United States, and has availed himself of the opportunity to see all the latest improvements in electrical traction and the working of tramways there.

Gloucester.—The refusal of the County Council to allow the Corporation to extend the tramways outside the borough boundaries was severely criticised at the last meeting of the Town Council. It is suggested by the County Council that they should lease the county lines from the Corporation and work them themselves.

Lee.—A largely-attended meeting called by the Lee Ratepayers' Association to protest against the action of the Lewisham Borough Council in opposing the electric tramways and widening the thorough-fares, proposed by the London County Council, has been held, when a resolution expressing the views of the meeting was carried.

Barrow.—The town clerk has been instructed to write to the British Electric Traction Company that in view of the present condition of the tramcars the Highways Committee cannot see their way to recommend the granting of a license to the cars. Negotiations are in progress for substituting electric cars for the present steam service.

Middleton.—A communication has been received from the Board of Trade agreeing to the proposed method of laying the trams in Grimshaw-lane, Middleton Junction. When this line is completed, together with the work now proceeding on the road from Blackley, there will be a through service of trams from Manchester to Chadderton.

London and Tilbury Railway Bill.—This Bill, under which the company seek powers, among other things, to enable them to use electricity as a motive power, was before Mr. H. Hobhouse's Committee of the House of Commons last week. The committee eventually passed that part of the preamble which had reference to the generating station.

Warrington.—As will be seen from our tenders columns this week, the Corporation have placed the contracts for the construction of the proposed tramways to Longford Bridge and the cemetery. It is intended to ask the sanction of the Board of Trade to the borrowing of £27,000, being the estimated cost of the work as submitted by Messrs. Preece and Cardew.

Newcastle.—At a meeting of the Finance Committee the question was asked if the rates would be reduced out of the tramway receipts. The Vice-Chairman stated that if the Tramways Committee paid interest, redemption, and working expenses out of the revenue arising from the working of the tramways, he thought that was as much as could be expected for the first year.

Gateshead.—An important change has been made in the running of the Gateshead tramcars, which is regarded in the town as a great benefit to the general public. Hitherto, the trams only stopped at certain fixed points on the different routes in the borough, but now they will be brought to a standstill at any street corner wherever required to take up passengers as well as at the various points.

Bradford.—On Saturday the electric cars made their appearance for the first time at Wyke, and for the present it is intended to run a 15 minutes' service between that village and Bankfoot. The section lying between Frizinghall and Saltaire was also to have been opened for electric traction on Saturday, but it was found advisable to defer matters until Monday. The Wakefield-road route will be opened in the course of about a week.

Deptford.—A resolution has been passed by the Borough Council inviting the London County Council to consider the desirability of formulating a scheme for constructing a line of tramway communication between the Lower-road and the Broadway, *via* Church-street or High-street, with such local widenings and improvements as may be necessary, and also a tramway communication between the Broadway and Lewisham, *via* Ravensbourne-road.

Durban.—A scheme for the construction of an electric or other motive power tramway from the southern boundary of Durban to the waterside township of New Brighton is appealing for sanction in the present session of the Natal Parliament. The Bill asks for power to lay either an overhead or underground current-conveying system, and also to supply current for lighting or motive power in the districts traversed.—*The British and South African Export Gazette.*

Eastbourne.—The Corporation have been very much disturbed by a report that Brighton is losing £120 per week, or about £6,200 per annum, on its tramways undertaking. The matter was discussed at the last meeting of the Eastbourne Council, when many of the speakers questioned the truth of the statement. In the result, a motion that the town clerk communicate with the Brighton Corporation and enquire whether the statement is correct was rejected by 13 votes to 12.

Ramsgate.—Arising out of the reading of the minutes at the last meeting of the Town Council a councillor protested against the Council incurring any further expenses in assisting the Isle of Thanet Tramways and Electric Lighting Company without a definite agreement being entered into between the Council and the company that such expenses should be made good. It was resolved to take the question as a matter of urgency, and a resolution on the lines indicated was passed.

Brighton.—The tramways engineer estimates the cost of steel girders, tramrails, fishplates, and sleeper joists for the tramways included in the provisional order at £2,354, and the cost of points, crossings, gusset pieces, drain boxes, gully grates and boxes, sole-plates, fishbolts, and other bolts for fastenings at £1,540. The specifications have been approved, and it is decided to advertise for separate tenders for the supply of the tramrails and for the points and crossings required.

Cheltenham.—The Town Council have decided to approve of the principle of the proposed extensions of the light railway to Charlton Kings and Leckhampton, provided satisfactory terms are arranged between the Corporation and the company. On the other hand, the Chamber of Commerce have passed a resolution that, while agreeing with the general extension of the Cheltenham and district light railway, the Chamber is of opinion that the proposed route through High-street would be impracticable.

Post Office Motorvan.—On the 1st inst. the first motor postal van in the service of the Government left Liverpool for Manchester. This new service supersedes the horse vans which have previously carried the parcels between the two towns. The car weighs just under two tons, and can carry a load of 30cwt., as against a load of 18cwt. borne by the old vehicles. The distance between Liverpool and Manchester is 38 miles, and the motorvans are schedule to maintain a maximum speed of eight miles an hour on the journey.

Salford.—The electric cars have now superseded horse traction on the Lower Broughton tramway, and the last of the horse cars has been seen at Victoria Bridge. The ordinary service is to be one of 7½ minutes, while at the busy periods of the day additional cars will be run. To-day a similar service will be inaugurated on the length from the sanatorium at Weaste to Eccles Cross. From May 2, 1901, to March 31 last, the end of the financial year, the Corporation carried 20,935,000 passengers on their tramways, the mileage being 2,100,000.

Weston-super-Mare.—Monday afternoon last saw the formal inauguration of the electric tramways at this place. Under present arrangements the cars will run every 10 minutes from 8 a.m. until 10.20 p.m., but as the season progresses these times will be subject to revision. At present the fares are 2d. for any distance travelled, but this, of course, is also subject to revision. No stopping points for picking up passengers have yet been decided on, and the hailing method at any point, for the time, will be observed. Each car accommodates 50 passengers.

Bury.—An agreement has been signed under which the Johnson-Lundell Company will lay down an experimental line on their surface-contact system in Rochdale-road, and a deputation from the Town Council are to visit Wolverhampton for the purpose of obtaining all information possible with regard to the new tramway system in that borough, and then report. The borough engineer in the meantime has been instructed to prepare specifications and drawings for laying the permanent way of the Fairfield, Bolton-road, Knowsley-street, Clough-street, and Heywood-street sections.

Darlaston.—It seems that the construction of the proposed new tramway between Darlaston and Morley is being delayed owing to the obstructive attitude which the Wednesbury Corporation have taken up. A short length of the tramway would be within the Wednesbury boundaries, and owing to a hitch between the British Electric Traction Company and the Corporation the work cannot at present be proceeded

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with. The Darlaston District Council, however, are in communication with the Wednesbury Corporation, and the company have stated that they hope very shortly to commence the construction of the tramway.

Loughborough.—The Light Railway Syndicate have intimated to the Town Council that promising negotiations are in train for the financing of the scheme for the supply of electricity and the establishment of the light railways, but as the arrangements are not complete the syndicate cannot take the risk of giving a definite undertaking. In the circumstances the Town Council have decided to interview the Board of Trade, and laying the special circumstances of the case before that authority with a view to getting a further extension of the time limit fixed by the Corporation Act of 1899 within which the electrical powers of the Corporation were to be taken up.

Cardiff.—The electric tramways were formally inaugurated on the 1st inst., when a service of electric cars was put on three of the reconstructed routes. Notice of motion has been given to be brought forward at the next meeting of the Town Council in favour of running the electric cars on Sundays. The Corporation have received a proposal from the Glamorgan County Council to confer with them as to the desirability of a joint promotion of tramways or light railways of the nature of tramways upon roads leading out of the borough into the county district, or, if thought advisable, on new routes. The matter has been referred to the Tramways Committee for consideration.

Blackpool.—The Tramways Committee's report presented at the last meeting of the Corporation showed that on the Promenade and Lytham-road tramways the receipts for the year ended March were £32,600, and on the Marton route £9,225, a total of £41,817. The total expenditure was £28,259, leaving a gross profit of £13,558. This was to be dealt with as follows: £6,648 interest on capital and sinking fund; £1,706 as the third instalment of doubling the line on the Promenade from Hounds-hill to Cocker-street; and a further expenditure of £1,723 for loans, etc. This left £3,479 to go the rates. There had been no fatal accident on the tramways during the past year.

Macclesfield.—A special meeting of the Town Council was held last week to consider an offer from a syndicate to lease the electric lighting from the Corporation and to construct electric tramways in the town. The scheme is a large one, including connections to other towns within the influence of Macclesfield, and involves an estimated expenditure of £500,000. As the result of a long discussion, it was decided to favour the introduction of trams into the borough and to appoint a sub-committee to deal with the matter. It may be mentioned that during the debate it was stated that the engineer (Mr. Godfrey Evans) advised that the electric lighting and tramway scheme should be combined.

Haslemere-Farnham Tramway.—It is suggested in the *Farnham, Hindhead, and Haslemere Herald* that an electric tramway without rails, or pneumatic-tyred motor-omnibuses guided and impelled by aerial electric cable, such as is being installed between the various villages on the borders of the Lake of Lucerne, should be constructed between Haslemere and Farnham, connecting Shotter Mill, Grayshott, Hindhead, Headley, and Frensham. This new mode of communication, which was fully described recently in this journal, does not involve nearly the outlay incurred for an ordinary electric tramway, but the question as to its adaptability to the country roads of England remains in considerable doubt.

Blackburn.—In connection with the loss of £6,000 or £6,500 on last year's working of the trams, the question was asked at the last Town Council meeting as to what amount, if any, was included in this item for depreciation of rolling-stock, tramrails, and the whole tramway equipment; or did this £6,000 or £6,500 represent actual working loss, apart from depreciation of rolling-stock, etc.? The Borough Treasurer pointed out that this was the first year that the tramways undertaking had been working at its full capital, and the necessity had not arisen to form a depreciation fund further than that provided for in the sinking fund, but in future years no doubt the need for such depreciation fund would arise.

Tottenham Court-road Tramways.—It will be remembered, with reference to the Tottenham Court-road tramways, that the London County Council had a clause in their General Powers Bill asking for power to lay tramways down Tottenham Court-road. That clause had to be dropped as the Standing Orders of the House of Commons had not been complied with by obtaining the consent of the St. Pancras Borough Council as the statutory road authority. The County Council now propose to introduce a clause in committee of the House of Commons endeavouring to coerce the Borough Council of St. Pancras into giving its consent by refusing to go on with the Hampstead-road widening unless such consent is given.

Douglas.—The Corporation have entered into an agreement with the Isle of Man Harbour Commissioners for an extension of the Bay Tramway on the Victoria Pier. This will be a great convenience to visitors, as it shortens the distance from the boat to the trams by 200 yards. The Clerk of the Rolls, sitting in Chambers at Douglas on Wednesday, granted the application of Mr. Ernest Schenk, of 20, Queen Victoria-street, and Crystal Palace, London, for an extension of time to complete the purchase of the electric tramway undertaking of the Isle of Man Tramways, Limited, to 31st inst. The purchase price is £252,000, and comprises the line from Douglas to Ramsey, and the line from Laxey to the summit of Snaefell, together with stations, plant, and rolling stock.

Birmingham.—The City Council on Tuesday adopted the recommendation of the Tramways Committee, that power should be obtained for the construction of a double line of tramway, two furlongs three chains in length, commencing at the junction of the existing tramways in Aston-street with those in Lancaster-street, and proceeding thence along Steelhouse-lane, and terminating in the last-named thoroughfare, near its junction with Bull-street; and for the equipment of the tramways now leased to the Birmingham and Aston Tramways Company within the city on the overhead electric trolley system. The Council also approved the inclusion of clauses submitted by the Tramways Committee in the General Powers Bill. It was explained that except for the omission of the Edgbaston and Harborne tramway scheme and the inclusion of the Steelhouse-lane route, the clauses were the same as were applied for last year.

Aberdeen.—On Monday the electric cars to the bathing station commenced running regularly. Much satisfaction has been expressed in the town with the decision of the tramways authorities to continue the double line in King-street to Merkland-road, instead of stopping at the City Auction Mart, as was at first intended, since a very large source of traffic can be tapped at Merkland-road. Rapid progress is being made with the work on the King-street route. Notice of motion before the Town Council has been given that "in connection with the report of the Finance Committee regarding the Aberdeen Suburban Tramway Provisional Order, the Council desires to express its strong dissatisfaction with the arrangement made by the Secretary for Scotland to hold the enquiry in Edinburgh, and that, in the opinion of the Council, the action of the Secretary for Scotland is contrary to the spirit of the Private Bill Procedure Act and against the public interest."

Shields and Sunderland Tramways.—The Duke of Northumberland's Committee of the House of Lords commenced consideration of the South Shields, Sunderland, and District Tramways Bill on Tuesday. Mr. Balfour Browne explained that the Bill would authorise the British Electric Traction Company to construct tramways between South Shields and Sunderland. The lines would start at a point in the northern part of South Shields, and would pass through Harton to Whitburn. There one branch would turn to the east for some distance and then go south to Sunderland, while the main line would proceed due south direct to Sunderland. In each case the lines would join the authorised lines in the hands of the Corporation of Sunderland. The length of the lines proposed to be constructed was eight miles one furlong. They would be constructed upon a 4ft. 8½in. gauge, and would be worked by electricity on the overhead trolley system. The parishes through which the lines would pass were supporting the scheme, and only the South Shields Corporation opposed it.

Manchester.—The financial year just closed has been a successful one for the tramways undertaking of the Corporation, and at a meeting of the committee on Wednesday it was decided to hand over £30,000 of the past year's profits for the relief of the rates. This is £10,000 more than the amount paid into the city fund last April. With regard to the purchase by the Corporation of the plant and properties of the Manchester Tramways and Carriage Company, Sir Frederick Bramwell has now issued his award, offering two alternatives. The arbitrator leaves it to the Law Courts to decide whether the purchase shall be limited to the plant that the Corporation actually require, or whether the Corporation shall buy the whole. He finds in favour of the company that the Corporation should buy the depôts, rolling stock, and horses for the whole system, and on this basis awards the company £496,068. If, on the other hand, the Courts decide that only such stock as is required by the Corporation shall be purchased, he reduces this sum to £229,353. Sir Frederick Bramwell himself is in favour of the purchase by the Corporation of the whole of the plant.

Singapore.—As we announced a week or two ago, it is proposed to lay down a system of electric tramways in the Settlement of Singapore. We now see from the Straits Settlement *Government Gazette* of March 27 last that an ordinance has been issued by the Governor of the colony authorising the scheme. The *Gazette* containing the ordinance, which gives detailed particulars of the requirements as regards construction, motive power, by-laws, fares, rates for supply of electric energy, etc., may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London, S.W., any day between the hours of 10 a.m. and 5 p.m. In Article 79 of the provisions of the ordinance it is provided that all engines, boilers, electrical generating apparatus, and power station equipment, car bodies, and electrical equipment therefor, including motors, shall be of British manufacture; and the Governor in Council may, in case the same or any of them shall not be of British manufacture, forfeit the same, and for this purpose remove the same and dispose thereof as he may think fit for the benefit of the Government.

North Metropolitan Tramways Bill.—This Bill, the preamble of which was passed last week, was further considered on Thursday by the Select Committee of the House of Commons presided over by Mr. H. Hobhouse in regard to clauses. Mr. Wheeler, K.C., submitted a proposal which would enable the local authority of Wood Green, which had obtained from the Board of Trade a provisional order empowering it to supply electrical energy, to provide the electric current for the tramways. The provisional order, he could assure the committee, was not a bogus one, and it was hoped that in due course it would be confirmed by Parliament. The Chairman said the Middlesex County Council, which was the road authority, intended to work its tramways in connection with the North Metropolitan Company, and would, therefore, use electricity. In these circumstances the committee could not agree to bring in another company with a veto as to the supply of electricity. If Wood Green desired to have this power, it should appear in the House of Lords when the Bill reached there, and ask for it. The clauses having been adjusted, the Bill was ordered to be reported for third reading.

Nottingham.—The Tramways Committee report that the property required for the widening of Upper Parliament-street, at the Derby-road end, has been purchased, and the old buildings thereon have all been pulled down and cleared away. The Council already possess parliamentary powers to construct a section of the tramways from the junction of Upper Parliament-street with Derby-road, along Upper Parliament-street to the bottom of Market-street, and the committee are of opinion that the lines should now be laid as far as the widened

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portion of the street extends, and they recommend the Council to authorise them to have this short length of the tramlines laid before the paving is done. The committee do not propose to construct the tramways along the remainder of Upper Parliament-street and down Market-street until the powers now being sought in the Bill in the present session of Parliament for making a communication between the Market-street tramlines and the existing tram system in the Great Market-place have been obtained. The official inspection of the Woodborough-road section of the Corporation tramways was made on Tuesday afternoon by Major J. W. Pringle, R.E., the inspector appointed by the Board of Trade, who expressed entire satisfaction with the route, and gave sanction for the cars to be run for public use immediately.

Light Railway Competition.—At the Board of Trade on Monday Sir Herbert Jekyll heard an objection by the London and South-Western Railway Company against the confirmation of the Poole and district light railway order, which raised the important question of whether light railways competing with existing railway companies shall go before the Light Railway Commissioners or before Parliament itself. Mr. Page, K.C., for the South-Western Railway Company, argued that where an existing railway company would be seriously injured by a light railway or tramway the scheme must go before Parliament, and could not be sanctioned by the Light Railway Commissioners or the Board of Trade. The railway companies all over the country had allowed these light railways to be promoted without opposition, and they were only beginning to find out what formidable competitors they might become in the future. There seemed no reason why, by a series of extensions, these light railways should not go parallel to the existing big companies all over the country. But Parliament, when it originally gave powers to the existing railway companies, did so on the distinct understanding that no rival schemes should be promoted without coming before Parliament for sanction. If it were otherwise, then the qualified monopoly obtained at great cost to the railway companies would be done away with, and the railway shareholders would be sufferers. Mr. Morse, for the promoters, submitted that Parliament had delegated the sanction of light railways to the Light Railway Commissioners and the Board of Trade, and they were to decide what was best for the public convenience. Sir Herbert Jekyll said the Board of Trade would consider the question and communicate their decision.

Embankment Tramways.—The Select Committee of the House of Commons of which Mr. H. Hobhouse is chairman have this week been engaged in considering the proposals embodied in the London County Council Tramways and Improvements Bill, one of which is for a tramway along the Victoria-embankment from Westminster Bridge to Blackfriars Bridge. There were 10 petitions against the Bill. Mr. Pollock, K.C., on behalf of the promoters, explained that there were altogether about 115 miles of tramways within the jurisdiction of the London Council, 74 miles were already under the control of the London County Council, 15 or 16 miles would soon come into its hands, and the County Council intended to take over the remaining 25 miles as soon as the licenses to the present owners had expired. It was expected that by the year 1910 the whole of the tramways in London would be under the control of the London County Council. The first new line the Council proposed would be one four miles in length from King-street, Hammersmith, to Putney Bridge, by way of Fulham Palace-road. The second would be along the Victoria-embankment from Westminster to Blackfriars. The minimum breadth of the Embankment, he pointed out, was 64ft., and the rails of the tramways would occupy only 13ft. The third proposed tramway was from Plumstead-road to Eltham, and the fourth from Camberwell Green by way of Grove-lane to the Crystal Palace tramway. These tramways would connect the other systems of the London County Council tramways, and would be worked on the underground electrical conduit system. Mr. Baker, vice-chairman of the County Council Tramways Committee, gave evidence on the Embankment tramways, and denied that it would be a disfigurement to the Embankment, as the conduit system would be adopted. The Council hoped to make the Embankment a means of taking through traffic from the north to the south. Ultimately, no doubt, the tramways would be carried over Westminster Bridge. Mr. John Burns, M.P., said he came before the committee in the interests of Battersea working men to give evidence in support of the Bill. His view was that the tramway ought to be taken over Westminster Bridge. He did not think the construction of the proposed subway down the new avenue to the Embankment ought to take more than 18 months, and did not agree that it was better to wait till that was constructed, and then come with the complete scheme. Asked whether the proposed tubes would not help Battersea working-men, Mr. Burns said the people in his district would rather travel at eight miles an hour on an electric tramway on the surface than at 14 miles an hour underground. The committee adjourned.

Middlesex Tramways.—The Bill promoted by the Middlesex County Council for providing tramway facilities in the county came before the Select Committee of the House of Lords of which the Duke of Northumberland is chairman. Lord R. Cecil, K.C., said the general nature of the proposals was that the County Council should in certain circumstances and with certain safeguards be allowed to purchase tramways in their county by agreement with local authorities. The great justification for the Bill was the peculiar geographical position of Middlesex. Throughout the county population was rapidly increasing; in 1891 it was 343,000, in 1901 it was 800,000. With this large and rapidly increasing population affected by London in various ways the existing railway accommodation was insufficient, and there had been enormous extensions of light railways and tramways passing through the district of various local authorities. The object of the Middlesex County Council was to be admitted as the general local authority within their county, and the Bill provided that the powers of purchase conveyed by the Act of 1870 should be exercised by the Middlesex Council with the consent of the local authority. It was in no way sought to vary the terms under which a tramway had been constructed, and he questioned the right of the United Tramway Company to appear against the Bill. Sir A. Binnie, C.E., gave evidence from his experience with the London County Council as engineer in connection with communication along main roads. He was in favour of the proposal in the Bill, which, if granted, would obviate the necessity for negotiating with many local authorities for securing unity of control over tramways. At the same time the Bill would in no way prejudice the rights of local authorities, inasmuch as the powers, if granted, would only be exercised by agreement. He hoped that at no distant date the tramway systems of London and Middlesex would be linked into through communication. Opposition was offered by the London United Tramways Company and several of the local authorities, but the chairman said the committee found the preamble of the Bill proved. There were, however, certain points they wished made quite clear. It had been urged that under the Act if the county council were by agreement to buy a tramway the district council could, at the expiration of a term of years, repurchase from the county council. If there was any doubt it should be made quite clear that it was not intended, if once the county council purchased, that a district council should have any further option. There was also a question raised whether the county council, having purchased by agreement before the expiration of 21 years, would be bound by any obligation the district council had entered into. It should be made clear that the council would be so bound.

London County Council.—At the usual weekly meeting of the London County Council on Tuesday the Highways Committee recommended the Council to spend £80,000 on the acquisition of the property of the Gaslight and Coke Company known as the Pimlico gasworks as a site for an electricity generating station for the supply of current to the western portion of their tramways. In their report the committee stated that the site in question has a total river frontage of 320ft., about 81ft. of which is freehold, and the remainder is held on lease, expiring in 1925. The works are situated between Grosvenor-road and Pulford-street, and the committee are advised by the tramways manager and the electrical engineer that the site is an eminently suitable position for the establishment there of an electricity generating station to supply the necessary electrical energy for the working of any tramways which the Council may construct or reconstruct for electrical traction in the western half of the county of London. Moreover, in addition to the position being good for the purpose, the facilities afforded by the wharf frontage will be of great value in regard to the carriage by water of the large quantities of coal and other materials which will be required for use at the station when established. The price of £80,000 exceeds by £10,000 the original estimate for the land, and the committee asked for authority to expend that additional sum, as well as another £1,000 for legal and other expenses. In a supplementary report the Finance Committee stated that an offer has been received to acquire some further property in Pulford-street, involving an expenditure of £64,000, including provision for rehousing persons displaced. It is estimated, however, that there will be a recoupment of about £25,000 from the resale of certain of the property not required, so that the net cost of the whole of the property for the generating station will probably not amount to more than £120,000. At the same meeting the Highways Committee submitted a report with regard to the laying of stoneware ducts for the electric cables for the tramways now under reconstruction between Westminster and Tooting. They think it advisable that as the ducts will have to be placed, where practicable, within or alongside, or under footways near to, the tramway tracks, the work should be done by Messrs. J. G. White and Co., the contractors for the roadwork in connection with the reconstruction of the lines. The ducts will have to be placed in the positions which may be found to be most suitable, and as some will have to be laid in the carriageways and some in the footways, it is almost impossible to arrange a price, at per yard run, as would, of course, be desirable, for the whole of the work. The electrical engineer's estimate, which is in the circumstances necessarily only approximate, of the cost of this work and also of the necessary repaving work is £10,000. They have obtained from Messrs. J. G. White and Co. a schedule of prices which are within the engineer's estimate and are, they are advised, reasonable for the laying of the ducts, and this schedule they have approved. The prices for repaving the footpaths, which work they think should also be carried out by Messrs. J. G. White and Co., will depend upon the character of the present paving, and will vary from 2s. 2d. per square yard for relaying York paving to 10s. 7d. per square yard for asphalte paving 1in. thick. The expenditure for these works is provided for in estimates which have been approved by the Council. As will be seen from another column, the Highways Committee have recommended the acceptance of the tender of Messrs. Siemens Bros. for high-tension cables and that of the British Insulated Wire Company for low-tension cables at £31,743. 17s. 6d. and £49,499. 12s. 6d. respectively—total, £81,243. 10s. It is revealed by the full list of tenders received that that of the St. Helens Cable Company for each description of cable is the lowest, being £31,454. 12s. 6d. and £47,298. 5s. respectively, making a total of £78,752. 17s. 6d., or £2,490. 12s. 6d. less than the accepted tenders. As regards this, the report states that the samples submitted by the St. Helens Company were not of an entirely satisfactory character for the purpose for which the cables were required, and, moreover, that firm has not in either case submitted a complete tender, certain information having been omitted. The times for delivery specified by the British Insulated Wire Company and Messrs. Siemens are quite satisfactory, and the amount of their respective tenders are within the estimates of the Council's officers. With regard to the Council's northern tramways, the Establishment Committee presented a report stating that they had received a memorandum from the Highways Committee to the effect that they have had under

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consideration the question of the steps to be taken with a view to the reconstruction, at as early a date as possible, of the Council's northern tramways, and in connection with this matter the committee have instructed the engineer to make a careful survey of the lines, including bridges, etc., in order to ascertain what difficulties are likely to be met with in carrying out the work. The work is of an urgent character, and the committee therefore propose to obtain additional assistance to enable the engineer to make the required survey as soon as possible.

LIGHTING AND GENERAL.

Tipton.—The Urban District Council's electricity order has been confirmed.

Lancaster.—The Town Council propose to borrow £25,000 for electrical purposes.

Leith.—Mr. A. Peden Rutherford has been appointed electrical engineer to the Corporation.

City Telephones.—Permission has been given to the Post Office to extend its telephone system to the Inner Temple.

Pontypridd.—The District Council intend to apply for sanction to a loan to enable them to carry out the electric lighting undertaking.

New Branch.—We are informed that Mr. G. Braulik has opened a branch at 115, Bath-street, Glasgow, for electrical supplies and accessories.

Dumfries.—The Town Council have appointed Prof. Capper, of King's College, to prepare a report on the proposed installation of electric lighting.

Willesden.—The polytechnic institute is to be lighted electrically. Mr. Frederic H. Taylor, consulting engineer, A.M.I.E.E., is dealing with the matter.

Scarborough.—The Telephone Sub-Committee have decided to apply to the Postmaster-General for a license to establish municipal telephones in the district.

Blaydon.—The Council are considering the lighting of Blackhall Mill by electricity. Mr. Berkley, manager of Hamsterley Colliery, is being consulted in the matter.

Sudbury.—An enquiry will be held on the 15th inst. into the Town Council's application to borrow £12,000 for electric lighting. The tenders received total £11,000.

Battersea.—The Borough Council have suggested to the London School Board that all its schools in the district should be lighted with electricity supplied by the Council.

Cheshunt.—Mr. H. Wall Wilkinson, M.I.E.E., A.M.I.C.E., Westminster, has been instructed to prepare a report on electric lighting for the Urban District Council.

Kettering.—Mr. H. P. Boulnois has held an enquiry into the application of the Urban District Council for sanction to borrow £43,275 for purposes of electric lighting.

Worcester.—The Council propose to apply for sanction to a loan of £1,000, repayable in 25 years, for defraying the cost of electricity meters and maximum demand indicators.

Derby.—The Parliamentary Committee have invited the Derby Chamber of Trade to send a deputation to the Parliamentary Committee to discuss the question of municipal telephones.

Dewsbury.—The electrical engineer has been instructed to lay down 90 yards of electric mains from the Market-place to the Masonic Hall in Longcauseway at an estimated cost of £40.

Ramsgate.—Application is to be made to the Board of Trade to extend the time for carrying out certain works under the Ramsgate Electric Lighting Order, 1900, for a period of two years.

Edinburgh.—An extension of the electric lighting of Causewayside is proposed. Eight lamps will be required, which, at £13 per lamp, represents an additional expenditure of £104 a year.

Market Drayton.—The Parish Council have decided to support the application of the Market Drayton Electric Light and Power Company's application for a license to supply electricity in the district.

Newark.—The Electric Lighting Committee of the Urban District Council are reported to have come to a final arrangement with an electric lighting company, which will be brought before the Council shortly.

Wolverhampton Exhibition.—We are informed that the Brockie-Pell Company have some 300 to 350 lamps now lighting the exhibition buildings and grounds of the Wolverhampton Exhibition opened on May 1.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramway and Electricity Board have elected a Liverpool architect to design and superintend the erection of buildings for the generating station and transformer stations.

London Gazette.—A first and final dividend of 2s. 3d. per pound has been declared in the estate of T. Morley, electrical engineer, 16, Whalley-road, Accrington. Payable from May 8 at official receiver's offices, 14, Chapel-street, Preston.

Runcorn.—A syndicate proposes to apply for parliamentary powers to erect electric generating stations and lay mains for the supplying of electricity throughout a district comprising the county of Chester and the northern portion of the county of Stafford.

Deptford.—Messrs. Handcock and Dykes, electrical engineers, of Victoria-street, have been engaged by the Borough Council to prepare an estimate and specification for wiring and providing the necessary fittings for lighting the town hall with electric light.

Hackney.—At the meeting of the Borough Council last night the following extensions of mains were recommended: to Filey-avenue, Clapton Common, amounting to £395; also to Station-buildings, Haggerston, amounting to £105—making a total of £500.

Amalgamation.—It is reported that the Helsby Company and the British Insulated Wire Company have amalgamated. The combination is expected to have an important effect upon the ever-growing foreign competition in the great industry of cable wire making.

Brighton.—Mr. Christie, the resident electrical engineer at Brighton, brought the Nernst lamp to the notice of the Electric Lighting Committee, who have authorised him to fit up 10 street lamps in the Montpelier district with it. The result appears to be very satisfactory so far.

Covent Garden.—The huge glass chandelier, the largest of its kind ever brought into a theatre, has been removed from Covent Garden Opera House. Weighing many tons, it has been supported by massive chains for more than 40 years. Light from the roof will in future be supplied by two circles of incandescent lamps.

Chelmsford.—The Town Council have agreed to pay the Chelmsford Electric Lighting Company's account of £335. 10s. 6d. for the quarter's lighting, less £2. 0s. 3d. deducted for lamps not kept alight, and to place three lamps in Manor-road, two in Marlborough-road, and one each in Redcliffe and Upper Roman roads.

Presentation.—Last Friday Mr. J. Gray Scott, the Leith Corporation's electrical engineer, was presented by the staff at the electric lighting station with a smoker's cabinet, on the occasion of his leaving to take up a similar position at Croydon, as a mark of their appreciation of the unfailing courtesy Mr. Scott had always shown them.

Hull.—The electrical engineer has been authorised to lend lamps and fittings for illuminating the town hall in connection with the Coronation celebrations free of charge. The resumed conference between a deputation of the Telephone Committee of the Corporation and the directors of the National Telephone Company has been adjourned.

Frome.—The scheme of electric lighting for the town is to be proceeded with, and at the July meeting of the Council a resolution will be submitted providing for application for sanction to the loan, and for arrangements to obtain tenders either for carrying out the work in the usual manner, or for carrying it out and insuring the Council against loss.

Barnstaple.—The Electric Lighting Committee have appointed Mr. T. B. Johns, of Bristol, as clerk of works to superintend the erection of the electric light station. Steps are to be taken to obtain a loan of £21,600 for the purpose of electric lighting in the borough. The front elevation of the lighting station against Castle-street will be of white Marland brick.

Londonderry.—Mr. Macrory, the electrical engineer, in his last report states that the first section of the cable conduit system has been completed, and several conduits saved, owing to several diversions and alterations from the original scheme. It is anticipated that there will be sufficient electrical power at the station to light the city gates on the occasion of the Coronation festivities.

Stock Exchange.—The Stock Exchange Committee has been asked to allow the following securities to be quoted in the official list: British Westinghouse Electric and Manufacturing Company's further issue of 50,000 6 per cent. preference shares of £5 each, fully paid; Edmundson's Electricity Corporation's further issue of 10,000 6 per cent. cumulative preference shares of £5 each, fully paid.

Eccles.—At the last meeting of the Public Lighting and Electrical Supply Committee, the question of the transformer required in respect of the electric lighting of St. Andrew's Church was referred to the Works Sub-Committee. An application was submitted for the lighting of Lewis-street, Patricroft, and it was resolved that, subject to the street being kerbed and channelled, the necessary number of lamps be erected.

Grimsby.—Particulars of tenders accepted by the Corporation for plant required to meet the load next winter will be found in another column. On April 8 the town clerk received the sanction of the Local Government Board to borrow an additional £17,000, £4,000 being for accounts overspent and £12,900 for extensions of plant and mains. This makes the total capital expenditures sanctioned by the Local Government Board £72,000.

Blackburn.—The president of the Institute of Civil Engineers having nominated Prof. Kennedy as referee in the dispute about the engines and dynamos for the electricity works, some 213 sets of tenders for engines, of types varying from 90 to between 300 and 400 revolutions a minute, were submitted to him, and he has selected three of moderate speed—180 revolutions per minute—from which the committee will make the final selection.

Electric Lighting Orders.—Bills to confirm electrical lighting provisional orders which have been granted to the Blaydon Urban Council and the County of Durham Electric Power Distribution Company in respect of Chester-le-Street, the Newcastle and District Electric Lighting Company (for Newburn), and the Northern Counties Electric Supply Company (for Earsdon and Tynemouth rural), have been reported to the House of Commons.

Bath.—Mr. Bicknell has held an enquiry into an application by the Corporation for a loan of £25,000 on account of the electric lighting. The sum is made up of two amounts, £11,195 being excess of expenditure over loans previously sanctioned, and £13,000 for new plant and alterations in the system of working immediately required to be expended to enable the works to be carried on during the next winter if the breakdowns of last winter are not to recur.

Electric Furnaces.—Three electric furnaces of 500 h.p. are said to have been erected in the valley of Camonica, Northern Italy, for the manufacture of pig iron under the Stassans patent. The furnaces in general outlines resemble cupola furnaces using coke, their special feature being apparent in the provision made for supplying electric current and in the electrodes placed at the bottom of the boshes. To obtain a metric ton of metal 3,000 horse-power hours are required.

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Mansfield.—On Tuesday the Mayor (Councillor T. Taylor) and Councillor W. J. Chadburn laid the foundation stones of the electricity works and refuse destructor, which the Corporation are constructing at an approximate cost of £60,000. The engineer is Mr. Robert Hammond, Westminster; the builder Mr. Robert Greenwood, Mansfield; and the architects Messrs. Vallance and Westwick, also of Mansfield. The Corporation anticipate to be able to supply power by November.

Hoole.—At the last meeting of the Urban District Council a letter was read from Messrs. Rowcliffe and Co., solicitors, Manchester, notifying the Council of their intention to apply on behalf of a syndicate for parliamentary powers to carry out the electric power scheme for Cheshire and North Staffordshire. The scheme would be on the lines of the Lancashire Electric Power Act. The chief object was to supply electricity for power purposes. The letter was allowed to lie on the table.

Blackpool.—The borough engineer and tramway engineer is to report on the best means of laying electric cables in the widened promenade for lighting and traction purposes. Applicants for extensions are in future to be asked to pay 6 per cent. towards interest and sinking fund of cost of the same until that sum has been assured by additional consumers. From March 31 the practice of charging by the maximum demand indicator for public street-lighting is to be discontinued, and a uniform charge of 3½d. per unit will be made.

Personal.—Mr. A. Venning, who has been chief engineer of the steam engineering and central-station department of the British Thomson-Houston Company, Limited, during the past five years, has now resigned his position with that company. He has had charge of the design of several of the largest and most important generating stations erected in this country by the above company, his latest work being in connection with the plants of the Great Northern and City Railway and Chatham tramways, both of which stations are almost ready for opening.

Fire.—We are informed that Mr. A. H. Hunt, whose premises at Gresham-street were recently destroyed by fire, has now started again at his new and more commodious address, 115-117, Cannon-street. Mr. Hunt is supplying the trade only, and among some of his specialities may be mentioned automatic distance switches, circuit breakers, iron case fuses, fuseboards, switchboards, fancy and cut glass shades and globes of English manufacture, etc. He is also representing the Walsall Electrical Company for the sale of their switchboard specialities and other apparatus, and Messrs. Geoffroy and Delore's for wires and cables.

Malton.—At the last meeting of the Urban District Council Mr. Fairweather and Mr. Brown, the engineer of the Northern Counties Electricity Supply Association, stated that they had been inspecting certain parts of Malton with the view of securing a site for their working plant, etc. They had already obtained an order from the Board of Trade enabling them to generate and supply electricity for the town, and they had contracted to instal electric light for public lighting purposes by July next. The consideration of a letter from the Postmaster-General with reference to the establishment of the telephone in Malton was postponed.

Manchester Telegraph Messengers' Institute.—The library which has been established in connection with the Manchester Postal Telegraph Messengers' Institute was opened this week by the Postmaster of Manchester (Mr. Phillips), who gave a short address to the boys. About a thousand volumes of books suitable for boys have been collected, and Mr. Phillips expressed the gratitude felt by himself and the committee of the institute to the donors. He also announced that the cricket, tennis, and cycle clubs, which form part of the institute, will begin their season next week. The swimming club is already a great success.—*Manchester Guardian.*

Colchester.—The Electric Lighting Committee have passed through a most difficult year. The pressure of supplies has been doubled through the entire system, and it was thought well at the same time to reduce the price of current to consumers. It was estimated that the utmost they could expect was to sell 180,000 units at a net profit of £110, but the result of the year's working shows a sale of 180,166 units at a net profit of £153. 4s. 10d. The income from private consumers has considerably exceeded the estimate, and the total net profit is £473. 18s. 4d. for the year, and would have been more had not much of the barrack occupation remained unoccupied during this period.

Worthing.—The Electric Lighting Committee have been authorised to construct the new buildings in connection with the contemplated extensions of that undertaking under the personal supervision of the borough surveyor, and the latter's salary will on the completion of the work be increased by 70 guineas. The estimated cost of the particular work is £3,500. The Council have decided to sanction the employment of the arc lamp columns in any scheme of decoration at the Coronation subject to the approval of the resident engineer. There are now applications equivalent to 8,600 8-c.p. lamps at hand; 6,700 of these are connected, and, as far as can be foreseen, by the end of July the whole of these applications will be connected up, which will test the existing machinery and plant to its utmost capacity.

Electric Barges.—The scheme for widening and deepening the Severn and the Birmingham and Worcester Canal, so as to form a continuous water route for vessels of 300 tons burden from the Midland metropolis to the sea, says the *Western Mercury*, has been hanging fire since the refusal of the Birmingham Corporation to join the Corporations of Worcester and Gloucester in guaranteeing the preliminary expenses connected with the obtaining of parliamentary powers. The committee (of which Sir Alfred Hickman, M.P., Sir John Gunn, of Cardiff, and the Hon. G. Allsopp, of Worcester, are prominent members) have, however, not abandoned their object, and hope to secure the co-operation of capitalists and the leading manufacturers of the Midlands in raising the necessary funds to place the scheme on a practical working basis. An important feature of the scheme is the proposed introduction of steel barges worked by electricity.

Epsom.—The Lighting Committee have re-elected Mr. Ledger as chairman. The resident electrical engineer in his last report states that the supply of current is continuous, and the machinery at the electric lighting works work satisfactorily. He also reported that a great many glasses appeared to be wilfully broken by stones, and the Council were recommended to bring the matter to the notice of the police and to issue a reward. The engineer is to be granted permission to take a student. With reference to the new £10,900 loan, the Council will instruct Mr. Hawtayne to take the necessary steps to get tenders for the increase of the generating plant, boilers, dynamos, etc.

York.—The Electric Lighting Committee propose to extend the main in Monkgate for the lighting of additional street arc lamps as required by the Streets and Buildings Committee and for private consumers, also to extend the main from Driffield-terrace to the city boundary on the Tadcaster-road at the estimated cost of about £1,000 altogether, to supply private consumers. In giving evidence on behalf of the Corporation's Bill before a Select Committee on Monday, the Town Clerk said they were increasing the generating station and extending their system. They had borrowed £40,000, and had applied for a new loan of £60,000. The revenue of the undertaking had largely increased, and they were putting up additional buildings and plant. The clauses were passed, as were those giving the Council power to supply energy outside and to companies and tramways, and the power to give 10 per cent. discount for prompt payment of electric accounts.

Coronation Illuminations.—The City will devote a sum of £500 to the decoration and illumination of the Royal Exchange, the pediment of which will be outlined in ruby lights, and it is also probable that the general scheme which was so successful at the Mansion House at the Diamond Jubilee will be, to a large extent, followed in the Coronation festivities. All the great banking and mercantile houses in the vicinity of the Lord Mayor's official residence are pushing forward their preparations for illumination. The Paddington Borough Council have voted £500 towards the decoration and illumination of the local public buildings and main thoroughfares. The Kensington Borough Council have voted £500; Hammersmith Borough Council, £1,350; and it is proposed that the London County Council should vote £3,500. The Lewes Electric Supply Company have decided to suspend the operation of the "maximum demand" system during the month of June, so that consumers may let themselves go without fear of more than trifling expense.

West Hartlepool.—About 9 p.m. on Thursday a considerable proportion of the electric lighting service temporarily failed. At the Grand and Gaiety Theatres there was a short delay before the gas supply replaced it, but no panic occurred It was reported at Tuesday's Town Council meeting that the amended draft licence had been received from the Postmaster-General for the establishment of a municipal telephone exchange for the Hartlepools, and that it had been decided to take out specifications, etc., for the work. It was pointed out the Corporations were not by this finally committed to go on with the scheme. Upon Coronation Day current will be supplied free to consumers for the illumination of their premises, subject to the fittings, etc., being to the satisfaction of the electrical engineer. The electrical engineer, Mr. Friederichs, has been instructed to report on the request by the Hartlepool Corporation for terms for the supply of electrical energy in bulk at the boundary of the borough, and the terms for distributing the same within the borough.

Birmingham.—An enquiry has been held into the Council's application for consent to borrow £251,974 for electric supply by Mr. E. A. Sandford Fawcett. Mr. E. O. Smith, town clerk, and Mr. Vaudrey, the city electrical engineer, gave evidence in respect of the scheme, from which we note that the sum sanctioned was considerably more than was actually asked for. This was due to the circumstance that certain work which was in contemplation at the time was not now proposed to be carried out. The cost of the site in Summer-lane was £23,174. The opportunity of the city authorities acquiring such a desirable site did not often occur. The amount proposed to be expended upon machinery, new buildings, and additions to existing power stations in Water-street and Park-street was £41,909. 3s. 2d., and the erection of the new generating station in Summer-lane was set down at £128,890. The estimated cost of laying new mains, in erecting and equipping a subsidiary station, providing meters, etc., was £58,000. With regard to the present generating stations in Water-street, Dale-end, and Parker-street, it was anticipated that they would be working at their full capacity in 1903. There was not sufficient land at those stations for the extension of the works.

Dudley.—At the Town Council meeting on Wednesday it was stated that the estimated revenue for the 12 months ended March 31 had been £6,117. 13s. 3d. The sum of £636. 7s. 4d. was put down in respect of the loss sustained with the meters. In addition to this, there was the interest on the money lying in the bank, amounting to £80, and the value of the stores, representing a sum of £62, making the estimated total on the credit side of the accounts £6,816. 6s. 7d. The expenditure had been £6,648. Deducting the expenditure from the gross estimated receipts there was a net profit, after paying interest on sinking fund, of £168. 7s. The number of units generated during the year had been as follows: 688,678 for traction purposes, 238,292 for private lighting, 37,335 for street-lighting, 10,148 for lighting the station, and 3,126 for testing purposes. The selling price of the electricity had only averaged 1½d. per Board of Trade unit. He was quite convinced that the town would ultimately derive a tremendous benefit from the electrical undertaking. The Town Clerk (Mr. Brettell) said that £41,500 of the capital in connection with the electrical undertaking had been expended, and sanction had been given for the borrowing of further loans amounting to £23,000, making a total of £64,500.

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Cheltenham.—The Corporation have replied to the Gloucestershire County Council that they are willing to supply electric power to work a light railway between the Cross Hands Inn at Brockworth and the city boundary of Gloucester, in the event of the County Council making and constructing such a line and desiring to take such power from the Cheltenham Corporation. The electrical engineer in his last report states that the equivalent of more than 36,000 8-c.p. lamps are now connected to the private supply mains. The Council have decided to increase the electrical engineer's salary to £450 per annum from Dec. 31 last and to £500 per annum from June 30 next.

Ipswich.—The Town Council have arranged with the Great Eastern Railway Company for the construction of so much of the siding as is upon the company's premises upon the following terms: the siding, points, and other works will be constructed by and at the expense of the company, and kept in repair by them, the Corporation paying to the company the sum of £50 a year for the accommodation, but against this annual sum the company will credit the Corporation with a rebate of 5 per cent. on the amount received by the company for the carriage of traffic over their system on to the said siding. The committee would also arrange with the company that they should forthwith construct at the expense of the Corporation so much of the siding as is on the Corporation's property. The estimated cost of this portion is £750.

Dartmouth.—We quote from the circular issued to Dartmouth householders by the Urban Electric Supply Company, Limited the following terms: "Free wiring—The company is prepared to fit up premises free of all initial cost to the occupier, charging in all ordinary cases a rental of 4½d. per lamp per quarter, and giving the consumer the opportunity of buying it outright at any time. Price of current—For any quantity up to the amount which would have been used if the 'maximum demand' had continued for 91 hours during the quarter (one hour per day), lighting 7d. per unit, power for motor 4d., for any further quantity 4d. and 1½d., for heating 2½d. per unit for any quantity; rent of meter, main cut-out, and maximum demand indicator, up to 50 8-c.p. lamps, 2s. per quarter; ditto over 50, 4s. per quarter. Prepayment meter—Lights will be supplied for small premises through prepayment meter (1s. or penny-in-the-slot meters) at 6d. per unit, which covers the rent for the wires and rent of meter."

Hastings.—The report of Prof. Kennedy upon the electric light undertaking, submitted to the meeting of the Council last Friday, has been circulated amongst the members. The *Hastings and St. Leonards Observer* understands that it is of a very satisfactory character, and says it seems a pity that it should not have been made public by being supplied to the Press. The professor enters into a lengthy review of the whole of the machinery, etc., and is most complimentary about the whole concern. Amongst other things, he points out that the plant is capable of doing quite 50 per cent. more business than is done at the present time, refers to the up-to-date character of the machinery, and speaks in high terms of Mr. Leonard Andrews, the electrical engineer. Mention is made of the failures experienced formerly in the light, but he points out that certain matters have been perfected, and there is less chance of such failures happening in the future, and he does not think there should be much cause for complaint as time goes on. The whole report is very complimentary and satisfactory. Allusion is also made to the economical way in which the works are managed.

Stockton.—On Tuesday a report was presented to the Town Council by Mr. J. J. Smith, the electrical engineer, on the question of the extensions to the electric light works, the expenditure for which has been sanctioned by the Local Government Board. The sum of £21,000 has been granted for new machinery and electrical equipment only, and does not include any expenditure that might be required on alterations to buildings. The expenditure on some of the items, he says, would certainly be exceeded; it was hoped that there would be a saving on others, but still he did not expect that there would be any margin as a surplus. The Electric Light Committee resolved that the engineer be instructed to prepare the necessary plans and specifications and to invite tenders for the machinery and works mentioned in his report. The gas manager reported that despite the introduction of electric light in the town, and its increase of popularity amongst the ratepayers, there was an increase of 157,000 cubic feet in the make of gas at the Corporation works during the past month, compared with the corresponding period of last year, when the total make was 33,889,000 cubic feet.

Darlington.—Mr. J. R. P. Lunn, in his last report, stated that four consumers were connected during the month, making a total of 148. Two hundred and seventy-three 8-c.p. lamps were connected, making a total of 11,058. He had applications from 33 intending consumers who would require 2,390 8-c.p. lamps; 14,416 units were generated, the revenue from which would be about £220; 518 yards of pilot and feeder cable and 1,190 yards of distributing cable were laid in the following roads: Carmel-road, Woodlands-road, Blackwell-lane, Coniscliffe-road, and High-row. During the year ending March 21 82 consumers and 5,925 8-c.p. lamps were connected. The engineer recommends that in future consumers of electrical energy be informed that all wall plugs connected to circuits which are supplied through the lighting meter must be of the two-prong type, and all wall plugs connected to circuits which are supplied through a power or heating meter must be of the concentric type. The annual statement of revenue and estimate of expenditure for the year ending March 31 shows a profit of £90. 1s. 11d. Messrs. Kennedy and Jenkin will be asked to advise as to what extension of the electric lighting generating station will be necessary in order to supply the electrical energy required for the Darlington light railways.

Institution "Journal."—The *Journal* of the Institution of Electrical Engineers, edited by Mr. W. G. McMillan, secretary, Part No. 156, (E. and F. N. Spon, Limited, 125, Strand, W.C.; 6s.), contains the following papers with the discussions thereon: "Researches on the Electrical Conductivity and Magnetic Properties of upwards of 100 Different Alloys of Iron," by Prof. W. F. Barrett, F.R.S., member; "Electric Shock and Legislation thereon," by Major-General Webber, C.B.; "Electric Shocks," by Mr. F. B. Aspinall, member; "Electric Shocks at 500 Volts," by Mr. A. P. Trotter, member; "Surface-Contact Systems of Electric Traction" (in abstract, Birmingham Local Section), by Mr. W. Kingsland, member; "Some Notes on Electrical Engineering Practice in Europe and America" (Cape Town Local Section), by Mr. John Denham, member; "Practical Notes on Continuous-Current Distributing Mains" (Glasgow Local Section), by Mr. J. C. A. Ward, associate; "The Supply of Electricity in Bulk" (Manchester Local Section), by Mr. H. A. Earle, member; together with the inaugural address of the chairman of the Dublin Local Section, Prof. W. F. Barrett, F.R.S., and two original communications from Mr. David Robertson, B.Sc., entitled "A General Formula for Regular Armature Windings" and "A Method of Studying Armature Windings by Means of Winding Diagrams."

New Issue.—The Bournemouth and Poole Electricity Supply Company, Limited, are issuing preference shares carrying £6 per cent. cumulative dividend. The rate of interest paid on the ordinary shares of the company was 4 per cent. for 1898, 5 per cent. for 1899, 6 per cent. for 1900, and 7 per cent. for last year, and the prospectus contains the following statement: "The directors anticipate that at Dec. 31 next the balance of profits remaining after paying all interest charges, and the dividend on the existing preference shares, and after providing for depreciation, will suffice to pay the dividend on the present issue of preference shares, and at least a dividend of 7 per cent. on the ordinary shares for the current year." The company is entitled to parliamentary powers in Bournemouth, Boscombe, Winton, Southbourne, Christchurch, Parkstone, and Poole, and the Board of Trade have within the last few days decided to grant a provisional order to the company for the area of Pokesdown. At the present time the number of lamps connected to the company's mains are equivalent to 69,795 of 8 c.p., over 12,000 of which were added during the past year. The supply mains have been recently extended to Parkstone and Poole, the company is supplying the motive power for the tramways from County Gates to Poole, and are making arrangements to supply the projected line from the borough boundary to Christchurch on the east side.

South Africa.—We glean from the *British and South African Export Gazette* as follows: The Bloemfontein Town Council have obtained authority to raise a loan of £25,000 for the extension of the electric lighting system. If the powers being sought by the Paarl Electric Power Syndicate, Limited, Cape Colony, are granted, valuable orders for electric lighting, traction, and telegraph and telephone material will be given out at an early date. The syndicate's aims comprise all the necessary works for the furnishing of an electric lighting and power supply installation, a tramway service, and a telephone and telegraph service, and include the building of reservoirs, aqueducts, the construction of a power station, etc. Electric lighting and tramway installations are mooted for Walmer, a Port Elizabeth suburb. The construction and equipment of a central power station for lighting and tramway purposes will shortly be undertaken by the Pretoria Town Council. The Borough Council of Kimberley have obtained the necessary sanction to borrow £10,000 for the extension of the electric lighting system, on the condition that it is first ascertained, by consultation with the directors of the De Beers Company, that the latter cannot deliver current to the Council at a lower rate than they themselves can produce it. Should the company be able to supply current on advantageous terms, the above loan will be diverted to cable extension and other works.

Bankfoot.—From the *Auckland Chronicle* we gain particulars of the laying down of a large electric plant at Bankfoot. Messrs. Pease have an electrical lighting installation at Peases West on the parallel system, which has been in vogue some two years or thereabouts. However, the firm are now introducing coal-cutting machines for long wall work, 110 yards back and forward to work in a clay seam or seams. An electric ram is being fitted by a German firm at the ovens, which will load, press coal in, and push coke out. The weight of the ram is 70 tons. It will have two motors in it, and its strength is 30 h.p. The Bankfoot works will be lighted up by the new plant on the series system, the French ovens having five arc lamps of 1,000 c.p. each. The engine to drive the whole of the electric plant is one of Robey's, of Lincoln. It is 320 i.h.p., and horizontal. Instead of a belt it will have 13 ropes, the fly and driving wheels having grooves. The dynamo, which is not as yet put down, will have a capacity of 500 volts and 400 amperes. This will drive four coal-cutters, the machines in the fitting shops, and the Bankfoot electric lighting installation. The station at Bankfoot, which is almost complete, has accommodation for another similar set if required. The Crook Urban Council are anxious for the electric light, and may, perhaps, here see their opportunity. Messrs. Reid and Ferens and Messrs. Scott and Mountain, of Newcastle, have the bulk of the electrical work in hand. Mr. S. Wraith, Messrs. Pease's electrician, is held responsible for this department, whilst Pease's general engineer is Mr. Wm. Oughton, of Stanley, and their chief agent is, of course, Mr. T. Y. Greener.

Southampton.—Colonel W. R. Slacke has held an enquiry into the application of the Corporation for sanction to borrow £30,000 for purposes of electric lighting. Alderman Bone, chairman of the Electricity Committee, said the proposed extension was due to increased demand for lighting, and also to the increase in the town itself. The area of the lighting was the same as the borough boundaries. They had also to provide for the extension of lighting and for the electric trams. At the present time they were charging 5½d. for light and 3d. for power, except in regard to the trams, which were their own undertaking. The electric light was commenced by a company, who got their license in 1890, and a further order in 1895. They commenced lighting about 1892, and the undertaking, which was a small one, was purchased by the Corporation in 1896. As far as the

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Corporation were concerned it had not been a remunerative undertaking. There was a small deficit up to last year, when there was a profit. Mr. Street, electrical engineer, gave evidence as to the capacity of the plant at the works, and said the extension of the existing works was not considered desirable, as they would have to pay a very high price for the land, and it would involve the removal of buildings. It was also unsuitable, because there was not available depth between the streets. They had estimated to provide on the site for two 500-kw. machines and the necessary buildings. All the plant at the present station was worked by one 500-kw. dynamo, and they had no reserve whatever. Extra provision for the trams would have to be made in the near future. It was also stated that at their last meeting the Council had decided to apply for power to borrow a further £2,500 to provide for distributing mains and services, so that they might connect customers when necessary. The inspector said that would have to form the subject of a further enquiry.

Cardiff.—Mr. Arthur Ellis has prepared a statement showing approximately the revenue, expenditure, and rentals of the electric lighting department for the year ending March, 1902. The gross expenditure has been £9,594, and £5,676 has been spent in loan charges, interest, and sinking fund—a total of £15,270. This shows an approximate profit of £1,023, as against a profit of about £9 for the previous year. The engineer adds that the gross profit works out to about 6½ per cent. on the capital. The statement is regarded as highly satisfactory. At the suggestion of the engineer it has been decided to extend the electric lighting mains at an estimated cost of £708. The Western Mail Limited have now added to their establishment a powerful electric light signal, which is described in a recent issue. The flat roofing of the higher turret of the journal's premises at the head office in St. Mary-street, Cardiff, has been regarded as the highest accessible altitude in the town, standing, as it does, 116ft. from the ground. Upon this an iron staging has been erected, about 30ft. high, and this is fitted with an electric lamp of 6,000 c.p. The staging is made in the form of an outer cage, within which the lamp may be moved up and down by the use of hand winches, and the lamp itself is hung in a movable inner cage, designed so that it may be adapted for signalling purposes. The signal throws a strong light over a wide area, and, by reason of its strength and the elevation that it occupies, may be seen practically all over the town, and even from some parts of Penarth and Rumney. It will be used for notifying to people of the town and neighbourhood when any remarkable events occur, of such events as the Anglo-American boat race and of the polings during elections in a manner that will be sufficient indication to the people of a wider area. Messrs. Clay Bros. and Co., Cardiff, have supplied the electrical fittings, and the current will be derived from the *Western Mail* generating plant.

Kingston.—The arc lamp question was discussed at the last meeting of the Council, and finally the following minutes were adopted: "At a meeting held on April 18 the action of the public meeting appears to have been discussed for the first time, the following reference appearing in the minutes of the committee: 'The committee had before them the following resolutions adopted at a public meeting held on the 13th ult., and referred by the Council to this committee—viz.: (1) That this meeting of burgesses emphatically condemns the extension of the arc lighting system in the main roads of the borough, and calls upon the Corporation to forthwith withdraw the order for 35 additional arc lamps passed by the Town Council at its meeting on Feb. 18; (2) that in the opinion of this meeting the present financial position of the borough electric lighting undertaking demands searching investigation, and the Town Council are hereby requested to take into their earnest consideration (1) the advisability of discontinuing the whole system of arc lighting in the streets, and (2) the means to be taken to make the private lighting into a commercial success.' Resolved that in regard to such resolutions this committee would remind the Council that the proposal to extend the arc lighting was approved so far back as 1900, that by the authority of the Council application was made to the Local Government Board for borrowing powers for the purpose, that the Local Government Board held a public enquiry on the subject on Jan. 8, 1901, and sanctioned the loan on March 13, 1901, and that orders for which the Corporation are now liable were authorised and given for a portion of the necessary plant in June, 1901, and subsequently for other portions of the plant. Therefore, having regard to all the circumstances, the committee cannot recommend the Council to attempt to withdraw their orders for carrying out the work which was decided upon after the most careful consideration. The further suggestion contained in such resolutions, that the whole system of street-lighting should be discontinued, the committee consider to be impracticable as involving unjustifiable financial sacrifice and a serious diminution of efficient lighting." During the discussion the Electrical Engineer (Mr. J. E. Edgcome) said it was only fair to Mr. A. H. Preece, under whom the present system was installed, to say that at the time it was laid down it was impossible under the regulations of the Board of Trade to put in any other system. Two years afterwards there was a radical change in the regulations, so that those municipalities which had laid down systems since 1895 had an advantage which was not open to Kingston in 1893. When statements were made that the original scheme was a wrong one, it was right to say that it was the only scheme that could be proposed at that time.

Colne.—Mr. A. G. Cooper, borough electrical engineer, has submitted the following report on the past year in his department: "Since my last report the plant mentioned therein as having been ordered has been set to work, and has run continuously up to the present. The steam-turbine was erected, together with the switchboard and balancers, in some five or six weeks from being delivered, and the current was first switched on to the mains for public use on Sept. 23 last. The conditions of supply were somewhat onerous, as the switchboard and balancers had to be housed in a temporary lean-to roof in the engine-room of the new works, but the committee had promised that the current should be available for use at the technical schools on the date mentioned above. As the building of the generating station in Phillips-lane progressed (which has been, unfortunately, slow owing to the failure of the contractors) further plant was ordered, consisting of a 30ft. by 8ft. Lancashire boiler, superheater, economiser, feed pump, etc., from Messrs. Yates and Thom, Blackburn, and a 160-kw. Belliss-Greenwood steam dynamo. The pipework incidental to this plant is being erected by Messrs. James Carter and Sons, Stalybridge. The engine-room is spanned by an overhead travelling crane made by Messrs. Rushworth Bros., Colne. The storage battery was set to work during the latter end of the year, and this enables a supply to be given continuously throughout the 24 hours, the same coming into operation when the engines have been shut down. The original generating plant at the refuse destructor will work in conjunction with the machinery in the main station across the river, steam being raised to drive the engine from the heat derived from burning refuse, which previously escaped up the smoke stack. The efficiency of the destructor as a destroyer of waste products is not affected thereby. Further generating machinery will be installed immediately on the construction of the Colne and Trawden light railway, the Corporation being bound to supply current for this purpose. A word as to the distributing system. The current is conveyed on paper-insulated lead-covered feeders in earthenware conduits to three feeding points situated at the technical schools, Dockray-street and Keighley-road. At these points the feeders are coupled to switchboards located in large chambers underground. From here the distributing or branch mains radiate in all directions. The financial result of the first three months' working—from Sept. 23, 1901, to Dec. 31—was as follows: Some 23 consumers have been permanently coupled to the mains, representing an equivalent of 1,578 8-c.p. lamps and one 6-h.p. motor. The revenue for the three months amounted to £86. 12s. 2d., exclusive of meter rents, etc., the average price for current working out from all consumers at the very satisfactory price of 4d. per Board of Trade unit."

London County Council.—The Council's Electric Supply Bill has failed to pass the Select Committee of the House of Commons. Practically the whole of the electric supply companies of London petitioned against the Bill, as well as the City Council of Westminster. The opponents contended that the proposals of the Bill would effect a breach of a parliamentary bargain, both as to the period within which local authorities might purchase electric undertakings, and in the respect that it would give the County Council power, not possessed by them at present, to purchase these concerns. On Tuesday last the Council granted an application of the Poplar and Stepney Sick Asylum District Managers for a loan of £2,200 for the installation of electric light in their asylum. The following notices under Electric Lighting Acts and Orders were agreed to: From the Brompton and Kensington Electricity Supply Company, under the House-to-House Order, 1899, of intention to lay low-tension mains along a portion of Cromwell-road; the Charing Cross and Strand Electricity Supply Corporation, under the St. Martin's District Order, 1899, and the company's Further Powers Act, 1900, to lay extra high-tension mains along portions of St. Martin's-lane, Garrick-street, Hart-street, Wellington-street, Bow-street, Long-acre, Endell-street, and Milford-lane; the Kensington and Knightsbridge Electric Lighting Company, under the company's order and the Kensington and Knightsbridge Electric Lighting Act, 1893, to lay mains along Burden-mews, King-street, Ball-street, and Young-street; the St. Pancras Borough Council, under the St. Pancras (Middlesex) Order, 1883, of intention to lay mains along Osnaburgh-terrace. A notice was received from the Bermondsey Borough Council, under the Bermondsey Order, 1899, of intention to lay mains, for the purpose of public arc lighting, along a portion of the Council's subway in Tower Bridge-road. The Borough Council is the undertaker under the order, and the Council have no power of approval or disapproval of works. The order contains, however, the usual clauses relative to the Council's subways. Another similar notice, from the Hammersmith Borough Council, under the Hammersmith Order, 1893, referred to intention to lay mains along portions of King-street and Standish-road. The supply of electric current to the Horniman Museum occasionally fails, placing the whole building in darkness. When this happens it is difficult for visitors to find their way out, as in both galleries the floor is covered with show-cases, and persons are liable to fall against the cases and injure themselves with the glass. Moreover, the confusion caused by the sudden darkness affords any evil-disposed person an opportunity of abstracting valuable articles from the collection. It is, therefore, proposed that when carrying out the alterations in the electric installation, already approved by the Council, the engineer should arrange for some of the lamps to be fixed on a special circuit, and for a small battery of accumulators to be provided, so that in case of emergency these lamps could be lighted for so long as it might be necessary to enable the building to be cleared. The cost of carrying out the arrangement is estimated at £260.

PROVISIONAL PATENTS, 1902.

APRIL 28.

9780. An improved fitting for electric incandescent lamps. Johann Kremenezky, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

9800. Improvements in switch or ringing keys for telephone switchboards. Lars Magnus Ericsson, 4, South-street, Finsbury, London. (Complete specification.)

9801. Improvements in telephone jack-strips. Lars Magnus Ericsson, 4, South-street, Finsbury, London. (Complete specification.)

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9788. Improvements in electric switches and in the application of the same to electrically-propelled vehicles. William Milton Brown, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

9789. Improvements relating to electric railway systems, and more particularly to crossings and switches for the same. Herbert Elijah Keeler, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

9803. Improvements in and relating to the electrolytic decomposition of alkaline salts. Meyer Wildermann, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

APRIL 29.

9815. Improvements in and connected with the provention of sparking on the interruption of ethereal telegraphic and other electric circuits. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Kristian Birkeland, Norway.)

9819. Improvements in insulators for supporting overhead electrical conductors for electric tramways and the like. John Berry Smith, 5, Blakiston-street East, Fleetwood, Lancs.

9825. Improvements in or relating to electric fuse boxes for street mains and analogous uses. Robert Frederick Hall, 24, Temple-row, Birmingham.

9836. Improvements in apparatus for working trolleys used in connection with overhead wires in electric traction. Walter B. Smith and G. Napier and Sons, Limited, Grant and Maddison's Bank-buildings, Canute-road, Southampton.

9849. Improved means or method of connecting incandescent electric lamps in festoons, and for other like temporary uses. William Barker, 254, Colne-road, Burnley. (Complete specification.)

9865. Improvements in electrical ignition devices for internal-combustion engines. Robert Samuel Lovelace, 70, Chancery-lane, London.

9873. Improvements in and relating to the connections or joints of cables for conveying electrical energy. Alfred George Brookes, 55, Chancery-lane, London. (Harry Grant Thompson, United States.)

9885. Improvements in electrical rock drills or rock-drilling machines. Arthur Henry Gibson, 40, Chancery-lane, London.

9895. Improvements in automatic signals for electric railways. Herbert John Haddan, 18, Buckingham-street, Strand, London. (The Storm Railway Signal Company, United States.) (Complete specification.)

9899. Improvements in apparatus for making aerated beverages and automatically and electrically controlling the gas pressure therein. Peter Engelbrecht Malmstrom, 19, Holborn-viaduct, London. (Complete specification.)

APRIL 30.

9947. Improvements in an electric low-water alarm. Charles Arthur Allison, 52, Chancery-lane, London. (Alfred Graham, United States.) (Complete specification.)

9949. Improved means and apparatus for effecting telephonic intercommunication. John Young, 21, Finsbury-pavement, London.

9956. Improvements relating to telephone receivers, audiphones, and the like. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Akouphone Manufacturing Company, United States.) (Complete specification.)

9977. Improvements in pole-pieces for dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Alexander Churchward, United States.) (Complete specification.)

9978. Improvements in pole-shoes for dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Alexander Churchward, United States.) (Complete specification.)

9982. Improvements relating to current-collecting devices for electric traction systems. Emilé Bede and Achille Auguste Condamin, 18, Buckingham-street, Strand, London.

MAY 1.

10000. Improvements in electrical resistances. Alfred Herbert Mayes, 40, Walsingham-road, Hove, Sussex.

10008. Improvements in intercommunication telephones. George Edmund Beckett, 73, Ogden-street, Ardwick, Manchester.

10022. Improvements in shuttles employed in connection with electric stop motions or automatic shuttle changing motions of looms for weaving. Robert Slack, 17, St. Ann's-square, Manchester.

10083. A new or improved method for producing electric insulating bodies. Herbert John Haddan, 18, Buckingham-street, Strand, London. (The "Pyrisolith" Isolating Material Manufacturing Company, Limited, Hungary.) (Complete specification.)

10091. An electric appliance for stopping clocks and giving an alarm. John Shirton and Herbert Yeates, 20, Lower Chestnut-street, Worcester.

MAY 2.

10097. Improvements in conduits for electric mains and in the jointing of same. Leonard Barlow and James Young, 8, London-street, London. (Complete specification.)

10098. Improvements in starting switches for electric motors. Thomas Edgar Weaver, 35, King Edward's-road, Moseley, Birmingham.

10137. A shade or reflector for electric lighting. James Bates Goodwin, 103, Uxbridge-road, London.

10141. Improvements in or relating to electrically-operated switch locking and operating devices, particularly applicable for railway and like purposes. Friedrich Prochaska, 111, Hatton-garden, London. (Complete specification.)

10144. Improved fuseholder for electric current. John Joseph Rawlings, William Robert Rawlings, and Rawlings Bros., Limited, 61, Carey-street, Lincoln's-inn, London.

10181. Improvements in syntonic space telegraphy. Oliver Joseph Lodge and Alexander Muirhead, 323, High Holborn, London.

10185. Means for removing moisture from electric conductor conduits. Isaac Shone and Edwin Ault, 77, Chancery-lane, London.

10189. Improvements in and relating to electric incandescent lamps and to means for connecting the same in the electric circuit. Arthur Llewelyn Lean, 5, Woodsley-terrace, Clarendon-road, Leeds.

MAY 3.

10193. Improvements in collectors for use in connection with overhead electric traction systems. Henry Peace, 24, Temple-row, Birmingham.

10204. Improvements in electrodes. James Hargreaves, John William Stubbs, and John Kearsley, May Villa, Farnworth-within-Widnes.

10206. Improvements relating to electrical fire-alarms and other electrical signalling systems, telegraphy, telephony, wireless telegraphy, and the like. Egerton Goulden Pulford, 10, St. George's-crescent, Liverpool.

10231. Improvements in and relating to high-speed electrical generators and motors. Sebastian Ziani de Ferranti, 18, Southampton-buildings, Chancery-lane, London.

10245. Improvements in receivers suitable for wireless telegraphy. Guglielmo Marconi and Marconi's Wireless Telegraph Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

10246. Improvements in receivers suitable for wireless telegraphy. Guglielmo Marconi and Marconi's Wireless Telegraph Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

10262. Improvements in and relating to arrangements for controlling automatic electric regulators, cell switches, and the like. William Edward Evans, 27, Chancery-lane, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published May 22.

1901.

6615. Arc lamps. Bremer.

9284. Electrical instruments for signalling on railways. Tyer, Hollins, and Leake.

10188. Electric indicators for use in sectional telephone circuits. Jacobs.

10655. Electrolytic cells or apparatus. Bell and Bell.

10793. Electric indicators. Polyblank.

11242. Electrical primers. Sir W. G. Armstrong, Whitworth, and Co., Limited, and Stuart.

12134. Electric arc lamps and electrodes therefor. Lee.

12342. Electromagnetic winding mechanism for clocks. Schäffer.

13159. Resistance switches and automatic cut-outs for starting, protecting, and regulating electric motors and their circuits. Edmondson.

14751. Process of electrometallurgic treatment of ores of copper and other metals with depolarised insoluble anodes. Tossizza.

15242. Automatic self-righting motion for swivelling trolley wheels on electric tramcars. Birkby and Birkby.

17039. Rifle range telephones. Crosse.

1902.

2820. Apparatus for the electrolysis of water. Garuti and Pompili.

4522. Electric ignition apparatus for internal-combustion engines. Apple.

4906. Controllers for electric vehicles. Simpson.

5851. Prepayment gas or other fluid or electricity supply controlling apparatus. Cooney.

6060. Apparatus for producing high electrical potentials and means for utilising the same for the ignition of explosive mixtures or compounds in explosion motors. Eisemann.

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6209. Electric arc lamps. Johnson.

6310. Electrolytic separation of metals. Thompson. (Ulke.)

7169. Electric battery. Allison. (Banks.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	May 7	683	652	+ 30	33,977	31,841
Birmingham Tramways	,, 3	4,834	4,471	+ 363	83,356	74,697
Blackburn Corporation	,, 3	724	648	+ 76	11,371	9,955
Blackpool Corporation	Apr. 19	278	269	+ 9	3,601	2,242
Blackpool-Fleetwood Tramways	May 3	357	360	- 3	4,246	3,950
Bolton Corporation	,, 4	1,536	1,398	+ 138	18,593	16,467
Bradford Corporation	,, 4	2,786	930	+ 1,856	38,796	14,308
Bristol Tramways Company	,, 2	4,157	4,494	- 357	—	—
Carlisle Tramways Company	Mar. 15	122	123	- 1	1,282	1,192
Central London Railway	May 3	6,987	6,428	+ 559	119,796	111,024
City and South London Railway	,, 4	2,920	1,862	+ 1,058	53,457	35,836
Cork E. T. and L. Company	,, 2	579	529	+ 50	6,712	6,520
Darwen Corporation	Mar. 22	169	154	+ 15	1,951	1,844
Darwen-Hoddlesden	,, 14	26	—	—	—	—
Dover Corporation	May 3	184	199	- 15	3,189	3,070
Dublin & Lucan Electric Railway	,, 4	107	105	+ 2	1,642	1,509
Dublin U. T., electric cars	,, 2	3,691	3,648	+ 43	—	—
Dublin S. District, Electric	,, 2	798	854	- 56	—	—
Dundee Tramways Company	Apr. 30	673	603	+ 70	—	—
Glasgow Corporation	May 3	11,686	11,756	- 70	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 3	1,608	1,584	+ 24	8,206	8,145
Liverpool Corporation	Apr. 26	9,258	9,224	+ 34	151,502	137,278
Liverpool Overhead Railway	May 4	1,399	1,632	- 233	25,258	27,551
Newcastle-on-Tyne Corporation	,, 3	2,451	—	—	—	—
Portsmouth Corporation	,, 3	1,318	591	+ 727	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 4	3,875	—	—	—	—
Southampton Corporation	Mar. 27	775	537	+ 238	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £974 decrease.

Barcelona Ensanche y Gracia, £85 decrease. Barcelona, £416 increase.

Brisbane, £332 increase (month of March, £10,934; increase, £1,789).

Buenos Ayres and Belgrano Electric (month of April, receipts £11,872; decrease £613), £223 decrease.

Calcutta, £20 decrease.

Cape Town (month of March), receipts, £17,888; expenditure, £7,343.

Isle of Thanet Electric, £85 increase.

Mexico Electric (month of April), receipts, £19,350; expenditure, £10,620.

Perth Electric, £162 increase.

Port Elizabeth (month of March), receipts, £3,818; expenditure, £1,947.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	¼-⅜
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¼-¼
—— Ordinary, 1-125,000	1 ..	⅜-½
British Insulated Wire, Ord., 1-70,000	5 ..	8-9 xd
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-5½
—— 5 per cent. Mortgage Debentures	100 ..	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5½-6
Brush Electrical Engineering, Ordinary	2 ..	¾-1¼
—— Nos. 90,001-105,731	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-2
—— 4½ per cent. Debenture Stock	100 ..	101-104
—— 4½ per cent. 2nd Debenture Stock	100 ..	95-100
Callender's Cable, Debentures	100 ..	111-115
—— Ordinary	5 ..	17-18
—— 5 per cent. Pref.	5 ..	5½-6
Crompton and Co.	3 ..	3-3¼
—— 5 per cent. Debentures	— ..	103-108 p.c
Edison and Swan United, Ordinary	3 ..	⅛-⅜
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	75-80
—— 5 per cent. Second Deb. Stk. Prov. Crts.	— ..	82-87
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-1⅜
—— 7 per cent. Cumulative Pref.	2 ..	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	98-101
W. T. Henley's Telegraph Works, Ordinary	5 ..	17-18
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	99-102
Parker, Thos., Limited, Ordinary	10 ..	15¼-16½
Telegraph Construction and Maintenance	12 ..	34-37
—— 5 per cent. Bonds	100 ..	103-106
Telegraph Manufacturing, Ordinary	5 ..	10¼-11½
—— 5 per cent. Cum. Pref.	5 ..	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	8¼-9½
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	106-107
Telephones.—		
National Telephone, Preferred	100 ..	95-99
—— Deferred Stock	100 ..	56-60
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— Preferred, 590,001-790,000	3½ ..	3⅛-3⅜
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4⅞-5⅛
—— 4 per cent. Deb. Stock, Red.	100 ..	94-97
—— 3½ per cent. Deb. Stock, Red.	100 ..	103-107
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅛-¼
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	100-104
Bournemouth and Poole, Ordinary	10 ..	11-12
—— 4½ per cent. Cum. Pref.	10 ..	9½-10½
—— Debenture Stock, Red.	100 ..	103-106
Brompton and Kensington, Ordinary	5 ..	9-9¼
—— 7 per cent. Preference	5 ..	9-9¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	8¼-9½
—— Nos. 20,001-30,000	5 ..	8-9
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, £10 Ord.	6 ..	10½ xd
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	106-108
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	8-9
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5¼-5⅝
—— 4½ per cent. Debentures	100 ..	110-113
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	103-106
County of London and Brush Provincial, Ordinary	10 ..	8-9
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6¼-6⅝
—— 6 per cent. Cum. Pref.	5 ..	6-6¼ xd
—— 4½ per cent. First Mort. Deb.	100 ..	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4-4¼
—— 5 per cent. Debenture Stock, Red.	100 ..	101-104 xd
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-6¼
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10-11
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10½
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	95-100
Metropolitan, Ordinary	10 ..	15¼-16½
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	14-15
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7¼-8
—— £2½ Shares, New	4½ ..	6¾-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	98-101
River Plate Electric Light and Traction, Deb.	100 ..	65-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1¾-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2¼-2⅜
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14¼-15½
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	98-101
Westminster, Ordinary	5 ..	11¼-12½
—— 5 per cent. Cum. Pref., 110,101-138,241	2½ ..	3¼-4
Electric Railways.—		
Central London, Ordinary	100 ..	103-106
—— 4 per cent. Pref.	100 ..	103-106
—— ,, ,, deferred	100 ..	100-103
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-118
City and South London, Consolidated Ordinary	100 ..	70-72
—— Ordinary	10 ..	—
—— 4 per cent. Debenture Stock	100 ..	113-117
—— 5 per cent. Pref. Stock '91	100 ..	128-133
—— ,, ,, ,, '96	100 ..	124-127
—— ,, ,, ,, '01	100 ..	120-124
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	3¾-4¼ xd
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-130
Blackpool and Fleetwood Tramroad	10 ..	13-14
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	3-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	104-107
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6¼-7
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-9⅝ xd
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £240 each	40 ..	101-103 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13¼-14¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12¼-12⅝
—— 5 per cent. Perpetual Debenture Stock	100 ..	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1¼-1⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4⅜-5¼ xd
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4⅝-5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2¼-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11¼-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	96-99
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys., 4 per cent. 1 Mt. Db. Stk., Prov. Crts.	100 ..	103-105
New General Traction, Ordinary	5 ..	2-3
—— 6 per cent. Cum. Pref.	10 ..	3¼-4¼
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10⅝
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	99-102
Potteries Electric Traction, Ordinary, 25,667-40,000	10 ..	9¼-10¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	10s. ..	⅛
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	50 p.c. ..	50 p.c.

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Supplement to "The Electrical Engineer,"

MAY 9, 1902.

LONG-DISTANCE TELEGRAPHY AND MARCONI'S LATEST EXPERIMENTS.

BY LIEUTENANT FERNAND PONCELET.

(*Concluded from page 588.*)

M. Guarini has experimented with another kind of antennæ. After his experiments described in the

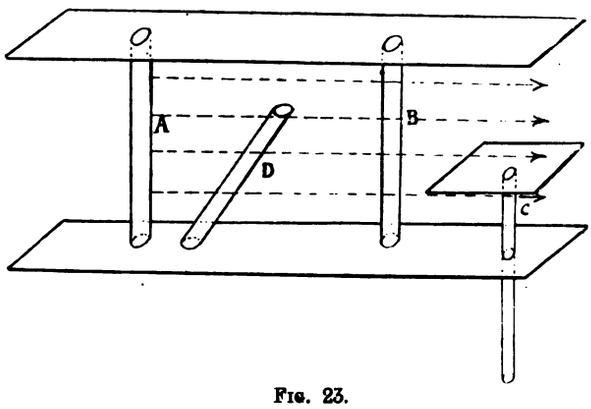

FIG. 23.

Electrical Engineer of July 12 and 19, 1901, he has arrived at this conclusion (British patent, No. 1,555, of

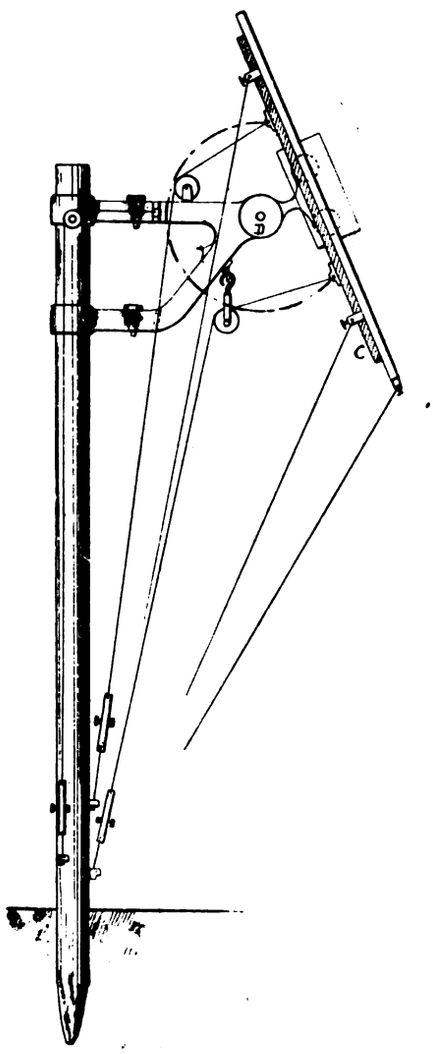

FIG. 24.

Jan. 24, 1900): The best effect is obtained by the use of two equal and cylindrical antennæ placed parallel and at the same height. Such is the case of the two antennæ, A and B, of Fig. 23. An inspection of this figure suffices to show why the antennæ C and D, equal in length to antennæ B, but placed at a different height or not parallel, receive less effect from the radiating antennæ A. A practical way to realise this conclusion can be seen in Figs. 24, 25, 26, 27, and 28 (Belgian patent No. 152,072, of Sept. 14, 1900, entered at the same time in the United

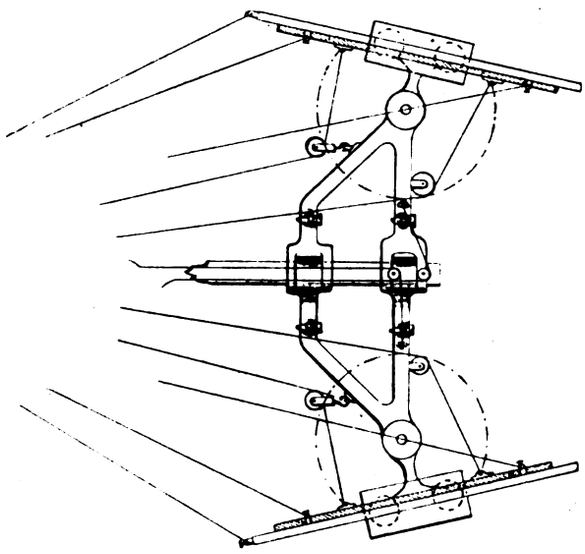

FIG. 25.

States, in Austria, Germany, etc.). Considering Fig. 24, we observe a post supporting at a convenient height two ends of radiating antennæ, A, and collecting antennæ, B, (Fig. 27) parallel to each other, and carried by an isolating plate, C. The oscillator, O, itself is placed on this plate. The antennæ are surrounded by a covering stuck to the insulating material (see the cut in Fig. 26), and in which a longitudinal slit has been made. The plate, C, carrying the two antennæ is susceptible of a rotation in two direc-

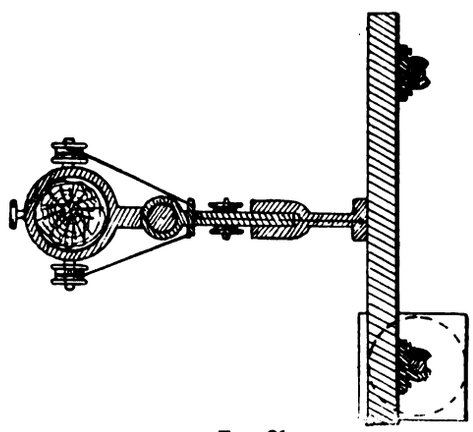

FIG. 26.

tions round the mast to allow a convenient orientation, and round the horizontal axis, D (Fig. 24) to give the required inclination on the vertical. The regulating of the distance between the balls and the oscillator (Fig. 28), and also of two rotations, is effected at the base itself of the mast; conductors join the antennæ to the generating or receiving apparatus placed in an adjoining shed. A transmission station, T, having to communicate with a receiving station, R, the plates, C (Fig. 27), are first placed so as they face each other from one station to the other; they are then inclined on the vertical by rotating them round the post D, so as to render their planes parallel; finally, they are lowered

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or pulled up along the mast, so that they shall be at the same height. The antennæ A (Fig. 27) of post T will influence the antennæ B of post R, and, to reply to the message, the antennæ A of this latter post will influence the antennæ B of post T. Fig. 25 relates to an intermediary post; the independence of the two plates will be

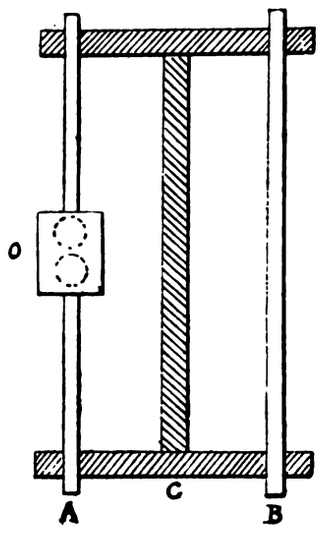

Fig. 27.

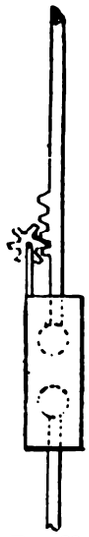

Fig. 28.

noticed. This is necessary to obtain a parallelism of the confronting antennæ all along the line. This arrangement might also be applied advantageously under water in the case of two submarine stations (Fig. 22).

Another way exists to save expense in the energy employed; therefore, to increase the carrying power of the transmission—that is, to seek the aid of flat surfaces

Fig. 29.

for the antennæ (M. Guarini's British patent No. 1,555, 1900). It is based on the following remark (M. Guarini's Belgian patent of June 24, 1899): the electromagnetic waves propagate in space in straight lines normal to the surface of the radiating wire; it is evident that the propagating rays will be parallel if this surface is flat. Fig. 29 shows a few sections of antennæ to meet this condition. In considering, for example, the case of antennæ of square

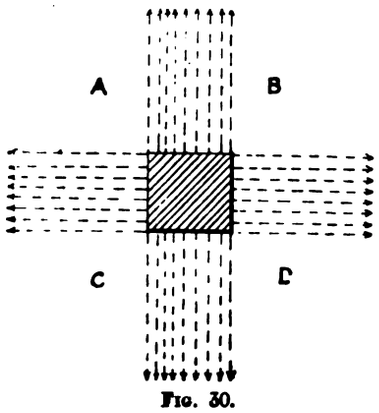

Fig. 30.

section (Figs. 30 and 31), we see that the energy only distributed in the guise of four series of radiations, when the antennæ is provided with the Guarini sheath (see the theory in *Electrical Engineer* of July 12, 1901). In Figs. 34 and 35 the insulating material is taken off so as to show better what happens respectively in the case of the Hertzian current or of high frequency (open-circuit antennæ), and in the case of alternating current or of low frequency (closed-circuit antennæ). It is evident that the radiating and collecting antennæ must then be correctly oriented, so that their uncovered face be well opposite to one another (Fig. 36). One can see on Fig. 7 how M. Guarini applies his system in the case of wireless trans-

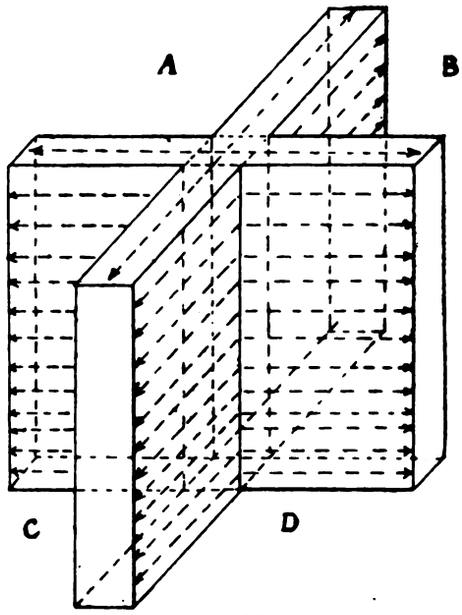

Fig. 31.

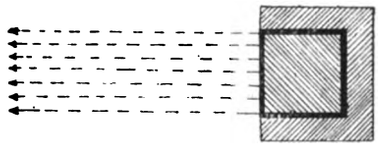

Fig. 32.

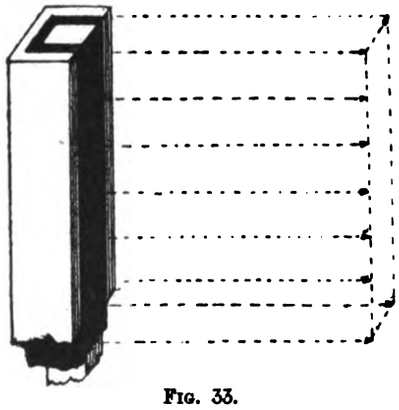

Fig. 33.

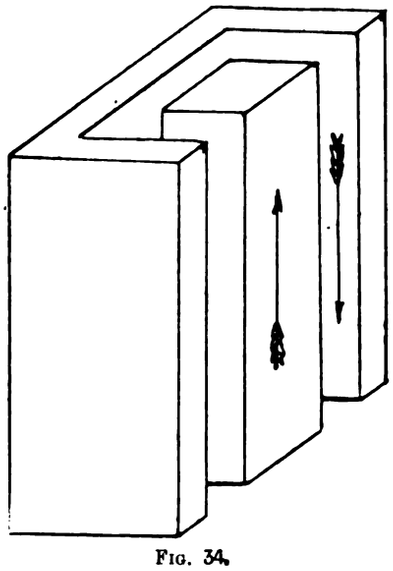

Fig. 34.

mission by alternating currents. This figure relates to the antennæ of circular section, and the insulating material is taken off so as to better show the connections.

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It is superfluous to add that the above-described Guarini apparatus are practically only applicable to fixed stations, as they require most minute regulating.

V.

Other systems still exist allowing to increase the importance of the transmission. We refer to the syntonisation systems of Messrs. Lodge and Muirhead, Blondel, Marconi, and Slaby. We know that the object of syntonisation is to obtain an electric signal in a predetermined receiving circuit for a given vibrating frequency and not for others. Messrs. Lodge and Muirhead are trying to

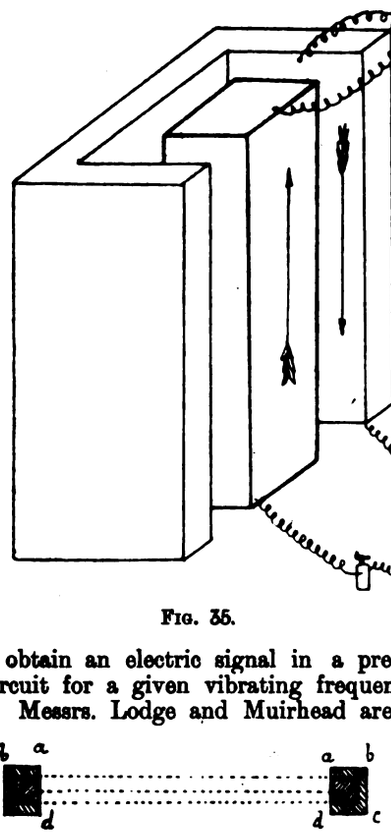

FIG. 35.

FIG. 36.

attain this by working on the self-inductance, L', and the capacity, C', of the receiving circuit so as to obtain the following equality in the oscillating periods:

$$T' = 2\pi\sqrt{L'C'} = T = 2\pi\sqrt{LC},$$

in which L and C belong to the transmitting circuit.

coherence of a coherer, as being "the electromotive power which continually applied prevent the tube from decohering sharply when agitated." They have found that, to be sensitive, a coherer must have a lower critical tension to the electromotive power generated by the waves. This is how M. Slaby utilises this property. At the spot, b (Fig. 38), where the collecting antennæ, $a\,b$, is put to earth, it unites two "extension wires," $b\,c = a\,b$ and $b\,d = \frac{a\,b}{2}$. If we produce two waves at the transmitter, the wave length of one of which equals $4\,a\,b = 4\,b\,c = 8^{bd}$, and the other is equal to $2\,a\,b = 2\,b\,c = 4\,b\,d$, we obtain respectively

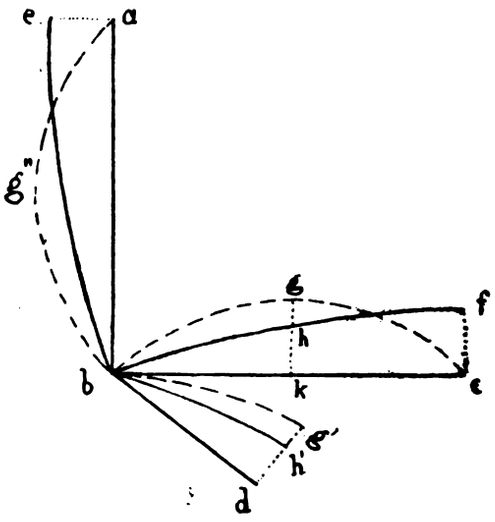

FIG. 38.

the tension curves, $e\,b$, $b\,f$, $b\,h'$, and $a\,g\,b$, $b\,g\,c$, $b\,h$. At the points c and d are placed two coherers, the critical tension of which, t, satisfies the relation: $g\,k\ (= d\,g') > t > h\,k\ (= h'\,d)$. We see that the coherer c will only be influenced by the wave the length of which equals $4\,a\,b$, and the coherer d by the wave the length of which equals $2\,a\,b$. The Slaby receiver, therefore, allows the receiving simultaneously two waves of different lengths—that is to say, two different messages ("Théorie Guarini," Paris *Electricien*, Jan. 18, 1902).

Marconi connects the antennæ to the earth through a transformer primary, of which the secondary meets a condenser and a coherer (Fig. 39). This condenser is for diminishing the tension at the pole of the secondary to which it is attached; the larger the condenser sooner will

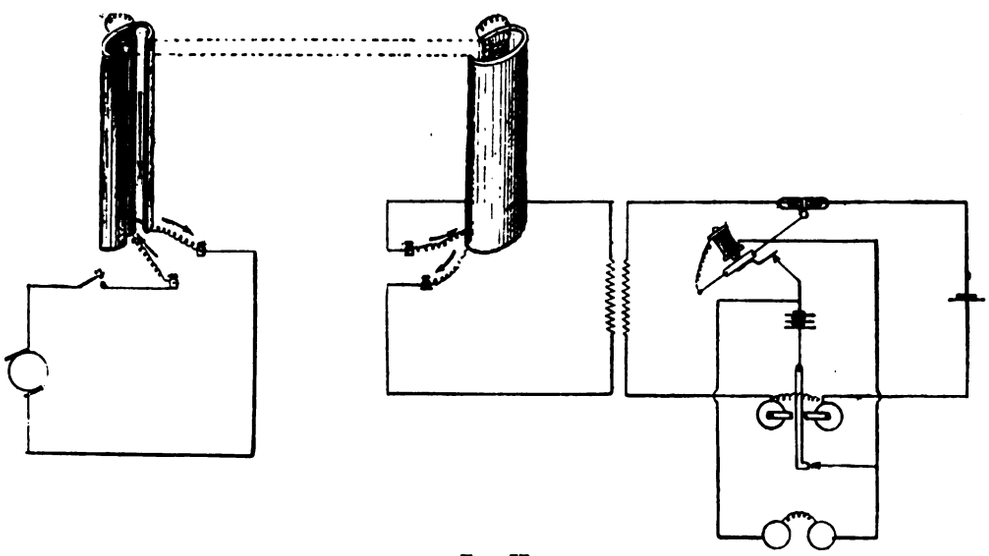

FIG. 37.

M. Blondel adjusts the frequency of the antennæ and that of a special selected receiver. We will here only mention the Marconi and Slaby systems, which result from the Lodge-Muirhead system, and they only have been subjected to numerous experiments. In a note presented to the Paris Academy of Sciences on April 23, 1900, MM. Blondel and Dollkeirtch have defined the critical tension of the tension be annulled, and at the limit—that is to say, when the condenser has the capacity of the earth—we obtain at this pole a node in the wave. The condenser, therefore, here plays the part of the earth connection, b (Fig. 38), of Slaby's system. According to M. Guarini (see the *Electricien*, Jan. 18, 1902), we also know that Marconi takes the length of his transformer secondary equal to the

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length of the antennæ. Therefore, we find ourselves in the conditions of Slaby's system, and the curves of tension of Fig. 38 can be applied to Fig. 39. The explanation to its working is the same. Fig. 40 represents a second coherer, which plays the part of coherer *d* of Fig. 38. M. Guarini replaces Marconi's condenser of Figs. 39 and 40 by the earth itself (Fig. 41). He is, therefore, in better conditions than Marconi, as the capacity of the earth is infinite compared to that of the condenser. In the Brussels-Malines-Antwerp experiments this system has been tried, and has given good results.

As to the secrecy of the messages that the syntonisation systems would afford, we do not believe in them. Referring to Fig. 38, we see that it is only required to sufficiently

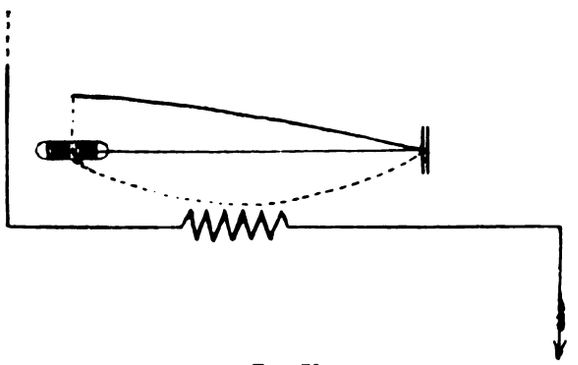

Fig. 39.

lengthen the extension wire, *b c* (the secondary in the transformers of the Marconi and Guarini systems), and to bring from *b* to *c* a coherer of low critical tension to obtain a receiver capable of receiving all the lengths of waves, therefore, to intercept all the messages. On the other hand, the Hertzian refractors are impracticable; similarly the reflectors. The lengths of waves actually in use would much exaggerate the dimension—in fact, we know that one must not place the reflectors at a distance to the antennæ equal to an uneven number a quarter of the wave-length. We only know of one solution of the secrecy to the messages problem—that is, the application of sheaths and flat surfaces advocated by M. Guarini, and which we mentioned in last chapter. We will, however, choose amongst the sections of antennæ, and will reject the circular section antennæ on account of its inconvenience. Fig. 42 shows that if the sheath, *b*, of the antennæ, *a*, subtracts the antennæ A B from all the wave power directed against the antennæ C; on the other hand, the antennæ, D, placed in the series of radiations are influenced. This defect is reduced to the point of being quite negligible if the faces, instead of widening as on Fig. 42, keep a constant size—

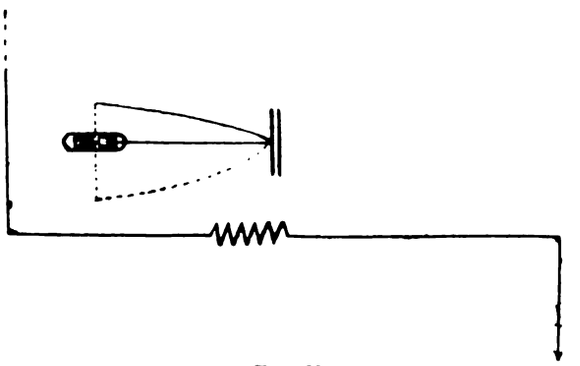

Fig. 40.

that is to say, if the antennæ *a* had a polygonal section. One may say that secrecy is absolute with the antennæ provided with sheaths of polygonal section, as not only the message cannot be intercepted, but it is impossible to blurr the communication, the faces, *a b*, *b c*, *c d*, of the sheaths (Fig. 36) allowing all the radiations which reach it to run to earth. Secrecy of messages can only therefore be obtained by the Guarini antennæ, and syntonisation cannot give it; at the utmost, it can be used for communication between shifting stations in view of increasing the length of transmission.

VI.

For the future of long-distance wireless telegraphy there is another important item to be considered. It is the speed of communication, which greatly influences the cost of messages. We have just seen that syntonisation allows multiplex transmission one way only; it is possible to receive simultaneously as many messages in one receiver than it comprises coherers joined to extension wires (Slaby system) or at secondary transformers (Marconi and Guarini systems) of different lengths. We will not

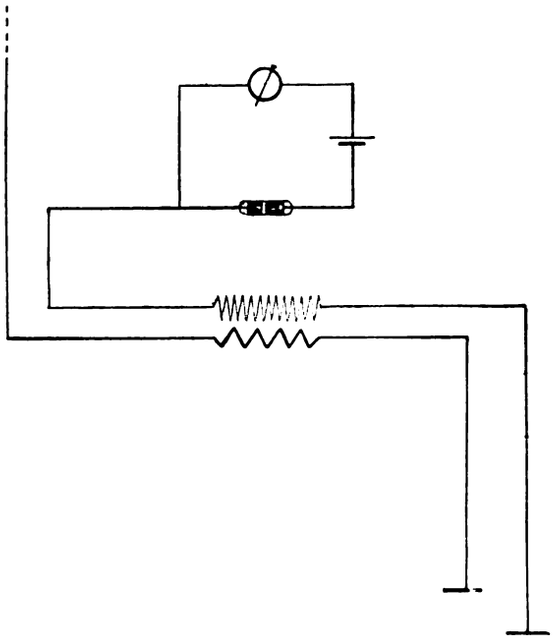

Fig. 41

enter into the details of improvements that one can bring to these systems in view of rendering multi-communication more complete, and we will only remark that the antennæ with polygonal section sheaths permit a multiplex communication both ways. To ascertain this, it is sufficient for one to refer to Figs. 24 and 27, and to imagine that the antennæ of these apparatus are of polygonal sheath and section.

Conclusions.

As the effects of atmospheric electricity can be annihilated to a great extent, chiefly by earthing direct the receiving

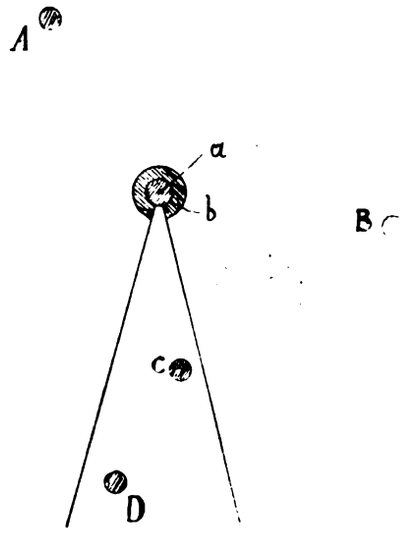

Fig. 42.

antennæ; that the apparatus now in use can be greatly simplified; the power necessary diminished, thanks to Guarini's automatic repeater, to his sheath antennæ, to syntonisation; that multiplex communication is possible one way with syntonised apparatus, and both ways with the Guarini antennæ, it is permissible to think of the future of wireless telegraphy over the ocean. When the improvements which we have mentioned will be facts, the

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new telegraphy will happily supplement submarine cables. Then it will take its place, as it is by far more economical, and we shall see the cable companies transform themselves into wireless transoceanic telegraph companies, and pay larger dividends to their shareholders. The wireless telegraphy operators will then recall and repeat with more conviction the victorious roar of Marconi: "That day (Dec. 12, 1901) I received from England the message which marks the death warrant of the submarine cables."

THE DISTRIBUTION OF MAGNETIC FLUX IN LARGE ELECTROMAGNETS.*

BY W. M. THORNTON, M.SC. (MEMBER).

(Concluded from page 592.)

§ 6. Permeability of Iron in Bulk.

Attempts have been made from time to time to measure the permeability of iron when in bulk. Even when the highest skill has been given to design, there are often unexplained discrepancies between calculation and performance in large machines. These are attributed when every other explanation fails, to the iron not being to sample. The method of manufacture of the frames must affect the magnetic properties, as, for example, the cooling of large castings too quickly, and the consequent hardening of the metal, reducing the permeability. The following method, which follows from the former part of the paper, may be used on any large magnetic circuit, whether that of a generator or motor, and with faster recording apparatus for transformers. Any large masses of metal of convenient shape on which coils may be placed can be so tested. In the case of machines, it is only necessary to know the exact dimensions of the various parts, though when in course of construction the influence of the air-gap may be avoided by using an armature of soft iron of known permeability fitted across the flat ends of the magnet cores, clamped to the yoke, and with a current passed round experimental coils in the ordinary way. The exploring coil may be placed round the yoke or core, and induced voltage curves taken as described. In practice it is possible to take a complete cycle of a large machine, including the development of the photographs, in less than an hour.

Plate IX.

Plate IX. gives the first set of curves with varied current taken with the Holmes machine, and from these the following values of B are found and of μ for the whole machine.

Table VIX.

Amperes.	Amp.-turns per cm.	Amp.-turns per inch.	H., C.G.S.	Area of diagram, sq. cm.	Flux.	B per sq. cm.	B per sq. inch.	μ per sq. cm.	μ per sq. inch.
·6	5·15	12·95	6·42	2·58	$8·96 \times 10^5$	692·5	4,460	107·8	272
3·35	28·79	70	35·95	22·12	$7·68 \times 10^6$	5,925	38,250	165	418
5·83	50·1	126·3	62·75	35·93	12·47 ,,	9,615	62,100	153·3	389
8·3	71·25	179·8	89·25	50·4	17·5 ,,	13,500	87,100	151·3	384
10·8	92·75	233·7	116·2	56·3	19·6 ,,	15,100	96,800	84	214·5

The total reluctance, R, is the sum of the terms $\frac{l}{A\mu}$ for each part where there is a variation of material or dimensions.

$$R = \frac{l_g}{A_g} + \frac{l_a}{\mu_a A_a} + \frac{l_y}{A_y \mu_y} + \frac{l_c}{A_c \mu_c} + \frac{l_p}{A_p \mu_p},$$

g, a, y, c, p referring to gap, armature, yoke, cores, and poles respectively. For any part of the circuit the flux is the ratio of the magnetomotive force required for that part of its reluctance. Thus the ampere-turns for the gap $= ·8\ N_g \frac{l_g}{A_g}$, and there are similar terms for the other parts.

The total ampere-hours $I T = ·8 \Sigma \left(\frac{N_g l_g}{A \mu}\right)$ or $= ·8\ \Sigma\ (N R)$.

The reluctance of the gap is known from its dimensions. The permeability of the armature for soft iron is given by the makers, and since the yokes, poles, and core are generally of the same material,

$$I T = ·8\left(N_g \frac{l_g}{A_g} + N_a \frac{l_a}{A_a \mu_a}\right) = \frac{·8}{\mu_c}\left(N_y \frac{l_y}{A_y} + N_p \frac{l_p}{A_p} + N_c \frac{l_c}{A_c}\right).$$

Let the ratio $l/A = k$, a constant for each part, then

$$I T = ·8\left(N_g k_g + \frac{N_a k_a}{\mu_a}\right) = \frac{·8}{\mu_c}\left(N_y k_y + N_p k_p + N_c k_c\right).$$

The left-hand side of the equation is known for any value of the magnetising current, and by means of a set of curves, as, for example, Plate IX., the fluxes, N, for all the parts are known. Thus

$$\mu_c = \frac{·8\,(N_y k_y + N_p k_p + N_c k_c)}{I T - ·8\left(N_g k_g + \frac{N_a k_a}{\mu_a}\right)}.$$

For different saturations the proportions between the various N's are not constant, and although one set of curves is sufficient to give the required value of μ under ordinary working conditions, yet the whole range of μ may be found by taking several sets of curves, one for each change in the magnetising current. Having determined the absolute flux through the armature, which may be done either by standardising the galvanometer or running the machine at a given speed on open circuit, and measuring the voltage, the value of μ can be expressed in terms of the relative areas of the curves—*e.g.*, in Plate III.

Write λ the ratio of the area of any curve to that of the armature curve. Then

$$\mu_c = \frac{·8\ N_a\,(k_y \lambda_g + k_p \lambda_p + k_c \lambda_c)}{I T - ·8\ N_a\left(k_g \lambda_g + \frac{k_a}{\mu_a}\right)}.$$

The second term in the lower bracket may generally be neglected by reason of the high value of μ_a.

For the Castle dynamo I = 10·75, T = 2,393, and from the dimensions

$k_g = ·069$; also $\lambda_y = 1·15$.
$k_p = ·06$ $\lambda_p = 1·2$.
$k_c = ·058$ $\lambda_c = 1·4$.
$k_g = ·00177$ $\lambda_g = ·91$.
$k_a = ·025$.

$$\text{Hence } \mu_c = \frac{·8 \times 14 \times 10^6\ (·069 \times 1·15 + ·06 \times 1·2 + ·058 \times 1·4)}{25{,}700 - ·8 \times 14 \times 10^6\left(·00177 \times ·91 + \frac{·025}{500}\right)}.$$

That is, $\mu_c = 371$.

The flux density is 15,100, and the above value may be compared with 219 (Witten), 423 (Fisher, Schaffhausen), and 580 (Plichon, Paris), found by Fisher-Hinnen for cast steel at the same flux density. The above is for Armstrong-Whitworth steel.

In the case of the Parker machine of § 5, the total ampere-turns were 53,500 distributed equally between the two bobbins, and there were no compounding turns. Also

$k_y = ·0812$; and $\lambda_y = 1·255$.
$k_c = ·1034$ $\lambda_c = 1·32$.
$k_p = ·1430$ $\lambda_p = 1·2$.
$k_g = ·00271$ $\lambda_g = ·915$.
$k_a = ·025$

The armature flux is $30·7 \times 10^6$ lines ; thu

$$\mu_c = \frac{·8 \times 30·7 \times 10^6\ (·081 \times 1·255 + ·1034 \times 1·32 + ·143 \times 1·2)}{53{,}500 - ·8 \times 30·7 \times 10^6\ (·00271 \times ·915 + ·025/500)}.$$

Hence $\mu_c = 358$.

Wiener's value for annealed wrought iron at the same flux density is 333.

The Silvertown machine has 49,500 ampere-turns, and

$k_y = ·1255$; also $\lambda_y = 1·145$.
$k_c = ·1125$ $\lambda_c = 1·29$.
$k_p = ·108$ $\lambda_p = 1·15$.
$k_g = ·00187$ $\lambda_y = ·84$.
$k_a = ·06$

The armature flux is $32·1 \times 10^6$ lines, corresponding to a flux density in the gap of 6,200 per square centimetre. Thus

$$\mu_c = \frac{·8 \times 32·1 \times 10^6\ (·1255 \times 1·145 + ·1125 \times 1·29 + ·108 \times 1·15)}{49{,}500 - ·8 \times 32·1 \times 10^6\ (·00062 + ·0001)}$$

That is, $\mu_c = 347$. With B = 15,100.

Wiener's corresponding value is 343.

The same formula applies to multipolar circuits. Measurements of the Brown-Boveri generator give the following data :

$N_y = 7·5 \times 10^6$; and $k_y = ·525$.
$N_p = 14·4$,, $k_p = ·0044$.
$N_c = 17·1$,, $k_c = ·074$.
$N_g = 14·4$,, $k_g = ·0035$, with $l_g = 1''$.
$N_a = 7·2$,, $k_a = ·37$.

The value of k_g was obtained on the assumption that the effective air-gap was 1", taking into account the reluctance of the teeth, which were not included in k_a. The ampere-turns per pole were found from the winding space to be 20,800, and in the absence of the maker's figures this is only an approximation. With these values :

$$\mu_c = \frac{·313\ (7·5 \times ·525 + 14·4 \times ·0044 + 17·1 \times ·074)\ 10^6}{20{,}800 - ·8 \times 10^6\ (·0198 + ·00228)}.$$

Thus $\mu_c = 670$, the average for core, yoke, and pole ; the flux density in the cores being 13,000 and in the yoke 11,000 lines per square centimetre. Wiener's value for cast steel at 12,400 is 740 ; Fisher-Hinnen for Fisher of Schaffhausen steel gives 750.

* Abstract of paper read before the Newcastle Local Section of the Institution of Electrical Engineers, March 24.

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§ 7. Application of Heaviside's Theory of the Decay of Induction in Cores.

Lamb and Heaviside have discussed the changes which take place in a solid conducting core when the coil circuit is interrupted or short-circuited. Using Heaviside's notation (Heaviside's "Electrical Papers," vol. i.), let H be the intensity of magnetising force at any instant at a distance r from the axis of the circular core.

Then
$$H = \frac{2 H_0 J_0 (n r) e^{D t}}{n c J_1 (n c) (1 + S^2 n^2)} \quad . \quad . \quad . \quad . \quad . \quad . \quad (i.)$$

where H_0 is the constant magnetising force due to the steady current in the coil when normally excited, c the radius of the core, and $S = \frac{L \rho}{2 \pi \mu c R}$, in which L is the inductance and R the resistance of the coil, ρ the specific resistance, and μ the average permeability of the core. Also $D = -\frac{n^2 \rho}{4 \pi \mu}$, n being the first root of the equation $J_0 (n c) = S n J_1 (n c)$, where J is a Bessel function of the order indicated.

Heaviside has given the roots when S and $c = 1$—that is, for a very small core. For one 20·32cm. radius, the results are best obtained by taking $c = 2{\cdot}032$ decimetres, changing the corresponding values of H_0, S, and μ, and solving by trial. Written fully, the equation is

$$1 - \frac{c n^2}{2}\left(\frac{c}{2} + S\right) + \frac{c^3 n^4}{16}\left(\frac{c}{4} + S\right) - \frac{c^5 n^6}{384}\left(\frac{c}{6} + S\right) \quad . \quad . \quad . \quad = 0.$$

The form of solution by successive equations does not lead to any definite result, but by trial and error, using the values of $J (n c)$ and $J_1 (n c)$, in Gray and Matthews's "Bessel Functions," it is found that with $(n c) = {\cdot}4$ the right-hand side is ·99, while $J_0 ({\cdot}4) = {\cdot}9603$, and with $(n c) = {\cdot}39$ the respective values are ·94 and ·9623. By interpolation, $(n c)$ corresponding to a root is ·3942.

Thus
$$n = \frac{{\cdot}3942}{2{\cdot}03} = {\cdot}1958.$$

Hence
$$D = -\frac{{\cdot}0384 \times 10^4}{12{\cdot}56 \times 158{\cdot}5} = {\cdot}1928.$$

Since $\bar{\mu}$ was found to be 158·5. This may be compared with the value actually found from the make curves—*i.e.*, ·185. The calculated value of D is on the assumption that the magnetic circuit is a closed ring of iron of circular cross-section, uniform along its length. The actual machine has sections of different shapes, circular in the windings' core, which is the most important part, rectangular in the poles and armature, and D-shaped in the yoke. Under these conditions the agreement may be considered close.

The whole flux N can be found from (i) thus. At any point

$$B = \mu H,$$
$$= \frac{2 \mu H_0 J_0 (n r) e^{D t}}{n c J_1 (n c) (1 + S^2 n^2)},$$

and
$$N = A B \bar{H},$$

where $\bar{H}$ is the average value of H over the core at time t. Then

$$N = \frac{2 A \mu H_0 e^{D t}}{n c^2 (1 + S^2 n^2)} \frac{1}{J_1} (n a) \int_0^c J_0 (n r)\, dr.$$

and
$$\int_0^c J_0 (n r) = c\left(1 - \frac{n^2 c^2}{2^2 3} + \frac{n^4 c^4}{2^2 4^2 5} - \frac{n^6 c^6}{2^2 4^2 6^2 7} + \quad . \quad . \quad .\right)$$

Thus
$$\int_0^{2 \cdot 032} J_0 (n r) = 2{\cdot}005 \text{ to five terms.}$$

And
$$N = \frac{2 \pi}{{\cdot}1958} \cdot \frac{1{,}585 \,.\, 4 \pi i t \times 2{\cdot}005}{[1 + \,.\, (25{\cdot}8 \times {\cdot}1958)^2] \cdot 1915 \times 28{\cdot}4} \cdot e^{-{\cdot}1928 t}$$

For in decimetre units
$$\mu = 1{,}585$$
$$l = 28{\cdot}4 \text{ decimetres.}$$
$$S = 25{\cdot}8.$$

Thus
$$N = 22{\cdot}9 \times 10^6 e^{-{\cdot}1928 t}.$$

The maximum value for the machine as found by test is

$$N = 20{\cdot}25 \times 10^6 e^{-{\cdot}185 t}.$$

It would be difficult to obtain an experimental verification of the theory except by tests on a massive non-magnetic anchor ring of high conductivity. The above value shows that even under very unfavourable conditions a fair agreement is found.

In making tests on machines with elliptical or rectangular cores, the eddy currents at make or short-circuit must follow the shape of the periphery as a limit. The distribution of magnetisation with space and time in such cases will no doubt be complex, for, especially in rectangular cores, the current density for the same current element changes in the inverse ratio of the radius vector of the circumference at any particular cross-section. The only guide to the distribution is the continuity which there mus be between the various parts of lines of flow in the core. The best conception of the true state is obtained by Prof. Hele Shaw's method of liquid stream lines, and even then these are in the true core distorted by the local variations of permeability with the strength of the magnetic waves. (Prof. Hele Shaw has kindly applied his method to the examination of the eddy-current paths in rectangular cores, the effect of variable permeability being imitated by spacing the entering holes of the flow first equally, then in proportion to the spacing observed at leaving the plate, this being repeated several times, until the change produced by successive alternation is too small to affect the position of the lines of flow. A change in thickness is, in general, the analogue to a change in permeability. The variation of permeability here with time renders some further approximation to the disturbed state necessary, such as the unequal spacing.) An elliptical core will, during the persistence of the eddy currents, have less permeability along the minor axis than the major. The average value might be the arithmetical mean of the two if the waves remained parallel to the boundary. With an alternating impressed force the reflections of the waves from the centre will set up a very intricate distribution in the core, but in the single wave at make or short-circuit the type will be simple until the disturbance is close to the centre.

The average radius vector for an ellipse may be proved to be

$$\bar{r} = \frac{b}{2} + \frac{a}{2e} \sin^{-1} e,$$

where a and b are the semi-axes and e the eccentricity. Thus for a core 80cm. by 50cm. the average is

$$= 12{\cdot}5 + \frac{20}{{\cdot}737} \sin^{-1} {\cdot}737,$$
$$\therefore \bar{r} = 34{\cdot}9\text{cm.}$$

The circle of equal area has a radius of 31·6cm., and whether the rate of decay will follow from this or the mean radius, or some intermediate value, can only be decided by experiment. The circle of equal area will have a greater apparent time-constant than an ellipse, and in the limit when the ellipse is extremely long and narrow the waves from the side will meet in a very short period, and the motion decay according to a logarithmic law. In a rectangular core the same effect takes place, the circle of equal area having the greatest possible time constant that the magnetism could possess, and a long flat rectangle—*i.e.*, a transformer plate, having no eddy-current circulation which can be directly observed. The equivalent circle has a radius $= 1{\cdot}128 \sqrt{ab}$. Lamb's and Heaviside's theory might be extended to these cases by considering the motion as one of flow of a viscous fluid in a prism round the axis, the viscosity varying with time according to some approximation to the curve of permeability.

From the tests on the Silvertown and Parker machines the time-constant may be approximately found and the equivalent circular core calculated.

Since $\frac{1}{D} = \frac{4 \pi \mu}{\rho n^2}$, and $n^2 = \frac{5{\cdot}783}{a^2}$ for the first root, then

$$a^2 = \frac{\rho \times 5{\cdot}783}{4 \pi \mu D};$$

$$a^2 = {\cdot}46 \frac{\rho}{\mu D} \text{ square centimetres.}$$

An assumption has to be made for ρ; μ can be found from the values of the time constant obtained from Plates XIV. and XV.

The average permeability was found by calculating the reluctance from the flux and ampere-turns for $R = \frac{\text{M.M.F.}}{N}$, and taking the average of the constants $k = \frac{l}{A}$. Then $\frac{\bar{k}}{R} = \bar{\mu}$.

Taking an average of 58, and $\rho = 10^4$, with D = 192 as found from the curve of make, $a^2 = 412$. Therefore $a = 21{\cdot}5$cm., or = 8·47in.

The core is 26½in. × 16in. = 424 square inches area, and the radius of the circle of equivalent area is 11·62in. Thus, according to the above figures, based on the assumption that there is a harmonic distribution of magnetism on the core, of which only the first root is important, the circle of equivalent decay is less than the smallest side of the rectangle.

In the case of the Parker machine with the same value of ρ, reluctance ·00132, $\bar{k} = {\cdot}08$. $\bar{\mu} = 60{\cdot}5$.

$$a^2 = \frac{10^4 \times 5{\cdot}783 \times 7{\cdot}3}{12{\cdot}56 \times 60{\cdot}5} = 555.$$

Hence $a = 23{\cdot}28$cm. = 9·29in. radius of equivalent circle.

The least radius of the rectangle is 7½in., the greatest 14in., and the circle of equal area is 11·4in. radius.

§ 8. Further Study of Leakage.

From Plates I. and II. it is seen that the leakage from the lower half of the left-hand bobbin, the surface of the pole not including the gap, and the bottom of the left-hand pole are respectively ·14, ·126, and ·101 of the armature flux. That is a total of 1·367 accounted for, as against 1·4 observed directly. A portion of the leakage was, however, inadvertently omitted, from the edges of the poles above and below the armature, and though some of this passes into the armature, yet the remaining ·033 might well be accounted for at these points.

Table X.	Reluctances.
Magnet core	·000156
Yoke	·00015
Poles	·00015
Air-gaps	·00177
Armature	·000059
Total in series	·002285

The closeness of the above agreement suggested that the reluctance of the leakage paths might be directly observed, and, if desired, the formulæ in text-books of design checked. The distribution is, however, so complex on account of the current surfaces of the Castle dynamo that it does not permit of exact comparisons. The Parker and Silvertown machines would be more suitable, having large rectangular surfaces. Between the middle and bottom of the left-hand bobbin of the Holmes machine $1{\cdot}96 \times 10^6$ lines are lost, representing an average surface density of leakage of 4,384 lines per square inch, or nearly one-tenth of that in

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the gap. The reluctance of the whole circuit, as given by the relation $R = M.M.F./N\phi$, includes all the leakage paths. Since the M.M.F. is 32,350 and the maximum flux 19×10^6, this reluctance is ·0017. That for 14×10^6 lines alone is ·0023, and for the leakage alone ·00578. Taking 370 for the permeability of the core and 500 for the armature at the working flux density we obtain Table X.

The reluctances of the various leakage paths would be known if the magnetomotive forces for each could be determined, the flux being already measured. The total magnetic potential on the circuit is 32,350 C.G.S. units, and the leakage between any two surfaces is proportional to the potential difference between them. The diagram (Fig. 15) shows the general analogy between the leakage distribution and a similar current network. From the reluctances the slope of potential throughout the circuit can be found when the flux for the various sections is known.

Thus, in the left-hand bobbin the M.M.F. = 22,150
in the right-hand it is ..... = 10,200

The total being 32,350

This is distributed as in Table XI.

TABLE XI.

	R × N.		M.M.F.
Left-hand bobbin core	·000078 × 18·5 × 10^6	.....	1,440
,, pole	·000075 × 16·5 ,,	.....	2,350
,, gap	·000885 × 12·7 ,,	.....	11,300
,, armature	·000059 × 14 ,,	.....	826
Right-hand gap	·0000885 × 12·7 ,,	.....	11,300
,, pole	·000075 × 16 ,,	.....	1,200
,, bobbin core ...	·000078 × 18 ,,	.....	1,405
,, yoke	·00015 × 17 ,,	.....	2,540
Total			32,356

These values have been drawn in Plate XXIV., the abscissæ being the respective lengths along the centre line of the machine. Thus the

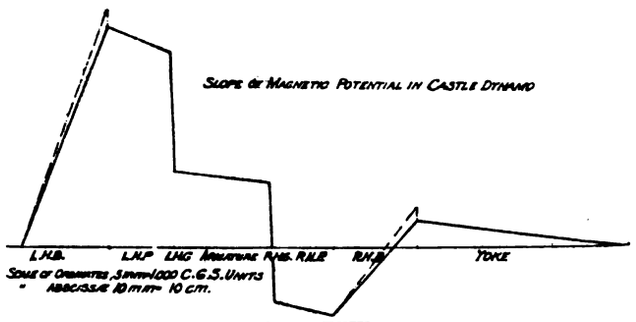


PLATE XXIV.

potential difference between the yoke and the left-hand pole surface is found by, in this case, subtracting the mean height of the yoke line of slope from that of the pole. Its value is thus found to be 17,000 units. The flux from the half yoke upper surface is 435,000 lines. The reluctance of this path is then $\frac{17,000}{435,000} = ·039$. Table XII. gives the values found in this way for the paths measured.

TABLE XII.

Path from	Flux.	M.M.F.	Reluctance.
Yoke to left-hand pole and lower half of bobbins	435,000	17,000	·039
Lower half of left-hand bobbins to yoke and right-hand bobbins	1,960,000	18,800	·0096
Outer surface of left-hand pole to yoke, bed-plate, and opposite pole	1,540,000	26,000	·01685
Bottom of left-hand pole to bed-plate, etc.	1,330,000	25,000	·0188
Bottom of right-hand pole to bed-plate, etc.	1,170,000	25,000	·0214

The same flux is here included in several of the paths, and it is horizontal a little above the centre line of the armature, all above going to yoke and bobbins, below to the bed-plate and opposite pole.

The relative leakage was determined by observing the current required in a coil of 500 turns and mean radius 85cm. to reverse the flux. The action of the coil in the strong leakage field causes a considerable disturbance of the lines, and the results could not be relied on as absolute measurements. For comparative work, however, it appears more reliable than the attracted soft-iron sphere method of exploring the leakage at the surface, and it can be used to find the intensity at any point of the field some distance from the machine. Using Fisher-Hinnen's and Wiener's formulæ for the permeance of simple leakage paths, the values in Table XIII. have been calculated.

TABLE XIII.

Leakage path.	Reluctance.
1. Upper to lower half of bobbins	·0146
2. Between circular cores	·0093
3. From yoke to left-hand pole surface	·12
4. Bottom of poles to bed-plate	·0114
5. Side of poles to bed-plate	·0125
6. Yoke to lower half of left-hand bobbin	·08

From these it is seen by comparison with Table XII. that there is considerable difference between calculated and observed values. All these are for no load, and that the distribution is materially modified by the action of the compounding coils was proved in Section 2. Several of the paths in Table XIII. are taken together in Table XII. Combining them, Table XIV. is obtained.

TABLE XIV.

Table XI.	Calculated.	Observed.
Paths 3 and 6	·048	·039
,, 1 and 2	·0057	·0096
,, 3 and 5	·0113	·0168
4	·0114	L.H. ·0188
—	—	R.H. ·0214

It is desirable that further measurements should be made on machines of simpler contour.

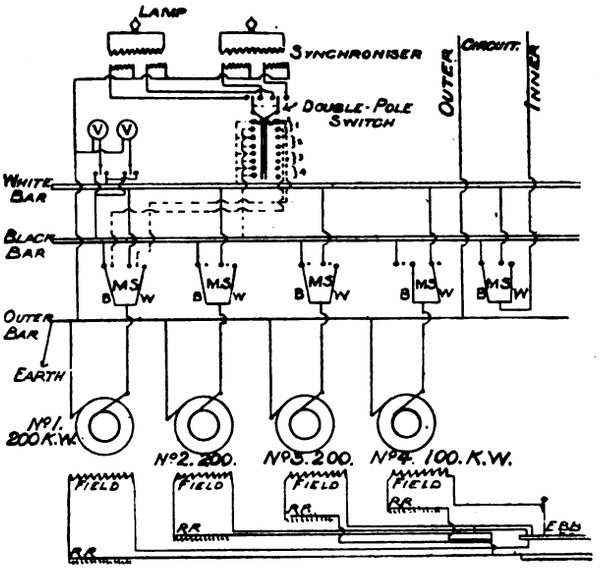
By means of the two methods—using coils surrounding the cores or placed about an area on the surface, and comparing one result with the other—a very complete knowledge of the true distribution of magnetism in and about large electromagnets can be obtained. To carry them out in practice it is only necessary to have a recording ammeter of sufficient dead-beatness and power, or freedom from friction and inertia.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Question No. 472.—Three 200-kw. Siemens alternators, each coupled direct to Willans engines, are running in parallel. Nos. 1 and 2 are fully loaded. A No. 4 set, of 100 kw. capacity, is the only spare machine. The exciters are running in parallel, and supply current to the field windings of alternator from 'bus bars. Please give a practical description of what to do should one of the armature coils start to burn out—say No. 1 alternator. A Ferranti switchboard is used.

Best Answer to No. 472 (*awarded* 10*s.*).—The accompanying sketch is a diagram of connections of a Ferranti switchboard and one form of synchroniser. It will be seen that the outer of each alternator is connected to a common "outer bar," which is "earthed," while the inner of each alternator is connected to a main switch, M S, which being double, enables each machine to be put on either the



"white" or "black" bars. The fields of the machines are connected in parallel through regulating resistances, R R, to the exciter 'bus bars, E B B. The circuits, as shown, can also be put on either the "white" or "black" bars with a common outer. Referring to the question given, Nos. 1, 2, and 3 are supposed to be running fully loaded on the "black" bar with their "black" main switches, B, closed, as shown. The circuit "black" switches are also closed. As soon as it is known that an armature coil of No. 1 is burning out, the first thing to do is to get the spare set, No. 4, started, and run up as fast as possible to the working voltage, say 2,000 volts, on the "white" bar, as shown in sketch. Next, get on to the circuits, pulling off the "black" circuit switches, B, and immediately putting on the "white" switches, W, until No. 4 gets pretty well loaded up to its capacity. This changing of part of the circuits from one bar to another only produces a momentary flicker in the lights, and there is not the chance of a "bad phase," as no synchronising is required so far. No. 1 must be got off as soon as possible, the other machines being overloaded for

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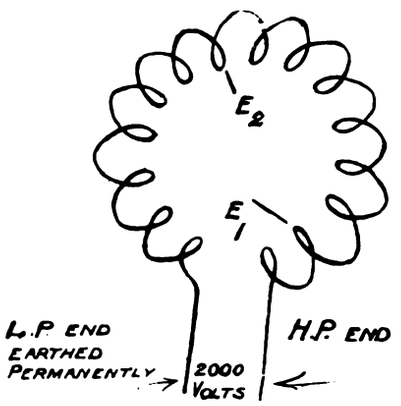
the time being. Suppose we have now got No. 1 off and Nos. 2 and 3 overloaded on "black" bar, and No. 4 in the same condition on the "white" bar, it only remains to synchronise the "white" bar with the "black," and when this is successfully accomplished by closing B switch of No. 4 at the right moment, then the B circuit switches may be closed and the W ones pulled off; and we now have Nos. 2, 3, 4 all running overloaded on the "black" bar, while the "white" bar is spare until required again. If this order of events is carried out there is no use of anyone getting excited, as the synchronising can be done at leisure. I have only shown No. 1 machine connected to the synchroniser, but the other machines are connected in precisely the same way. No instruments are shown except synchronising voltmeters, V.—R. S

Answer to No. 472 (*awarded* 5*s.*).—If when running three alternators in parallel the armature of one set starts burning up, the following procedure would have to be gone through: (1) Switch out faulty alternator by pulling out main alternator switch (if there is sufficient time full steam would be put on other sets, and load reduced on faulty set before switching out). (2) Switch out field switch of faulty machine, which cuts off exciting current and prevents unnecessary damage to armature. (3) If exciter of faulty set is paralleled on 'bus bars with other exciters, load will have to be got off this exciter by putting resistance in exciter field and exciter main switch pulled out, and then the faulty set can be shut down. (4) Switching out a fully-loaded set wire naturally causes volts and speed of remaining sets to fall. Full steam (by means of governor wheel and cut-off) will be put on remaining sets, and resistance taken out of field circuits in order to raise the pressure. The excitation must not be increased too much, or it will pull down speed of engines instead of raising pressure. (5) Meanwhile spare set will be run up to speed, and steam pressure on boilers got as high as possible. The spare set running at lowest speed on governor will most probably be running too fast for paralleling with other sets; by nearly closing stop valve, and regulating speed by means of stop valve, it can be got right for paralleling without much difficulty. (6) Machine is then switched in and stop valve opened gradually, and resistance taken out of field circuit, in order to make the set take up its share of the load.

In most cases the above can be successfully done, but if the load on the remaining sets is so great that there is not sufficient pressure to parallel by, one or more feeders will have to be switched over on to the spare set, and machine paralleled with others afterwards. Siemens's alternators will stand shorts and overloads without much risk to the machines, but if the machine fuses are too light they will be liable to go.—H. B. D.

Answer to No. 472 (*awarded* 5*s.*).—(1) We will commence by considering what happens if a coil burns out.



It will not burn long before it puts the machine to earth, and if this coil happens to be at or near the high-pressure end of the armature a dead short occurs around that machine, and it also short-circuits the others. If the machines are fused reasonably 400 kw. should blow a 200-kw. fuse, and thus cut the machine off the 'bus bar. But there is still a short-circuit around that particular machine, which if left long enough will burn the armature out. Therefore, as the governing of a Willans engine is very good, switch off the field and shut the engine down as soon as you can. (2) But if the machine went to earth at, say, E_2 in the figure, the fuse would not blow, but the section of the armature between the earthed end and E_2 would soon burn up. Therefore, dispatch is very essential in order to avoid these things.

"R. H." does not state if his engines are condensing or non-condensing. Let us consider the two cases: (1) *condensing*—the engine will do 25 per cent. overload with 26in. vacuum; (2) *non-condensing*—the engine will do 10 per cent. overload.

The above points should always be tested on the spot. If you are within these limits, let them have it, and put in your spare machine as soon as you can. But if you are not, parallel your spare machine if you can.

The Worst Conditions.—We will now suppose the three 200-kw. machines are fully loaded, and that when trying to parallel your fuse goes: (1) take out your exciter switch and shut down; (2) pull out the machine switch. You are then in a very bad position, your volts are down considerably, and the synchroniser voltmeter will not read. If you have no other instruments—and I *must* take it you have not—a low-reading voltmeter would get you over this difficulty. (1) Ease the load off your engines by decreasing the excitation, getting your driver to cut an equal amount of steam off each. (2) Take out the feeder switches. (3) Parallel the 100-kw. machine on the empty 'bus bar with the two 200-kw. sets. Get the speed and volts high. (4) Put in the feeder switches as near as possible together, and bring up the engines to normal speed. As you are then running at an overload, this may not be possible, but it is the nearest thing possible.—P. A.

Answer to No. 472 (*awarded* 5*s.*).—In a case of this sort quickness on the part of the switchboard attendant is the most essential thing, and to keep a cool head, or else it is 10 to 1 he will shut the station down or do something equally as silly. As soon as he sees what is happening, let him get the machine off the load as quickly as possible and the exciting current broken. If the machine is motoring while the short is on, he should be careful to see that the needle of his ammeter is at zero, as otherwise he will get a destructive arc on breaking contact. If the needle is hard over, lower the exciting current to permit of switching safely. Now, as soon as the machine is out, he will find that the remaining ones are a trifle overloaded, so that if scares him, let him take off some of the circuits that he is feeding (and which can be done without for a short time) while the 100-kw. is being run up to synchronism, and then parallel it. Of course, he will continually have an overload if he puts his circuits on again; but still that shouldn't worry him or the station chief, as I daresay the machines will do it without hurting them so very much.—A. H. E.

Answer to No. 472 (*awarded* 5*s.*).—It is evident from the question that there will be more than a full load for the two big sets alone. However, as coils that burn up have a habit of giving no warning, it would be best to let the machine with the faulty coil rip until you had opened right out on the No. 3 set, then pull No. 1 set's main switch and exciter switch out as near simultaneously as possible, and let the two big sets take the whole of the load until you have paralleled the spare machine. Of course, there will be a certain amount of voltage drop, and most likely some motoring. The latter can soon be stopped, especially if the engines have variable cut-offs (as this size of Willans engine often has), by adjusting the same; or, on the other hand, by taking one of the sets off the governors on to the valve. No doubt No. 4 set would have to be put in on the valve, and as it is more difficult to phase machines on the valve than on the governors, I should advise a flying shot at the first phase up; then, when in, open her out, and if the machines are by this time running steadily, bring the engine which is on the valve on to the governors again, and resume the working conditions. This operation ought not to last more than three minutes.—R. N. T.

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NOTES.

"The Electricals."—A smoking concert arranged by "The Electricals" will be held at the Bedford Head Hotel, Tottenham Court-road, next Friday evening, commencing at 7.30 sharp. Sir David L. Salomons, Bart., will occupy the chair, supported by Mr. C F. Quicke, the vice-president of the club. An excellent programme is promised, and a large attendance of members and friends is looked for.

Royal Institution.—On Tuesday next (May 20), at three o'clock, Prof. Karl Pearson will deliver the first of three lectures at the Royal Institution on "The Laws of Heredity, with Special Reference to Man." On the following Thursday Mr. H. H. Spielman commences a course of three lectures on "Contemporary British Sculpture," with lantern slide illustrations; and on Saturday Prof. Brander Matthews gives the first of a course of three lectures on "The Development of the British Drama." The Friday evening discourse on May 23 will be given by Canon Ainger, his subject being "The Ethical Element of Shakspere;" the discourse on May 30 will be delivered by Mr. G. Marconi on "Electric Space Telegraphy," and that on June 6 by Sir Benjamin Baker on "The Nile Reservoirs and Dams."

Electrolytic Estimation of Iodine.—Mr. Erich Müller in a recent paper on the electrolytic estimation of iodine in the presence of bromine and chlorine, shows that when an alkaline or neutral solution containing various haloid salts is electrolysed, the iodide is quantitatively converted into iodate, which can be estimated by treatment with potassium iodide and titration with thiosulphate. To prevent the reconversion of iodate into iodide, the electrolysis is carried out in the presence of a little potassium chromate, which must be allowed for when titrating. The cathode used was a gauze of platinum wire 10cm. long and 0·5cm. thick, the anode a piece of platinum foil 14cm. square and platinised on each side; a current of 1 ampere for 1½ minutes is employed, and the E.M.F. must not exceed 1·7 volts or some bromide will be converted into hypobromite.

Formation of Ozone by the Electric Discharge. This subject was recently studied by Mr. A. de Hemptinne, who has now published his conclusions in the form of a paper. He finds, as a result of his research, that the amount of ozone produced by means of the electric discharge varies greatly with the distance of the tinfoil plates from one to another, and with their size. It is not proportional to the amount of air passed in a given time, and the pressure has apparently little influence. The intensity of the electrical current has also a very considerable influence on the amount of ozone formed, a current of low potential and high density being more advantageous than one of high potential. For a given value of electrical energy, there will be a given value of those different factors for which the formation of ozone is a maximum. The increase in the amount of ozone by employing oxygen instead of air is not sufficient to justify its use from an economic standpoint.

Glasgow Local Section.—Owing to the last report of the committee of the above section of the Institution of Electrical Engineers being delayed till the commencement of the present session, the second annual report, which was presented at the general meeting at Glasgow on Tuesday, only covers the work of the past six months. In that period seven meetings have been held, the attendance at which has been satisfactory, the average number present on each occasion being about 50. Although the papers submitted during the session have been few in number, they have all been of a very high standard. An increase of 31 in the membership of the section is shown for the past six months, bringing the total up to 189, which the committee regard as very satisfactory. With regard to the coming session the committee have already had some valuable papers offered, but they hope that members of all classes will support the section, not only by contributing papers, but by attendance at the meetings and by taking part in the discussions.

Institution of Junior Engineers.—At the meeting of this institution held on May 2 the paper read was on "Some Factors in Colonial Railway Construction," by Mr. Lewis H. Rugg. In the course of his remarks the author pointed out that from a financial point of view steep grades and high summit leads were desirable, it being quite a mistake to suppose and to agree with the popular idea that easy grades and curves resulted in a successful railway. Nothing less than 2ft. 6in. should be adopted per gauge; this was adequate for the sharpest curves. In dealing with surveys, the author pointed out that the tachometer was unfortunately still to a large extent ignored in this country. Its advantages were apparent, as it contained the theodolite, chain, and spirit-level in one. A vote of thanks was passed to the author, and the proceedings terminated with the announcement of the visit on May 10 to the Great Eastern Railway Works, and a special notice with reference to the summer excursion of the institution to Lancashire—Preston, Blackpool, etc.—Aug. 9 to 16.

New Literature.—We understand that a volume containing the physical papers of Prof. Henry A. Rowland, for 25 years professor of physics in the Johns Hopkins University, is now in preparation. The book will contain Prof. Rowland's articles and memoirs on physical subjects, together with his popular writings and addresses, numbering 60 in all. They have been collected from over 20 different magazines and journals. The subjects treated in these papers cover a wide range. In heat there is the great memoir on the mechanical equivalent of heat, with several shorter articles on thermometers. On the subject of electricity and magnetism there are the fundamental researches on magnetisation, on the magnetic effect of electrical convection, on the value of the ohm, on the theory and use of alternating currents, etc. In light the renowned discovery and theory of the concave grating and the long series of investigations made in the field of spectroscopy are described. The memorial address of Prof. Mendenhall and a portrait of Prof. Rowland will also be included. Orders for this volume at £1. 1s. per copy may be sent to Prof. Joseph S. Ames, Johns Hopkins University, Baltimore, Maryland.

Electricity Supply in St. Marylebone.—At the Surveyors' Institute, Westminster, there is at present in progress an arbitration enquiry, under the Lands Clauses Act, which is of great importance not only on account of the large sums involved, but because it is the first enquiry of the kind ever held. The proceedings are taken to decide the amount which is to be paid by the St. Marylebone Borough Council to the Metropolitan Electric Supply Company, Limited, for the acquisition by the Council of that portion of the company's electricity supply undertaking and business situate in the metropolitan borough of St. Marylebone. It will be remembered that last session the Council obtained parliamentary powers to purchase, and, negotiations as to terms of purchase having failed, the present arbitration has been resorted to. The result of the enquiry, which is likely to last for some days, will be watched with the keenest interest, as the question of elec-

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tricity supply in St. Marylebone has long been the subject of conflict between the municipal authorities and the company. Mr. C. A. Russell, K.C., is the umpire, and assisting him in the capacity of arbitrators are Mr. Robert Vigers and Mr. W. C. Ryde.

Electromobile Trials.—We have received from the Automobile Club a preliminary notice with reference to the forthcoming trials of electric vehicles arranged by the club to take place from July 7 to 12 this year. Cars may be entered for either of the following classes: (1) town carriages; (2) country carriages weighing over 30cwt., including accumulators; (3) country carriages weighing under 30cwt., including accumulators. The following is the general arrangement of the routes chosen, but special optional routes will be selected for town carriages: (*a*) London to Brighton; (*b*) Brighton to London; (*c*) London to Sandown and back; (*d*) London to Windsor and back; (*e*) London to Ascot and back; (*f*) special route for observations. In order to enable the Trials Committee to make proper arrangements for the charging of cars, intending competitors are requested to inform the club secretary how many cars they propose to enter in the trials, and to state in respect to each car (*a*) the charging voltage at the beginning and end of charge, (*b*) the average current during charge, (*c*) the approximate time required for charging. Official entry forms, together with full programme of the trials, will be issued in due course.

Institution of Civil Engineers.—The students connected with the above institution held their annual dinner on Friday night at the Restaurant Frascati, Oxford-street, with Mr. C. Hawksley, the president, in the chair. In proposing the toast of "The Institution of Civil Engineers," Mr. H. E. Wimperis referred to the recent splendid endowments of the late Mr. Cecil Rhodes, and expressed the hope that some millionaire would similarly endow their institution. It was only after a training of some seven or eight years that the majority of young engineers was enabled to earn a living, and the supply of scholarships was an economic necessity. As showing the scarcity of scholarships there was in this country, he stated that there were not more than a dozen devoted to engineering which were of any value, and which were not tied to any particular locality In response, the chairman alluded to the fact that there were now five past-presidents of the institution who were over 80 years of age, which spoke much for the long life of engineers. Mr. W. H. Barlow, one of their past-presidents, had just attained the age of 90 years. Proposing "The Students," Sir A. Binnie remarked that scholarships might help to stimulate and assist them, but that would be a very false help if the students relied entirely upon them and neglected the study of nature.

A Cable Drill.—At a recent exhibition of agricultural machinery in Paris, there was on view a drill designed for quickly laying electric cables in a light soil or in sand. The machine was designed by Mr. Bajac, and it is proposed by him to use the apparatus to lay telegraph wires in the Sahara Desert. The cable is contained on a drum which is placed vertically over a hollow drill, which projects down into the ground the desired depth. According to the inventor, this depth may be as much as 3ft. This hollow drill has at the bottom a jockey pulley round which the cable passes, so that the drill has only to be drawn forward in order to uncoil the cables from the drum, which passes vertically down to this pulley, and is then laid in the ground at the depth mentioned. In the front of the hollow drill are two ordinary drill heads, which break up the ground in front of it, and in this way reduce the work which has to be done, and behind again is a small roller, which assists to press the earth down on to the cable after laying. There is no information in the description of the apparatus we have seen as to the power required to work this drill through various soils, and although it would do its work more quickly than with the ordinary digging, it seems to us there would be many cases in which its use would be debarred owing to obstructions in the ground.

Belated Transformer Patents.—In a recent issue we commented on the fact that the United States Patent Office had in March this year granted a patent to Messrs. Thomson and Houston relating to improvements in transformers the application for which was filed so long ago as Feb. 19, 1887. This record, however, has now been broken by another patent issued to Prof. Elihu Thomson last month on an application filed on Nov. 2, 1885. This latter patent claims a system of electrical distribution consisting of a number of transformers having secondary working circuits, and with the primaries in multiple on a single supply circuit. The claims of the previous patent were for transformers arranged in multiple, and for a system wherein the circuits supplied by the secondaries to the working circuits are of greater amperage and less potential than the current in the primary. Discussing the matter editorially, the *Electrical World* expresses the opinion that, in view of the fundamental claims of these belated transformer patents, they promise to provoke an interesting litigation in which, in all probability, the question would be taken up as to the validity of patents covering fundamental principles of an art which were not used until many years after the art which they would control had become perfected and of world-wide application. As we have before pointed out in these columns, the practice of granting patents years after the applications for the same have been filed is likely to be an injustice to the electrical industry. It is quite conceivable that the patents may be acquired by some large company and used for the purpose of hampering rival concerns.

Electrolysis of Brine.—An electrolyte cell recently patented by Mr. F. McDonald, and designed for the production of chlorine and caustic from brine, is described in the *Electrical World* as belonging to the type rendered familiar by the early constructions of Le Sueur and the later forms of Hargreaves and Moore, in which a perforated cathode is employed as a support for the diaphragms which enclose the anode compartment. The device now patented operates upon the Le Sueur principle, and is, therefore, to be considered as a modified form of this cell. The anode is formed of a number of platinum wires or ribbons fused into a glass tube, and contacting therein with mercury, through which the electrical connection is made. The details of construction are as follows: The iron tank is divided by perforated iron cathode plates, suitable flanged, into three compartments, of which the central contains anodes. The diaphragms, comprising layers of asbestos cloths, faced with asbestos paper, are supported by the cathode. The cover of the anode cell is sealed by cement into the upper flanged portion of the cathode plates, and the anodes are supported by this cover. A bed of cement covers the bottom and end walls of the anode compartments, and protects the iron from the action of the electrolyte. The lateral or cathode compartments are likewise tightly covered, and are provided with suitable induction pipes for water and with eduction pipes arranged to draw the caustic from the bottom of the cell. The anodes comprise a glass tube, into the lower end of which platinum wires are sealed. The anode conductor is in contact within the tube with mercury, as are the platinum wires. These wires constitute the working anodes, and hang freely in the vicinity of the diaphragms. The chief departure in

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this cell from the Le Sueur type is the substitution of vertical perforated plate cathodes for the inclined bed of wire sponge originally used. The changes involve both the structure and position of the cathode, and both are said to be distinct advances on previous inventions in that they facilitate the free escape of the liberated hydrogen.

Municipal Telephones.—The connections to the Corporation telephone exchange at Glasgow are rapidly increasing, new orders coming in at the rate of about a dozen a day. According to a recent report by Mr. A. R. Bennett, the general manager of the municipal system, there are now 7,066 orders on hand, of which 5,055 have been executed, leaving 2,011 still to be connected. During the previous fortnight new orders were received at the rate of 13 per day, while subscribers were put on to the municipal lines at the rate of 23 per day. We understand that the system has been extended out to Clydebank, and many residents there are now connected with the Corporation exchange. With regard to the financial side of the undertaking, it is encouraging to find that it is quite satisfactory. After paying all working expenses, Post Office royalties, and interest of sinking fund on the whole of the capital expended to date, there remained a good balance for the month of April. Relief cables are now being laid in many parts of the city, notably for the Bridgeton and St. George's Cross districts. While on this subject, we regret to see that the same practice is being adopted at Eastbourne as was employed at Tunbridge Wells by opponents of municipal telephones, of writing anonymous letters to the Press. For the most part these "contributed articles," as they are called, are personal attacks upon Mr. Bennett, whose efforts in the direction of cheap telephony are naturally not welcomed by the telephone monopolists. The reasons for which these offensive anonymous letters are written and published in the local newspapers are so obvious that any comment on our part is unnecessary.

Steam v. Electricity on Railways.—In a recent discussion of this subject in the States, Mr. C. H. Davis expressed some interesting conclusions with regard to the economic electrical future of railways, which he has now embodied in a paper before the Canadian Society of Civil Engineers. To put it shortly, the author finds that steam railways will not in the near future handle their freight traffic (other than mail, express, and light local freight carried in suburban trains) and long-distance passenger traffic by any other motive power than steam locomotives, but there may occur infrequent cases in which electricity will be used under exceptional conditions of large volume and great density of passenger traffic. New railway lines connecting very large centres of population will, however, be operated by electric motors. Again, there are three conditions under which suburban and short-distance interurban traffic will be handled profitably by steam railways converted to electric traction—viz., where units can be light and frequent and operated over comparatively short distances, where gross receipts can be so increased by the change of system and mode of operation as to pay for the increased investment and possible increase in operating expenses, and where competition of parallel electric roads compels the change, to save what traffic there is, irrespective of how operating expenses are affected. Lastly, the author finds that in the future development of steam railway systems they will eventually be operated jointly with surface electric railways, either through mutual ownership or by traffic contracts, leases, etc. Dealing with the question of created or induced traffic, the author gives an outline of the general laws of passenger movement, although they are not as yet very clearly defined. Velocity of transportation, for instance, is not primarily effective in inducing travel, but together with other conditions it tends to increase traffic. These other conditions include proximity of departure and arrival points to possible passengers, frequency of service, and character of terminals. Also as the density of the districts served increase, it is probable that the riders *per capita* per annum also increase, while, again, the effect of various industries and the kind of population must have a decided effect on the passenger traffic. The author offers no detailed defence for these laws, but he thinks they will generally be found to be correct.

Molecular Surface Energy of Solutions.—The May number of the *Journal* of the Chemical Society contains a good abstract of a paper under the above title by Mr. D. Pekar, in which the method used for the determination of the surface tensions is first described. It consists essentially in the comparison of the curvature of the liquid contained in a narrow vessel with that of a liquid of known surface tension. The molecular surface energy was determined in the case of ethyl ether, carbon disulphide, and benzene. The values of the critical temperatures—that is, the temperatures at which $\gamma (M v)^{\frac{2}{3}} = 0$—for the compounds were found to be respectively, 187·7, 271, and 274 degrees, whilst the mean temperature coefficients are 0·230, 0·203, 0·233, indicating non-associated liquids (these numbers are not expressed in the same units, and are not directly comparable with those of Ramsay and Shields). In the case of mixtures of these compounds, although the molecular surface energy itself may not be the additive mean, yet the temperature coefficient is still normal, and hence, if the molecular weight of one component of a mixture is known, that of the other is calculable. This result is in accord with that of Ramsay and Aston, with which work, however, the author was not familiar until the end of his research. The molecular weight of sulphur was then ascertained by means of the determination of the molecular surface energy of its solution in carbon disulphide and in disulphur dichloride. In both solvents it was found that the dissolved sulphur has a molecular weight corresponding with S_6 or S_8, a result in accord with most determinations, but not with those of Orndorff and Terrasse, who, by the cryoscopic method, obtained the value 61·9 for the molecular weight of sulphur in disulphur dichloride solution.

Electrical Engineers Volunteers.—A Bohemian concert, given by the Electrical Engineers (R.E.) Volunteers' Cycling Club at the headquarters in Regency-street, Westminster, on Saturday evening, showed that the spirit of goodfellowship among the members of the corps has in no way died out since their return from South Africa, and a goodly number of young electrical engineers with their lady friends were present at this agreeable form of entertainment. The drill hall, in which the concert was held, was prettily decorated with flags and flowers, while on the platform itself a number of small electric incandescent lamps embedded among ferns and other greenery added to the brilliance of the gathering. Major R. S. Erskine occupied the chair, and was supported, among others, by Colonel Crompton, who is colonel of the regiment. The programme provided was of a well-varied description, and as the artistes warmed to their work, so the interest increased. To mention a few of those who kindly gave their services on this occasion, Miss Lilian Harvey, a delightful young contralto, was heard to great advantage in "Love the Pedlar," and later on in that favourite coon song which never fails to ensure an encore, "Ma Curly-headed Babby." Some excellent musical sketches by Mr. Griffith

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Humphries deservedly found great favour with the audience, who warmly applauded his clever witticisms. Mr. Dennis Drew, a baritone, also gained a sympathetic hearing in "The Mermaid" and "The Border Ballad"; and among others who contributed to the evening's entertainment may be mentioned Sergeant G. D. Leys, Sapper S. S. Webb-Bowen, C.S.M. E. G Sheppard and C.S.M. G. A. Poynton. The concert throughout must be voted a great success, and it is to be hoped that the Volunteers' Cycling Club will give us many another like entertainment in the near future, as they will do much to popularise the club with the profession in this way. It may be mentioned here that one of the objects of the club is to promote social intercourse among members of the corps, and it seems to us a pity that although the club has now been in existence for over three years, it should not be more largely patronised by the younger members of the profession than it at present is. Compared with the long roll list of the regiment itself, the membership of the club is rather insignificant, but now that the summer is fast approaching, and the delights of long bicycle runs in the country may well be anticipated, it is hoped that the numbers will considerably swell. In our opinion the club is deserving of the most unselfish support.

Electrical Equipment of the Boston Elevated Railway.—A well-illustrated description of part of the electrical equipment of the Boston Elevated Railway appears in the current number of the *Wisconsin Engineer* from the pen of Mr. C. H. Hill. The article is practically devoted to a treatise of the method employed on this railway for the transmission of power, which is furnished from three of the company's power stations—all in the vicinity of the structure. In calculating the copper required for transmitting the power to the motors, a 2,000,000 circular mil. wire was determined upon as a unit in the feeder system. At the switchboard each feeder panel carries one carbon break circuit breaker, having a capacity for carrying 3,000 amperes continuously without heating, one ammeter measuring up to 6,000 amperes, and one quick-break switch having a capacity of 3,000 amperes continuously. The electrical current is carried from the station to the elevated structure, using 2,000,000 circular mil. lead-covered, rubber insulated cables, which are drawn in conduits built of vitrified clay pipe. The conductor in each cable is insulated with five-thirty-secs. of an inch of rubber compound, covered with a tape and protected with a lead covering $\frac{1}{8}$in. in thickness. At each end of the cables it was deemed desirable to discontinue the lead covering, and splice on from 40ft. to 60ft. of rubber-insulated triple-braided wire. Describing the third-rail system which is used in transmitting the power from the feeder system to the cars, the writer says that each car carries four contact shoes, carried outside the forward and rear trucks and hanging at such a distance as to come in contact with the third rail, which is so placed outside the running rails that its contact surface is 19$\frac{1}{2}$in. from the gauge of the running rail and approximately 6·2in. above. An ordinary "T" rail, 85lb. to the yard, is used for the third rail, the steel in the elevated structure throughout being employed as a part of the return system. In addition to this, one rail in each track constitutes part of the return circuit. The joints on the third rail are bonded nearly to the full capacity of the rail itself, and at 500ft. to 600ft. intervals the rail is bonded to the longitudinal girders of the structure. One rail of each track is used as a part of the signal circuit, and is, therefore, not available for the return system. As our readers may know, the Boston Elevated Railway Company own and operate surface lines in conjunction with the elevated system, and it has been found desirable to connect the elevated structure with the surface tracks and return wires at frequent intervals, thus giving a well-balanced return system.

The Institution Building Fund.—Mr. Langdon made a most encouraging statement at the meeting of the Institution last week with regard to the building fund, which we are sure will be read with the deepest interest by all members of the profession. It was to the effect that this fund has now reached the round sum of £10,000. In making the announcement, the President was anxious to congratulate the treasurer, Prof. Ayrton, on having accumulated that amount, and at the same time he wished to take advantage of this opportunity to ask members for their liberal support of this fund. After all, £10,000 was not a large sum towards the object they had in view, which was to obtain a representative building for the Institution of Electrical Engineers. The field before electrical engineers was undoubtedly a large one, and they might look forward to this Institution not only becoming a very popular but a very influential body in the future, and it was most desirable that they should one and all aim towards gathering together the means of providing a representative building for the profession at large. Such a building would not only be a great advantage to the Institution as a body, but it would also be a place of comfort and pleasure to individual members. Owing to the rapid growth in the membership and the consequent increase in the work of the executive, they were at the present time considerably hampered for want of accommodation. Of course, it was not to be expected that they would get a building entirely suitable to their wants for some time, but if they did not progress faster in the future than they had done in the past—having due regard to the fact that the Institution had been some 30 years in existence, and that during that time the amount accumulated was only £10,000—it would be many years before they got their building. He appealed to the members to put their shoulders to the wheel and help this fund all they could. The membership was now some 4,500 strong, and he pointed out that if every member made an annual donation of 10s., it would result in an addition to the fund of £2,000 or £3,000 a year. The advantage of having such a building as was proposed would be reaped by the whole Institution, and he earnestly appealed to every gentleman present that night and every member of the Institution, whether resident in London or in the provinces or in the Colonies, to lend their help towards the fulfilment of the object which they all had in view. In tendering these few remarks it must be understood that he did not forget in any way the great services that had been rendered them by the Institution of Civil Engineers. They had received at the hands of that institution the greatest courtesy and the greatest kindness, and he was sure they would always be prepared to recognise this. He trusted that all of them would do their utmost to contribute to this fund, so that it might be built up in the future much faster than it had been in the past.

Mr. Marconi on Wireless Telegraphy.—A large audience assembled in Kinnaird Hall, Dundee, one night last week to hear Mr. Marconi give an exposition of his system of wireless telegraphy, which has been long promised to the inhabitants of that city. At the outset the lecturer referred to the life and work of James Bowman Lindsay in connection with wireless telegraphy. Lindsay's system, however, was not at the time of practical utility, owing to the large amount of electrical energy required even for the most moderate distances, and also on account of the

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considerable distance apart at which it was found necessary to place the two immersed plates connected to his circuit, but had he lived to the present time, when the developments of modern electrical engineering have placed such very powerful means in the hands of the electrician, Mr. Marconi predicted that Lindsay would have done as much as he himself was now able to do. In any case the name of James Bowman Lindsay must go down to posterity as that of the first man who thoroughly believed in the possibility and utility of long-distance wireless telegraphy. After describing the system elaborated in later years by Sir Wm. Preece and the discoveries of Clerk Maxwell and of Hertz—the direct precursors of his own system of æther-wave telegraphy—Mr. Marconi mentioned that in March, 1899, the first international communication by wireless telegraphy was established between the South Foreland and a village near Boulogne—a distance of 32 miles. At the present time his system was in use in no fewer than 40 coast stations (most of them controlled by Lloyd's) in Great Britain and in Europe; in 66 vessels of the British navy, and 12 vessels in the Italian navy. It has also been adopted by many of the Transatlantic lines of passenger and freight vessels, and by the Belgian mail steamers. As showing the commercial application of the system, he stated that lately the Cunard Company had received in receipts from the "Campania" for messages transmitted from passengers as much as £60 on one trip. Referring to the possibility of "tapping" the messages, Mr. Marconi said that the introduction of the tuning system obviated this difficulty. In his opinion the day was rapidly approaching when ships would be able to be in touch and in communication with the shore across all oceans, and then that isolation from the outside world still possible on board ships would be a thing of the post. The possibilities of the system on land, especially between this country and the Colonies, would be much more far-reaching. It should be mentioned, in conclusion, that Mr. Marconi hopes to have his Canadian station ready in about eight weeks, when, as he put it the practicability of a Transatlantic service will be determined.

The Proposed General Conditions.—The adjourned discussion of the proposed form of model general conditions for use in connection with contracts for electrical plant was taken up by Mr. G. H. Nisbett last week at an extraordinary meeting of the Institution, held in the rooms of the Society of Arts. Continuing his remarks from the previous meeting, Mr. Nisbett argued that the form had not been drawn up with due regard to the interests of the contractor. Looking through the conditions, he found that there were 57 clauses which safeguarded the interests of the purchaser, as against only 17 that gave any rights at all to the contractor. He complained, for instance, that no provision had been made for penalties in the event of non-fulfilment of the contract by the purchaser, and suggested several other additions and amendments with a view to putting the contractor on a more level footing with the purchaser. He pointed out, further, that whereas the purchaser had the power to reject any machinery which did not come up to the test, the contractor was quite unprotected in this respect, and he suggested that the contractor should be allowed a period of, say, one month in which to make good defects. Mr. Stuart Russell supplemented these remarks with a few other suggestions in favour of the contractor, and was followed by Mr. C. C Hawkins. It was most important, he said, that the contractor should maintain his free and undisputed right to appeal to arbitration on any matter whatever, and he asked that this might be made perfectly clear in the model conditions. Again, while the contractor was perfectly willing to admit his liability for damage to plant when in course of erection, the present clause relating to this subject was so loosely worded that it laid him open to any claim for damage whatsoever that the purchaser chose to prefer against him. Mr. J. E. Kingsbury, in looking through the form, was struck with the good work which the committee had carried out, and he was sorry to note that some captious criticisms had been indulged in concerning it. He heard it remarked, for example, that the conditions were in favour of the buyer, and he asked, what prospect was there of getting any form of general conditions used that was in favour of the seller? He was glad to see that the committee in drawing up these conditions had taken the advice and assistance of representative bodies of contractors and manufacturers, so that they really did have a hand in making the laws under which he hoped they were going to be ruled. Mr. J. Shoolbred having spoken in favour of the document, Mr. W. B. Esson took up the discussion with the remark that if these conditions were going to be made fair to both sides, they must yet have considerable modification, pointing out that what would apply to the building contractor was not fair for the contractor who supplied and installed machinery. Dealing with the clauses, he urged that the provision which made the contract subject to the sanction of the Local Government Board should be struck out altogether. Another suggestion which he made was, that it should be specifically stated in the form that the purchaser was liable for any damage to machinery in course of erection which was not directly attributable to the fault or neglect of the contractor. He also thought that the onus of applying for an extension of time for the completion of works should not be put upon the contractor, but that the consulting engineer should give it without any application being necessary. Mr. W. E. Gray expressed the view that nothing had been said during the discussion which would weigh materially against the adoption of these fairly generous model conditions. Mr. N. Gunz was glad to note that provision had been made for the payment of penalties on the part of the purchaser in the event of his not taking delivery according to contract. Mr. C. H. Yeaman suggested that, in order to avoid a misunderstanding between the purchaser and the contractor, the latter should send in drawings with his tender, and that in the period between the acceptance of the tender and the signing of the contract these drawings should be altered if necessary, and agreed upon finally. Mr. Robert Hammond, who is acting as reporter to the committee which framed the conditions, made a few remarks in reply to the discussion. He assured the contractors present that the committee was by no means an anti-contractors' committee. It would be his pleasure to lay the views of those members who had spoken before the committee, and endeavour to produce a set of conditions which would be acceptable, not only to the contractors of the country, but also to the town clerks and solicitors of the purchasers. He appealed particularly to the Institution, however, not to press the committee to lay it down that the contract must be delivered absolutely in its final form, with complete drawings, before the contract was signed. They must allow the contractor a little latitude with regard to his drawings. He maintained that the best thing for the industry was to encourage the engineer to state exactly what he wanted, so that the contractor should know perfectly what he was called upon to supply. On behalf of the committee, he thanked the Institution most heartily for giving a second evening to the discussion of these conditions, and he assured the meeting that every suggestion that had been made would be most carefully weighed by the committee in preparing the form for final adoption.

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CARDIFF ELECTRICAL TRAMWAYS.

(Concluded from Supplement.)

There are seven main feeding points at Cardiff. To five of these points feeders having conductors of ·6 square inch sectional area are taken, the remaining points being fed by cables of ·5 and ·4 square inch sectional area respectively. Two negative feeding points are further provided. One of these is situated at the junction of Castle-road and Newport-road, and the other at the junction of Custom House-street and Bute-street. To the former are run two cables, each of ·6 square inch sectional area, and to the latter three cables, two of ·8in. and one of ·6in. sectional area. Special care has been taken to ensure good earthing, all the negative feeders being earthed at the negative feeding points. All the cables are of the lead-covered, paper-insulated type, and were supplied by the British Insulated Wire Company, Limited, Prescot. They are drawn into conduits supplied by Messrs. Doulton and Co., Limited, Lambeth, London, E.C. These conduits are of the three-way stoneware type, each way measuring 3in. by 3in., and were laid by the Corporation. They are jointed with cement, the method of building them up in concrete being clearly shown in Fig. 23. Starting from the generating station, no less than 10 conduits are built up as shown,

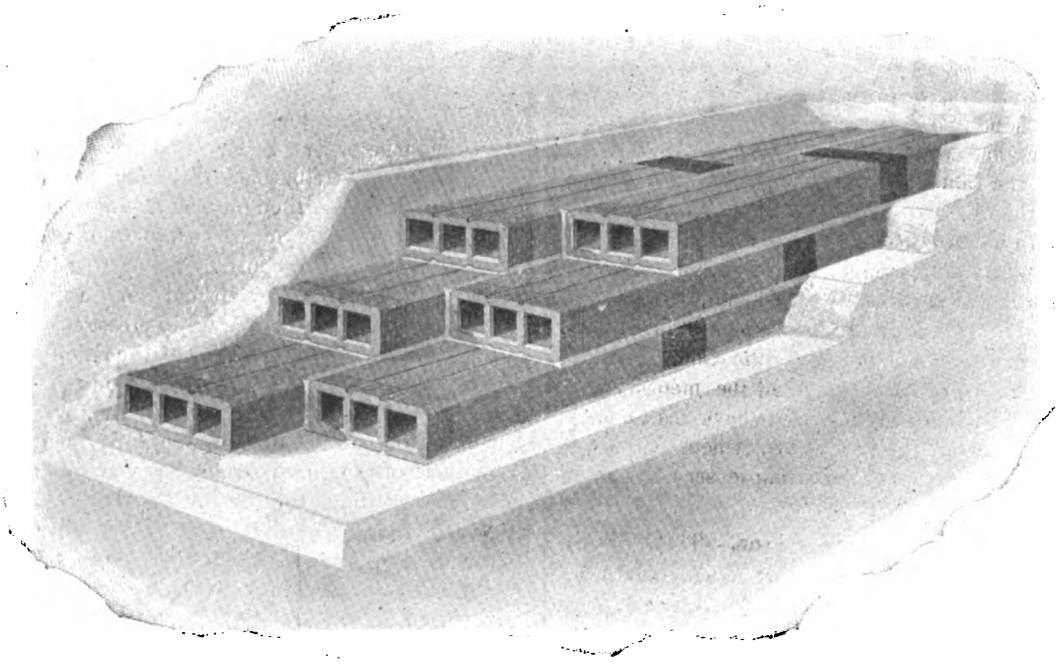

FIG. 23.—Method of Building Up Doulton Conduits in Concrete, Cardiff Electric Tramways.

thus providing 30 ways, which allows ample scope for future extensions of mains. Armoured cables are laid from the station to the first road box where the conduit commences. It should be mentioned that a three-core combined pilot and telephone cable is run to the end of each route, one core serving as a pilot and the other two as telephone wires. A pilot wire is also run to each of the negative feeding points. In all there are 12 pilot wires and 14 points to which they connect. Eventually there will be 10 separate routes, but at present there are only eight. The telephone pillars are of the British Insulated Wire Company's make, and each contains a telephone test box. It may be mentioned that the work of laying the cables has been superintended on behalf of the British Insulated Wire Company, Limited, by their engineer, Mr. F. Bradford, who is now engaged with the separate network destined to supply power to the docks and for general lighting purposes.

Section Boxes.—These are of the standard type supplied by Messrs. Bergtheil and Young, 12, Camomile-street, Bishopsgate-street Within, London, E.C., and are fitted with this firm's patent "L"-type switches. It will be seen from the illustration (Fig. 24) that the switch consists of two copper blades secured so that they move together, and separated by a distance-piece to allow the switch lever to lie between them in the closed position. This arrangement reduces the height from the base upon which the switch is mounted to a minimum, and enables the depth of the box to be kept correspondingly small. The arrangement of the switches on one of the section-box panels is shown in Fig. 25.

We understand that the connections are such that any section of the trolley wire can be fed from either end. The advantage of this is that in the event of the distributing cable between two section boxes breaking down, the faulty section can be bridged by means of the trolley wire until the fault in the cable has been removed. Presumably in regular working the double connection to each section of the trolley wire will not be used.

Overhead Equipment.—The chief feature with regard to the overhead work at Cardiff is its solid construction The work of erection has been carried out by the Corporation, the poles, bracket arms, and line material being supplied to them under separate contracts. Centre poles with double bracket arms predominate. These poles and arms have a light and elegant appearance despite their substantial design. Where span wires are employed, the supporting poles are provided with exceptionally heavy bases. All the line material was supplied by Messrs. Robert W. Blackwell and Co., Limited, of 59, City-road, London, E.C., and is of their Liverpool type with extra heavy ⅜in. Ætna insulating bolts. The single and double pull-offs are made of phosphor bronze in order to obtain greater tensile strength. It should also be mentioned that the ears used were designed by Mr. Ellis, and secure greater strength than is usual. The illustration (Fig. 26) is the only one we have of the line work. We are afraid it does not show much detail, but it will serve, at any rate, to illustrate the knowledge of the local Press on things electrical.

Rolling-Stock.

The rolling-stock comprises three types of cars—namely, double-deck bogie cars, mounted upon four-wheel maximum traction trucks: single-deck bogie cars, similarly mounted; and double-deck four-wheel cars, with fixed wheel bases.

Double-Deck Bogie Cars.—A full view of one of the first-mentioned type is shown in Fig. 27, while in Fig. 28 the arrangement of the reversed stairway with half-way platform is seen to greater advantage. These cars each provide seating accommodation for 68 passengers—30 inside and 38 outside. They are very similar in design to those supplied to the London United Tramways Company, Limited. The principal dimensions are as follows:

Length of car body outside	22ft. 3in.
Length of car body inside	21ft. 4in.
Length of each platform	5ft. 9in.
Length over platforms	33ft. 6in.

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Width over roof	7ft. 0in.
Clear height inside at centre	6ft. 0in.

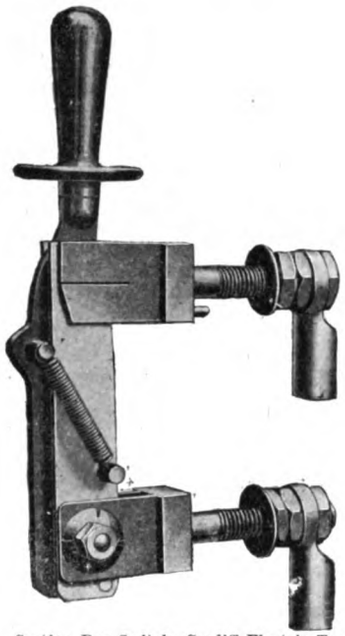

FIG. 24.—Section Box Switch, Cardiff Electric Tramways.

Distance between centres of driving axles	14ft. 6in.
Gauge	4ft. 8½in.
Height from level of rails to trolley plank	9ft. 0in.

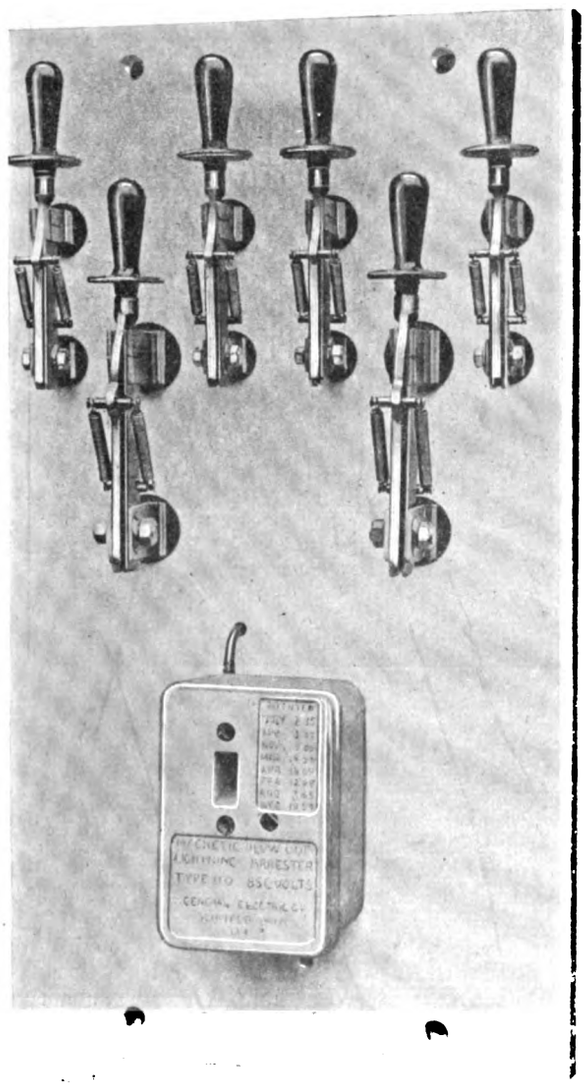

FIG. 25.—Arrangement of Switches on Section Box Panel, Cardiff Electric Tramways.

It will be gathered from the above dimensions that the platform at each end of the car projects 5ft. 9in. beyond the end of the car body. A collapsible gate is provided at each end of the car over the openings for the steps. The roof seats are of the reversible (garden) type. The lighting of the cars, both inside and outside, is very complete, as also the systems of bells and signals. A special circuit is

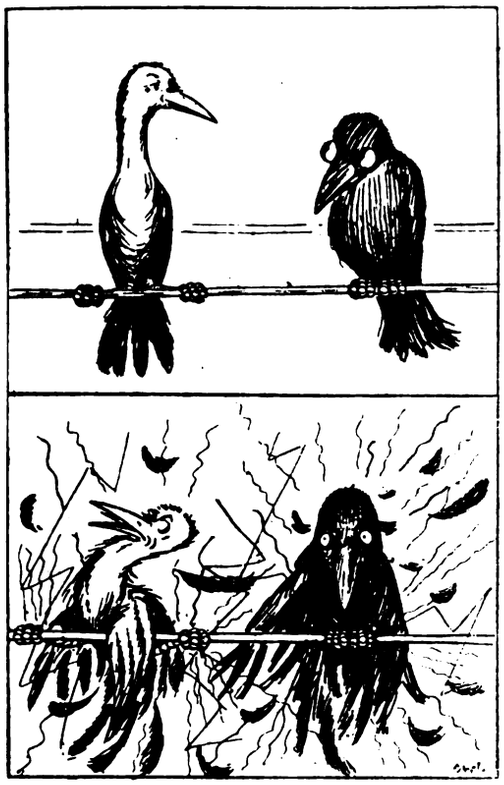

FIG. 26.—An Electric Shock.

First Cardiff Bird: Dear me. The Corporation are very considerate—providing such nice clothes-lines.

Second Cardiff Bird: The Cardiff Corporation are always in the van of Progress. Oh——O——O——D——.

(Just then the electric current was turned on at Roath Station.)

provided for illuminating the destination boxes, also for earthing the trolley standard through a ruby lamp fixed at each end of the car.

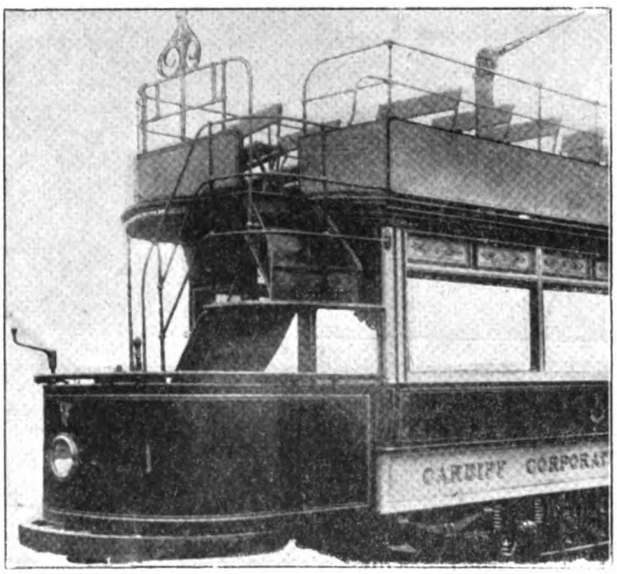

FIG. 28.—End View of Double-Deck Bogie Car, Cardiff Electric Tramways.

Single-Deck Cars.—These cars each provide seating accommodation for 34 passengers. The principal dimensions are as follows:

Length of car body outside	25ft. 0in.
Length of car body inside	24ft. 4in.
Length of each platform	3ft. 9in.
Length over platforms	32ft. 6in.
Width over roof	7ft. 0in.
Height inside at centre	7ft. 9in.
Distance between centres of driving axles	17ft. 6in.
Gauge	4ft. 8½in.
Height of end-door openings	6ft. 1in.

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Double-Deck Four-Wheel Cars.—These cars each provide seating accommodation for 52 passengers—22 inside and 30 outside. The principal dimensions are approximately as follows:

Length of car body outside	16ft. 0in.
Length of car body inside	15ft. 4in.
Length of each platform	5ft. 9in.
Length over platforms	27ft. 6in.
Width of roof	7ft. 0in.
Clear height inside at centre	6ft. 0in.
Wheel base	6ft. 0in.
Gauge	4ft. 8½in.
Height from level of rails to trolley plank	9ft. 0in.

Details of Equipment.—Each of the cars, irrespective of type, is fitted with two controllers—one on either platform. Each of these controllers has 14 operating points—viz.: motors in series—three resistance points and one running point; motors in parallel—three resistance points and one running point; on braking side—six points. The electric braking is effected by the controller connecting the motors as series generators in parallel with one another, and in series with the same resistance as used for starting the car. The four-wheel cars are fitted with trucks of the Brill No. 21 type, while the bogie cars are mounted on Brill maximum traction trucks. Each of the latter has a wheel base of 4ft., the other dimensions being as follows:

Centres of side frames	5ft. 9½in.
Length of axle	6ft. 4⅞in.
Extreme width over all	6ft. 6¾in.
Centre of motor axle to bottom of car sill	11in.
Diameter of driving wheels	30in.
Diameter of small wheels	20in.
Diameter of driving axle	4in.
Diameter of small axle	3¾in.
Diameter of large journal	3⅞in.
Diameter of small journal	3in.

The compression device fitted to these trucks consists of a plunger supported by a large spiral spring held in position by a malleable iron casting, bolted to the cross-bar of truck, arranged with set nuts on the under side of the plunger head, so that the weight from the downward pressure of the compression device plate on the car body may be increased or decreased as required by the conditions under which the trucks are to be operated and the weight which may be required on the small wheels. Two series-wound motors are fitted to each car. Each motor is designed to give 1,400lb. draw-bar pull, with 30in. car wheels, and at this load, with a pressure of 500 volts at the motor terminals, is capable of operating the car at a speed of eight miles per hour. The motors, which are of the four-pole type, are capable of carrying the above load for one hour, and 100 per cent. overload for short periods, without undue heating or sparking. The armatures are geared to the car axles by means of a single-reduction spur gearing. The field magnets consist of four poles projecting radially inwards from a cast-iron frame, but the armature connections are arranged so that only two sets of brushes

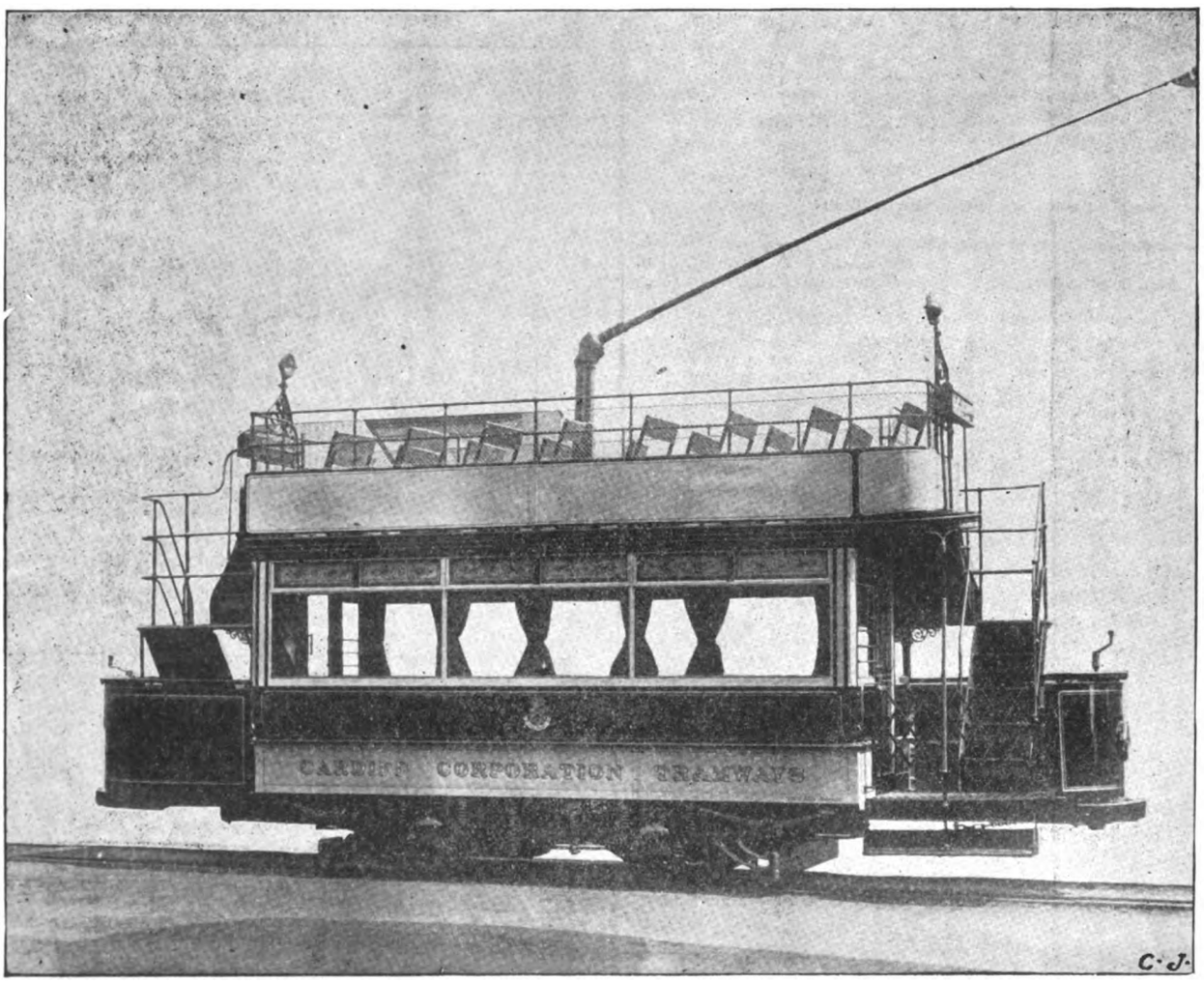

Fig. 27.—Double-Deck Bogie Car, Cardiff Electric Tramways.

are necessary. It may be mentioned that the insulation of the armatures and field coils from the frames was subjected to a pressure test of 3,000 volts alternating. Another point worthy of note is that all the wheels of the cars have been manufactured by Messrs. John Baker and Co. (Rotherham), Limited. The driving wheels are made in accordance with the firm's registered design (No. 356,095), while the pony wheels are of the disc type. In both cases the wheel centres are made of solid forged wrought iron, and are fitted with renewable steel tyres, which are weldless and are made from the very highest possible quality of Siemens-Martin open-hearth acid steel. During the execution of the order careful mechanical tests have been made from each batch of tyres, the lowest results being 52½ tons tensile strain, 14 per cent. elongation, on test pieces 2ft. long. In addition to this, the test tyres have been placed in a hydraulic press, and compressed cold to the extent of 4in., in no case showing the least sign of fracture or distress, the percentage of carbon

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being 0·63. The wheel centres are, as already stated, of solid forged wrought iron, the driving wheels being somewhat similar in design to a locomotive wheel. It has been found that this type of wheel runs almost noiselessly; in fact, it is claimed to be the most silent wheel made, while as regards durability, the wheel is expected to run about four or five times as long as the old pattern wheel. Freedom from broken or snipped flanges, which play such havoc with the track, especially with the points and crossings and curves of short radii, is another advantage claimed for the wheel. When the tyres are worn out it is not necessary to scrap the wheels, as new tyres can be fitted at comparatively small cost, and the wheel becomes as good as new again, the wrought-iron centres being practically everlasting.

The cars themselves, it should be stated, together with their equipments, were supplied by Messrs. Dick, Kerr, and Co., Limited, 110, Cannon-street, London, E.C., the bodies being manufactured by the Electric Railway and Tramway Carriage Works, Preston, and the equipments by the English Electric Manufacturing Company, of the same town. There are in all about 120 cars on order.

We are indebted principally to Mr. Harpur and the various contractors concerned for the particulars and drawings which have enabled us to compile the above article.

ECONOMICAL INSTALLATIONS IN VILLAGES.

BY B. C. H. J.

It is likely that the end of the tether will shortly be reached as regards the profitable supply of electricity to towns and villages other than those which now have installations of their own or are within a power company's area of supply—that is, if the same conditions of plant and working are observed, and no sweeping invention occurs. Under the conditions prevalent in present practice, there is too little chance of paying interest even upon capital expended to make the enterprise worth the risk. But there are plenty of small towns, and even hamlets, where a revised arrangement of present-day practice would result in profit to all concerned; and the gist of the method proposed by the writer is electricity (1) generated as a joint product, and (2) distributed on simpler lines.

As regards the first clause, there are various methods open. In most small towns and villages there are factories of some description which have steam plant that is worked only during the day, and usually intermittently during that period. In some cases where the factory is lit and worked by electricity, there is practically nothing more to be done to start the concern than to set up a separate switchboard and to lay the mains. The building, boilers, engines, and dynamos are all there, and can be added to as results direct. This is an exceptional instance, of course, but take the more usual case of a factory run by shafting, and lit by gas. Here the building, boilers, and engines are provided, and a dynamo, switchboard, and perhaps cells, would have to be installed, the cost of these latter being but a small proportion of the former. The attendance bill also would also be reduced, as the engine-man at the mill would bear a hand, at an increased wage of course, and with the system of mains to be described, nothing could happen outside that could not be seen and rectified without using specially skilled labour. In the event of half a dozen or more of these joint installations being within reasonable distance of one another, a skilled man could be engaged to pay weekly visits of inspection, or to be called upon in case of accident.

Now as to the mains: time-honoured custom must be put upon one side for economical first cost. Whatever may be done with the feeders in the way of laying underground in conduits or troughs, or armoured direct, the writer recommends for the distributors bare hard-drawn copper wires slung to glass (as being stronger than porcelain) insulators upon wooden cross-arms supported by ordinary scaffold poles, about 18ft. long and fixed about 150ft. apart. This is an easily installed system, cheap in upkeep, and offering facilities for altering the sectional area of the conductors with a minimum of expense. Thus in putting up these mains there is no need to lock up more capital than will be earning money: a size of wire can be erected just suitable for current requirements. Should an unlooked-for increase in demand take place, then another wire could be slung up alongside the original one or the latter replaced by a thicker wire. The current in the distributors of such small towns as would perforce have to use this method would not require abnormally heavy wires, but if much current was required, then it would pay to put down proper underground mains. Services from the overhead wires would present no difficulty, and besides being cheap on account of the absence of excavating and joint-box, would be open to inspection, and likely to make the local professor of jointing more particular than where his joints were covered in and left, until the blown fuse should reveal the lack of filling compound or the fitting out of place. With this method the problem of cheaply lighting thoroughfares would be a simple one, by means of a bracket on each post, and a push-and-pull switch at the usual lamplighting height; watertight holders being, of course, a necessity.

The beauty of this arrangement, from the point of view of the cautious business man, largely consists in the diminution of risk. Should, by reason of any unthought-of contingency, the enterprise come to grief, there is little that need be wasted. Dynamos and switchboards are saleable second-hand commodities if properly advertised, and the overhead mains can be easily reeled up again on to drums and will fetch about 60 per cent. of their original value as scrap copper. The poles, too, are marketable wherever there is a house decorator's business.

Now, if a station is set up with underground mains throughout there is much larger amount of capital to pay interest upon, that must be absolutely unremunerative; for it is impossible to exactly calculate the demand of a district, or even a street, beforehand; and, if unsuccessful, the buried cables or conduits would cost as much as they were worth to exhume. The buildings would also be of little value if a separate station was built and came to grief.

To an ambitious promoter content to start in a small way, this beginning would probably pave the way to the establishment of other factories and of forcing houses for horticultural plants, light railways, and at the proper time, no doubt, a more orthodox central station could be erected to cope with the demand created.

It is likely that this class of work will be more prominent in the near future, if only promoters can avoid running up against consulting engineers of the class that thinks firstly of the 5 per cent. commission; secondly, of the advertisement to themselves of a gilt-edged central station with fancy machinery specially built to specification—and ninthly, of whether the concern will ever pay. There may then be better times coming for the fittings manufacturers and installation contractors of this country, and eventually more demand for generators and cables.

FORMERS AND FORMER-WINDING.

BY F. W. DAVIES.

(Continued from page 658.)

II. Formers for Field-Magnet Coils.

The formers for field-magnet coils not being used to any great extent, it is unnecessary to devote much time to a description and consideration of them. The expedient of winding the coils of a field magnet on a former is one that was thought of and put into practice at a comparatively early date. To devise a suitable former for field-magnet winding is a matter presenting but little difficulty. The principal point requiring attention is the method of removing the former from the coil when wound. The simplest former (which is also the most inefficient) consists of a plain block of hard wood of slightly larger section than the magnet core. It must be made larger in order to allow for the insulation. On this block, which is placed between centres for winding, the coils are wound. Owing to the difficulty of keeping the wire in its place at the end of the coil during the process of winding, and especially when removing the former from the coil, each layer has usually

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two turns of wire less than the preceding layer, and sometimes four turns less. Such a method of winding is known as a "step" or coned winding, owing to the coned appearance presented at the ends of a coil wound on this method (Fig. 1). To avoid any possibility of the coil becoming disintegrated, four or more lengths of strong cotton tape are laid on the former before commencing to wind; and when the coil is wound these are brought over the ends and inserted under two or three turns of wire on the outer layer, as shown in the figure. One *supposed* advantage of the "step" winding is that coils wound in this fashion keep cooler, owing to the slightly greater cooling surface which this winding presents; but in practice this slight increase of cooling surface is quite negligible.

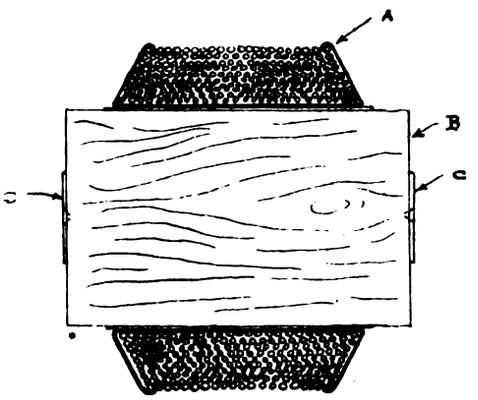
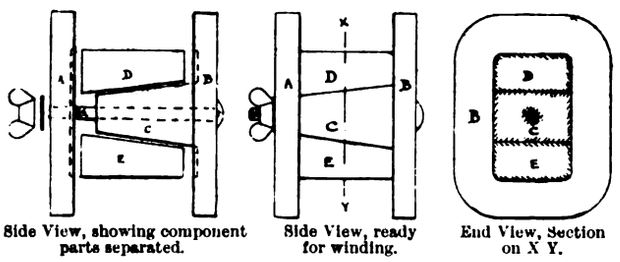


FIG. 1.—Section through Magnet Coil, wound on Simple Block Former. (A, coil; B, former; C, metal plates drilled in the middle for centres.)

The simple block former just described is now practically obsolete, on account of the great difficulty there is in withdrawing it from a coil after winding. To facilitate its withdrawal from the coil, the former should be made of several wedge-shaped sections. There are various methods of constructing such a former, but it is not necessary to enumerate and describe them all, as the differences in them are very slight. A good former of simple construction is shown in Fig. 2. In one view it is shown with the component parts separated from one another, while the other two views represent the former built up ready for use. To remove the former from a coil, unscrew the wing-nut and remove the left-hand flange, A. Then withdraw the wedge, C (to which the right-hand flange, B, is permanently fastened). This done, the loose pieces, D and E, can easily be removed from the coil. A former of this description



Side View, showing component parts separated. Side View, ready for winding. End View, Section on X Y.

FIG. 2.—Divided Block Former (A and B, flanges; C, wedge fixed permanently to flange B; D and E, removable wedge-shaped blocks.)

can be removed from a tightly-wound coil with the greatest ease, and on this account it is immeasurably superior to the simple block former. In this case, also, it is well to bind the coil together with a few pieces of strong cotton tape in the same manner as for a "step"-wound coil. It would be quite possible to wind a coil on the divided block former shown in Fig. 2 with a "step" winding; but, as has already been pointed out, the advantage gained thereby would be extremely slight. Besides this, there are fewer turns of wire on a coil so wound than there are when the coil is butt-ended. It is usual to insulate the coils by binding them all over with cotton tape (Fig. 3), after which they are "served" with insulating varnish. By this means, the possibility of any of the turns of wire in the coil becoming loose is avoided, and it, moreover, gives the coil a neat and compact appearance. Before beginning to wind a coil a layer of stiff paper (preferably with a glazed surface) should be wrapped round the former in order to prevent the wire from making grooves in the wood; for the formation of such grooves makes its withdrawal a difficult operation. The finer the wire with which it is wound, the more paper should there be put on, as with fine wire the coils contract to quite an appreciable extent when taken off the former, especially at the corners.

For bipolar field magnets of the horseshoe type, the use of former-wound coils is not advisable, as they are very liable to damage on account of their exposed position. They are eminently suitable for the field magnets of motors of the protected and enclosed types. There is no reason why they should not be more extensively used for dynamo field magnets when these are of the "iron-clad"

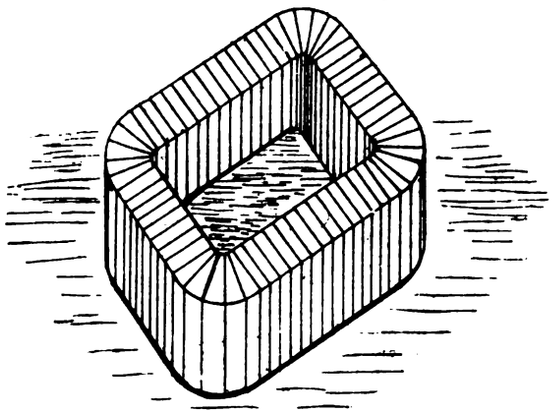


FIG. 3.—Perspective View of Field Magnet Coil. (Taped all over.)

type, as in this type of magnet the yoke usually overhangs the coils to some little distance, and thus forms an adequate protection for them.

When either a simple shunt or series winding is used for the magnet coils, no special difficulties present themselves; but when the coils are compound wound the case is not so simple. The problem which then presents itself is to find the most advantageous arrangement of series and shunt coils. If the series coils are wound on the top of the shunt coils, there will be a danger of the latter being damaged by the heavier wire or strip used for the series coils.

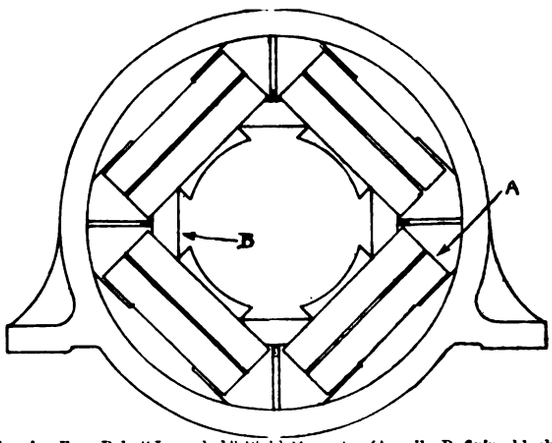


FIG. 4.—Four-Pole "Iron-clad" Field Magnet. (A, coil; B, fixing block.)

On the other hand, if the series coils are put on first, the arrangement is not a convenient one for bringing out the ends of the series winding. The best plan appears to be to place the series and shunt coils (which should be wound independently) alongside one another on the core. It is immaterial in what relative position they are placed—that is to say, it does not matter whether the series or shunt coils are placed the nearer to the pole-pieces.

That the field-magnet cores should be cast with the yoke is obviously desirable from the manufacturer's point of view. But it is not always possible to get the coils on when this is done, especially in four-pole machines, as the distance between the tips of adjacent pole-pieces is frequently very limited. In order to be able to get the coils on in the case of a four-pole machine, two of the cores, or more often all four of them, are by many makers cast separately from the yoke, and then bolted on to it after the coils have been placed in position. The expense

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of doing this can be avoided by the simple expedient of winding each coil in sections—that is, by using, instead of one long coil, two short coils, each of one-half the length; or three short coils, each of one-third the length. It is then a simple matter to get them in place on the cores. In actual practice it will usually be found sufficient to wind each coil in *two* sections. A four-pole "iron-clad" magnet with the coils wound thus is shown in Fig. 4.

When the cores are cast with the yoke it is necessary to adopt some means of keeping the coils in position, as the pole-pieces are of necessity not enlarged like they are when the cores are cast separately. There are various methods of fixing the coils in position. Perhaps the best method—certainly the cheapest—is that shown in Fig. 4. A number of blocks of hard-wood or other suitable material (the number being, of course, the same as the number of poles) of a section similar to that shown, and about as long as the polar face (measured parallel to the shaft), effectually keep the coils in position. The blocks are fixed by means of small screws or bolts passing through the yoke of the magnet.

(To be continued.)

ELECTRIC TRACTION PROGRESS.*

BY PHILIP DAWSON.

The real advent of electric traction in England may be said to date back to the opening of the Bristol line in 1895. The Bristol electric tramways, although not by any means the first opened, was the first electric line which was commercially successful from the beginning. Since that date enormous progress has been made, so that at the present day there are 85 electric tramways and railways in actual operation, while there are over 100 tramways and light railways under construction or conversion, which are intended to be worked electrically. The following figures give a very good idea of the state of things at the present day:

ELECTRIC TRAMWAYS AND RAILWAYS IN THE UNITED KINGDOM.

	Route mileage.	Track mileage.	Number of cars.
Constructed (approximate)	800	1,300	4,000
Under construction	600	900	800
Authorised and about to be constructed	1,000	1,400	—
Total	2,400	3,600	4,800

I have compiled a series of tables which I thought would be of interest to you, and would give you an idea of the cost of installation and operation, as well as of the probable results which may be expected. There is no time to read through these figures to you, but from the printed copies which I have here you will be able to study them at your leisure. I have also compiled some figures showing the enormous increase of traffic which takes place when electric traction is introduced and the rapid growth of electric traction. This system is no longer in its infancy, and it has not only been applied with remarkable success in the United States and on the Continent of Europe, but it has within the last six years found great favour in our country, and the importance which it has attained may be gauged by the capital which has already been invested in it.

In 1896 the total capital invested in electric undertakings in this country was about £6,000,000. No corporation had at that time invested any money in that branch. At the end of last year the total capital invested by private companies exceeded £40,000,000, and municipalities had invested over £11,000,000, making a total investment of over £51,000,000. The schemes of power distribution may, for our purposes, be also counted in, as a large number of them will undoubtedly supply electric current for traction purposes. The capital which has already been raised for such undertakings amounts to nearly £20,000,000. If we take into consideration the new tube railways, and the conversion of the Metropolitan and District Railway to electric traction, which that successful American financier, Mr. Yerkes, has now in hand, we shall have to add another £20,000,000; it will thus be seen that, taking all the power distribution and traction schemes which are now either completed or under construction, the total amount of money invested reaches nearly £100,000,000. Taking the capital expended on electric light undertakings, we find that the municipalities have spent, in round figures, £16,000,000 and private companies £28,000,000. It will be seen from these figures that the subject which I am considering to-night is therefore a very important one. The enormous increase of electric traction in the United States is remarkable; thus, while in 1894, of the total tramway systems in America, amounting to nearly 13,000 miles, 9,000 miles were operated electrically. At the present moment over 20,000 miles are operated electrically, and approximately 60,000 cars are in circulation.

The total station capacity in kilowatts installed for lighting and traction purposes in the United Kingdom amounts to above 500,000 kw., and that at present being installed in the neighbourhood of 150,000 more. The total station capacity installed in London for all purposes is not much over 100,000 kw. This sounds a great deal, but if we compare these figures to those of New York City, we find that New York has nearly 250,000 kw. You may be interested to have some figures showing what surface lines or tramways have done in other towns. Taking New York City

* Paper read at Northampton before the Tramways Committee and others.

TABLE I.—New York City Surface Lines (from *Street Railway Journal*).—Population, 3,370,000.

—	1901.	1900.	1899.	1898.
Miles of track	963	952	930	914
Passengers carried	871,799,558	816,661,361	753,740,052	679,967,283
Car miles operated	110,557,911	112,361,704	112,671,413	105,797,835
Car miles per mile of track	114,800	118,000	121,100	115,800
Passengers carried per mile of track	905,000	858,000	810,000	744,000
Number of times population carried	260	240	220	200

TABLE II.—Growth of Passenger Traffic on New York Surface Lines. Approximate.

1890	224,000,000	
1891	238,000,000	
1892	268,000,000	Period of changing motive power and consolidation of lines.
1893	265,000,000	
1894	263,000,000	
1895	263,000,000	
1896	320,000,000	
1897	386,000,000	
1898	400,000,000	
1899	465,000,000	
1900	559,000,000	

TABLE III.—Approximate Capitalisation of Electric Tramways.

Name.	Population.	Miles of route.	Capitalisation — Total.	Capitalisation — Per mile of route.
Birkenhead	110,926	11	112,000	10,000
Blackburn	137,000	4	225,000	56,000
Blackpool and Fleetwood	—	9	190,000	21,000
Bradford	279,767	25	338,000	14,000
Bristol	321,908	28½	960,000	34,000
Coventry	73,000	10½	130,000	12,000
Dover	44,000	3½	38,000	11,000
Dublin United	252,239	45	1,715,000	38,000
Glasgow	762,000	20	1,681,000	84,000
Halifax	106,000	13½	117,000	9,000
Huddersfield	95,000	20	266,000	13,000
Hull	240,620	9½	270,000	28,000
Leeds	428,953	25	217,000	9,000
Liverpool	684,947	66	1,084,000	16,000
London United	—	13	494,000	38,000
Manchester	543,969	75	900,000	12,000
Norwich	111,728	14·4	330,000	23,000
Portsmouth	189,160	15	602,000	40,000
Sheffield	400,000	18	233,000	13,000
Central London	—	6·5	3,550,000	546,000
City and South London	—	6·0	2,081,000	347,000
Liverpool Overhead	—	2·5	790,000	318,000

TABLE IV.—Approximate Cost of Various Parts of Electric Traction System.

Approximate Cost of Modern Power Plant per Kilowatt Installed.

Buildings	£4 0 0 to £16 0
Boilers	2 0 0 ,, 5 0
Steam and water piping and feed pumps	0 12 0 ,, 3 0
Steam-engines and condensers	3 0 0 ,, 11 0
Dynamos and switchboards	2 10 0 ,, 12 0 0

Total cost of power plant, not including buildings, £25 to £35.

Approximate Cost of Rolling-Stock.

Maximum traction trucks per set	£130
Ordinary bogie trucks per set	125
Standard four-wheel truck	70
Extra long truck	75
Double-deck car bodies	£220 to 300
Single-deck car bodies	210 ,, 265
Double-motor equipment, including resistances and controllers	260 ,, 320
Single-car motor, 15-50 h.p.	75 ,, 120

Cost of Track Laying.

Cost per mile of single track, 4ft. 8½in. gauge, 100lb. rails, wood or granite paving, including necessary electrical bonding	£5,500 to £6,500

Overhead Work.

Cost per mile, three-section tubular poles, standard brackets, 1/0 trolley wire.

Double trolley wire on side brackets	£1,100—1,400
,, ,, span wire	1,700—2,000
,, ,, centre brackets	1,300—1,500
Single trolley wire, side brackets	1,000—1,200
,, ,, span wire	1,600—1,800

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TABLE V.

Name.	Population.	Miles of route.	Passengers carried.	Passengers carried per mile of route.	No. of times pop. was carried.	Total receipts.	Receipts per cap.	Receipts per mile of route.	Receipts per car mile.	Average fare per passenger.	Ratio of expenses to receipts.	Total expenses.
						£	s.	£	d.	d.	Per cent.	£
Bristol	329,000	28	26,972,000	960,000	82	165,115	10	5,900	—	1·47	67	110,795
Cork	75,000	10	5,137,000	514,000	68	21,875	6	2,200	7·2	1·02	63	13,840
Dover	42,000	3	2,710,000	903,000	65	11,141	5	3,700	10·0	·98	85	7,997
Dublin United	252,000	45	45,165,000	1,000,000	180	241,825	19	5,400	—	1·28	67	161,692
Halifax	106,000	13·5	9,430,000	700,000	89	39,383	7	2,900	13·3	1·00	77	30,273
Hartlepool	23,000	5·0	2,130,000	426,000	93	12,266	11	2,400	—	1·38	62	7,557
Hull	241,000	9½	19,350,000	2,040,000	80	80,118	7	8,400	10·5	·99	49	39,754
Leeds	429,000	25	39,240,000	1,570,000	92	183,199	9	7,300	12·6	1·12	61	121,402
Liverpool	685,000	66	93,768,000	1,420,000	137	455,530	13	6,900	12·2	1·16	73	330,073
Middlesbro'-Stockton.	—	9	8,783,000	976,000	—	47,219	—	5,200	—	1·29	69	32,581
Norwich	112,000	14·4	7,816,000	542,000	70	36,376	6	2,500	9·4	1·11	62	22,463
Blackpool	47,000	9·5	4,912,000	517,000	104	33,060	14	3,500	15·0	1·62	59	19,535

with a population of 3,370,000, we find that the tramways carry the total population 260 times every year. For more details, and to show the rapid increase in traffic due to the electrification of the New York line, I would refer you to Tables I. and II., from which you will see that within the last five years the traffic has more than doubled. Taking into consideration the elevated roads and the various outlying districts which make up greater New York, we have a population of, in round figures, 3,500,000, and the tramway and elevated railway system carry 1,200 million passengers per annum, or, in other words, the total population of New York is carried once a day. Comparing these figures to what is obtained in London, we find that the tramway omnibuses and metropolitan lines only carry from 60 to 70 per cent. of the population of greater London every day, from which it is evident that the inhabitants of London do not move about as much as those of New York. This may possibly be attributed to the difference of temperament, and the different mode of conducting business. The total length of the London tramway system is in round figures 140 miles. A very important point, and one which has to be considered when comparing financial results obtained in England and America, is the average fare per passenger carried. From careful investigations which have been made, and from the figures given by Mr. James Dredge in an article of his which appeared in the March number of a journal called *Traction and Transmission*, it appears that the average amount paid per passenger on the different London transit systems is approximately 1½d., whereas in New York there is a uniform fare of 5 cents, or 2½d. It is evident from this that lines which would pay very well in America might not pay in England. Besides this fact, there is another one which has to be considered—viz., that the difference between the income and the actual expenses incurred by the working population of this country is a much smaller quantity than that which is at the disposal of the American workman, and that it is, therefore, probable that whilst the American will travel on an electric car for a very short distance, and whenever he gets a chance, the English workman will only travel when he is forced to do so.

It may be interesting to you to examine the probable costs of electric installation, and for this purpose I have prepared some tables, from which I will give some extracts. It will be evident, from a glance at Table III., that there is a very large variation of the capitalisation per mile of route. It is also evident that the smaller the system the less will be the cost per mile of route, provided the general conditions are favourable. It will be seen that the total expenditure varies from a minimum of £9,000 per mile of route in the case of Leeds and Halifax to respectively £56,000 and £84,000 in the case of Blackburn and Glasgow. As regards main lines, railways, such as the Liverpool Overhead and the London Tube, the capital expenditure must be very much heavier, and has reached, in the case of the Central London Railway, over half a million per mile of route. It may be stated that for estimating purposes the very best system, including power station, track, car, overhead work, feeders, etc., should be installed for from £15,000 to £20,000 per mile of route.

It may interest you to have an idea of how this total cost is made up, and for this purpose I have made out Table IV., from which you will see that the total cost of the power station can be safely taken at £30 per kilowatt installed, and that as regards the motorcars, a figure of £750 is a safe one to estimate on. For the permanent way with standard gauge and for heavy rails, such as are now nearly always adopted, £6,000 per mile of single track should be allowed. As regards the overhead construction, a figure of from £1,500 to £2,000 per mile of route is a safe one to estimate on. It must, however, be pointed out that all these figures can be used for roughly approximating costs and preliminary estimates only, as the conditions that obtain may considerably influence the total cost. It is only by a traction expert examining these conditions in the light of his experience that a real idea of the total capital which will eventually have to be expended can be obtained.

In investigating the question of how much money can be properly invested, it is necessary to ascertain the probable receipts and expenditure, and for this purpose I have prepared Table V. It will be seen that the population, in the cases given, is carried from 65 to 180 times a year. The receipts per head of population vary in the figures I give between 5s and 19s. per head. It will be seen that the receipts per mile of route vary between £2,200 and £7,300. The average fare per passenger varies from ·98d. to 1·62d., and the ratio of operating expenses to receipts from 49 per cent. to 85 per cent. I give, in Table VI., some figures for electric systems in the North of France, and it shows the rapid increase in traffic, and the decrease in ratio of expenses to receipts. Table VII. gives the increase of passengers carried in the case of some British electric tramways. It will be seen, for instance, that in the case of the Dover electric tramways, the passengers have more than trebled within the last three years. In this connection the figures as regards the city of Berlin, with a population of 1,810,000, may be of interest. The tramways, which have now been converted entirely to electric traction, carried 188,000,000 passengers in 1899, as against 306,000,000 in 1901.

TABLE VI.—Roubaix-Tourcoing Electric Tramways.

Increase in passengers carried.

1897	4,484,025
1898	4,763,980
1899	5,365,500
1900	7,120,420

30 km. of route at end of December, 1900.

Ratio of expenses to receipts.

1895	65 per cent.
1896	58 ,,
1897	56 ,,
1898	54·8 ,,
1899	53·5 ,,
1900	54·6 ,,

Population, 204,000.

TABLE VII.

—	Passengers carried per annum.			Miles of route open.		
	1898.	1899.	1900.	1898.	1899	1900.
Blackpool Cor.	2,279,209	2,881,027	3,421,736	4	4	6
Blackpool and Fleetwood	Opened July	1,782,683	1,831,531	—	8	8
Cork	,, Dec.	4,744,528	5,137,141	—	8·25	9
Dover	787,745	2,170,590	2,437,863	3½	4½	4½
Halifax	Opened June	2,594,478	7,308,998	—	6·33	11·125
Leeds	15,620,985	24,237,440	27,634,105	21·75	23	26
Liverpool	Opened Nov.	63,771,450	82,367,958	—	78	82

TABLE VIII.

Name.	Max. grade.	Average Board of Trade units per car mile.	Average speed miles per hour.	Pounds of coal per car mile.
Aix-la-Chapelle	1 in 11	·589 to 1·236	8	3·5 to 6·9
Hamburg	—	·902	6 to 12	3·21
Brussels—La Petite Espinette	1 in 25	1·2 (heavy cars)	16	4·6 to 4·9
Glasgow	1 in 14	1·370	6	8
Bristol	1 in 15	1·000	8	7

TABLE IX.—German Power Stations.

Name.	Mean grade.	Number of motor-cars.	Number of trial cars.	Total capacity in kilowatts of station.	Battery capacity in ampere-hours.	Total station capacity per kilowatt, including motorcar.	Total power, including spares per mile of single track.	Capacity of cells in ampere-hours per motorcar.
Bochum	1·20	32	32	400	165	9·3	12	4·1
Dortmund	1·25	36	32	375	264	8	28	5·5
Plauen	1·20	13	—	144	100	11	32	7·7
Horder	1·14	30	15	300	277	8·5	25	8
Coblentz	—	29	—	300	—	10·4	—	—

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TABLE X.

Name.	Total station capacity, kilowatts.	Total track length	No. of motor cars.	Total station capacity— Per mile of track.	Per motor-car.
Bristol	2,000	52	200	38	10
Dover	200	4·5	16	44	12
Dublin United	3,000	74	240	40	12·5
Halifax	600	15·25	42	39·4	14
Liverpool	7,200	114	441	63·2	16·3
London United	3,000	26	150	77	13·3

TABLE XI.—Influence of Load Factor on Cost of Generation. Station of at least 2,000 kw. capacity.

Load factor. Per cent.	Cost per unit generated.— Fuel at 10s. per ton.	Total.
10	·6	1·0
15	·5	·78
20	·4	·56
25	·35	·45
30	·32	·4
35	·3	·35
40	·26	·33
45	·25	·3
50	·24	·28
60	·22	·25
70	·19	·24
90	·16	·23

These costs do not include interest and sinking fund, but they do include maintenance and repairs in the generating station.

Load Factors Usually Obtained.	Per cent.
Ordinary town lighting, with no motor load	10
Lighting goods yards and railway lighting generally	15—20
Cotton mills and ordinary engineering works, working in daytime only	25—30
Ditto, working double shifts	35—45
Coal-mines under favourable circumstances	40
Traction	15—30

TABLE XII.—Rates Charged to Ordinary Consumers by the Cataract Power and Conduit Company.

1,000 units or less per month			1	per unit.
1,000 units up to	2,000 units per month		0·75	,,
2,000 ,,	3,000 ,,	,,	0·60	,,
3,000 ,,	5,000 ,,	,,	0·50	,,
5,000 ,,	10,000 ,,	,,	0·40	,,
10,000 ,,	20,000 ,,	,,	0·375	,,
20,000 ,,	40,000	,,	0·35	,,
40,000 ,,	80,000	,,	0·33	,,
80,000 ,,	200,000	,,	0·32	,,

TABLE XIII.—Prices paid by Tramways for Electric Power.

Supplying station.	Tramway.
Blackburn, 1·5d.	Blackburn Corporation.
Plymouth, 2·3d.	Plymouth Corporation.
Ashton-under-Lyne, 4·5d.	Oldham, Ashton, and Hyde.
Cheltenham, 2·0d.	Cheltenham Tramway Co.
Hamburg Lighting Co., 1·0d.	Hamburg Tramway Co.
Geneva Corporation, 1·0d.	Geneva Tramway Co.

TABLE XIV.—Leeds Corporation Electric Tramways. Year ended March 25.

	1900.	1901.
Total electric car receipts	£63,436 10 5	£133,449 11 5
Total car mileage	1,205,812	2,506,655
Receipts per car mile	12·62d.	12·77d.
Working expenses per car mile	5·97d.	6·49d.
Ratio of expenses to receipts	47·3 per cent.	50·8 per cent.
Cost of generation per B.T. unit	·82d.	·67d.
Total units generated	1,095,231	2,452,741
Supplied to arc lamps, shed lighting, etc.	59,682	190,251
	1,035,549	2,262,490

To give you an idea of the total amount of power which will have to installed, I have compiled Tables VIII., IX., and X. From Table VIII. the amount of power per car mile run can be ascertained. I may state here that, for rough estimating purposes, it is safe to take one Board of Trade unit per car mile for the conditions which generally obtain in this country. Tables IX. and X. show the amount of power installed in various German and British stations per motorcar operated, and per mile of route. For rough estimating purposes, it may fairly be said that approximately 10 kw. per car operated should, under normal conditions, prove sufficient.

The question of laying down a proper power station which will economically supply electricity for traction purposes is a very important one, and as the conditions that obtain in traction are entirely different from those which are met with in lighting work, a station eminently well designed for lighting purposes will generally be uneconomical for traction work. Electricity has been used commercially for lighting during the last 20 years, but the amount of power used for generating purposes would not be excessive, even if electric light were to supersede all other methods of illumination. The hours during which light is required every day are restricted, and the generating plant has to be idle the greater portion of the 24 hours, hence, even with the most careful study of the conditions that obtain, it is generally impossible to lay down a purely lighting plant which can produce electricity at all economically. The load on a station used only for lighting is very uneven, increasing from an insignificant amount most of the day to a very heavy demand for a few hours in the evening. Furthermore, the demand in winter and in summer is very different. and the maximum load in winter may attain proportions necessitating a plant which will lie idle most of the year. These conditions call for a large number of units of varying sizes, and it is often essential to have as small a first outlay as possible, as no economy in working can make up for the loss due to the capital which lies unproductive for relatively long periods, and for the waste due to maintaining steam and keeping the engines hot. This accounts for the heavy price which we have to pay for our electric lighting.

The extensions in the uses of electricity have naturally influenced the design of the power-house. Electric light was the first comer, and the plants laid down were as far as possible designed to fulfil the special conditions required in lighting. Thus, up till quite recently, with the exception of those who, like myself, have grown up with electric traction, practically all electrical engineers who were not telegraph men were lighting engineers. When electric traction began to come into use many stations were consequently designed as though intended for lighting. Indeed, it was not till electric tramways had been in operation some time that it was discovered by costly experience that what was right for electric lighting was out of place in traction work. A few moments' consideration will show that this result was inevitable by reason of the widely different demands. An electric lighting station, as we have seen, only works for a comparatively short time every day, and the load, though varying, is more or less steady. On the other hand, a traction plant works nearly continuously, and the load is scarcely ever steady for two consecutive minutes, due to cars starting and stopping. It is not an infrequent occurrence for a considerable number of cars to start simultaneously, thus putting a heavy overload on the generating units. The capital expenditure in the case of a traction installation is much greater than in the case of a lighting plant, and the long hours of working render the question of labour and fuel consumption of the very first importance. The practice is now coming in of designing stations to supply power for all purposes. When this is done at the commencement a very good station can be obtained, but where existing lighting stations are utilised the results are generally far from satisfactory. This appears to have been generally admitted, and except when a new station designed for traction and lighting work was being laid down, special plants have been put down. As examples I may give Glasgow, Leeds, Newport, etc. In the case where an old lighting station exists and power is required for traction work, in nine cases out of ten there is but one thing to do, and that is, to instal an entirely new plant, with the possible exception of boilers, for the traction work. This method may appear drastic, but it is the most economical in the end. The whole question of cheap power supply depends upon the station being properly laid out, so as to adequately fulfil the conditions required, and to secure as good a load factor as possible. It may be well to state here that by load factor is understood the ratio of the actual Board of Trade units measured at the switchboard in the power station to the amount which would be generated if the plant ran continuously at the maximum load which it is at any time called upon for. I have prepared Table XI. from an article which I have written for *Traction and Transmission* on the important question of the standardisation of power stations, and it will be seen from this table how much importance attaches to getting a high load factor.

It is evident that a lighting load by itself can under no conditions be favourable to a good load factor. It need hardly be pointed out that before proceeding to lay down the station the question of what load factor can be secured should be most thoroughly investigated.

It has been assumed by many that where free water power is available electrical energy can be generated very cheaply; this, however, is not always the case, as the capital required to harness the water power is often so great as to more than outweigh the saving in cost of production. Thus the electrical energy generated at Rheinfelden, at Zürich, and according to Mr. Kearshaw, even at Buffalo, costs more than it would if generated in the coalfields of England in large central stations by steam power. In the case of Zürich, the city engineer stated to me that notwithstanding the high cost of fuel (30fr. to 35fr. a ton), the only way to cheapen the cost of production was to increase the steam plant, which at the present moment generates electrical energy approximately at five-eighths what it costs to do it by water power. In this connection I have inserted a table of the price of selling electrical energy at Buffalo, as supplied from Niagara—it will be seen here that for amounts exceeding 80,000 units per annum the price charged is less than one-third; when we compare this to Table XIII., which gives some of the prices charged for electrical energy for traction purposes, it is remarkable that, under the high rates charged for electrical energy, electric tramways should be able to exist, except where they generate their own supply of power. Table XIV. gives some very interesting results of the Leeds tramways; it will be seen that the cost of power, which does not include sinking fund or interest, is very low, and that the results generally obtained are most satisfactory.

TRACTION SYSTEMS.

If we neglect the method of working tramcars by means of accumulators carried on the car itself, and which has been abandoned, there are three methods of operating an electric tramway all similar, in that current is generated at a central station and picked up by cars from a charged conductor. These systems of traction are known as: (*a*) the surface-contact system; (*b*) the underground conduit system; (*c*) the overhead trolley system.

Of the above, the last two are really the only practical methods in

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existence: (*a*) In the surface-contact system a number of contact studs are laid in the track, each stud containing a switch by means of which it can be connected to the feeders leading from the generating station. The switches are designed to be only operated when the car is over them, this being done by an automatic device of which there are several varieties. Most of them are based upon the action of an electromagnet. When the stud is not covered by the car the connection between the stud and the feeder is broken, and the stud is dead and harmless. The car picks up the current from the stud by means of a slipper, which is made rather longer than the distance between the studs, so as to always make contact with one of them. This system, while perfectly correct theoretically, cannot be said to have been a success commercially. In Paris, a number of miles of track were equipped on this principle, but this system was found to be a complete failure. At present most of the lines in question are being converted to the overhead trolley system. There is only one example of the surface-contact system in England, and that is the experimental line which has just been put in by the Lorain Steel Company at Wolverhampton. The chief objections to the system are: (1) There is always a possibility that one of the automatic switches may fail to act, with the result that a stud will be left energised after the car has passed. (2) The studs must project to a certain distance above the level of the road, or else the collector on the car will not make contact without rubbing on the road; hence the studs must always offer some obstruction to ordinary traffic. (3) There is considerable loss through leakage from the studs. Practically the only thing that can be said in its favour is it obviates the necessity of overhead wires, with their possible dangers, without the terrible expense which is entailed by the construction of an underground conduit.

(*b*) In the underground conduit or slot system a conduit is constructed under the whole length of track, which conduit contains the charged conductors from which the car collects current. Communication between the car and the interior of the conduit is established through a narrow slot in the roof of the latter, which permits the collector carried by the car to move along the conduit, and thereby making rubbing contact with the conductors. The conduit can be constructed with a separate slot rail in the centre of the track, or under one of the track rails, which combines the offices of slot rails and track rail. The objection to this latter method is the difficulty experienced at points and crossings. This difficulty can, however, be overcome by deflecting the conduit to the centre of the track when points or crossings are encountered. The chief qualities required of a conduit are that it should have ample strength to resist any tendency of the slot to close, and that it should be easily cleaned out. The chief objection to the conduit system is its very heavy first cost, and the amount of disturbance caused to ordinary traffic by excavations which are necessary when building it. In the case of the conduit of the Metropolitan Street Railway of New York, the cost of construction came out at about £30,000 per mile of track. With conduits special work is very expensive, not only in first cost, but in repairs and maintenance owing to the additional number of slot points and crossings. The principal advantages of the system are: (1) an insulated return can be used, and the use of the track rails for this purpose dispensed with, thus avoiding bonding and any possibility of electrolysis; (2) it is not necessary to have overhead trolley wires, and thus any danger from their presence is done away with. The system is a thoroughly sound one, and has operated with perfect success commercially in several cities in the United States and Continent.

(*c*) The overhead trolley system is the one which is almost universally used for tramways and light railways, and it is very doubtful if engineers would ever instal any other system, except under special circumstances. Where such has been the case, however, it will usually be found that the reason why the overhead system was not employed was because the city authorities would not grant permission to erect overhead wires. There are very few real objections which can be urged against this system. Many people object to the trolley wire on the ground of its appearance, but this is a matter which is generally remedied by use and familiarity; after a short time it is scarcely noticed. It lacks one advantage of the conduit system—viz., the insulated return circuit—and special care in the bonding of the track is consequently necessary. Of course, it would be quite possible to have an insulated return circuit overhead, but the additional trouble and expense of stringing double trolley wires would completely swamp any slight advantage which might be gained therefrom. The real objection to the overhead wire is that there is always a possibility, however slight, of its breakage and fall. This, however, is a most infrequent event, and there are numerous safety devices to prevent the possibility of any serious accident should such a thing happen. On the other hand, the system has considerable advantages. It is much cheaper than conduit construction, and putting down the line does not cause nearly such disturbance in the streets. All the insulators, etc., are visible and accessible, thus facilitating and cheapening repairs and maintenance. Electric traction is having a considerable influence on the value of land, and considerable areas which before the advent of electric traction were a drug in the market are now being covered with houses. The reason of this is that the rapid transit facilities afforded by the use of electricity enables people to live at considerably greater distances from their work than formerly, and bring the outlying suburbs into much closer touch with the centre of business. It is in this expansion which is thus rendered possible that we may look for a solution to the ever-present "housing" problem.

Advantages of Electric Traction.—In the present state of affairs horse traction is quite inadequate to satisfactorily cope with the demands of a public who require to be carried quickly and cheaply from one place to another. Horses are slow and expensive and unsanitary, besides occupying a considerable amount of space, of which there is generally none too much. They can neither start nor stop quickly, but waste a considerable amount of time in doing either, especially the former. Thus, some form of mechanical traction is absolutely imperative, and of all forms of mechanical traction, electricity possesses the most advantages and desirable qualities. It is silent, clean, rapid, and economical, and when starting from a standstill full speed can be reached in very short time. It is this quality of rapid acceleration which rendered electric traction so specially suited for its work. It is only on comparatively rare occasions that a tramcar has a straight unimpeded run on which it can go at the maximum speed allowable—generally it is constantly being slowed up by the rest of the traffic. Thus on a crowded road a horse tramcar very rarely, if ever, runs at anywhere near its maximum speed, for by reason of the constant stops it never has time to get up speed before it has to slow down again. On the other hand, an electric tramcar being able to get up speed with extreme rapidity, can take advantage of every opening which presents itself, and maintain a very fair average speed under extremely difficult conditions. At one time cable traction was considered a serious rival to electricity, but practical experience has proved the superiority of the latter system, except under most exceptional circumstances. Where cable traction fails is in its rigidity—if by any cause traffic is stopped and the cars get "bunched" together, it is practically impossible to separate them again, as a cable car cannot make up time like an electric car. Another disadvantage is that it is quite possible for any gripman by making a mistake at points or crossings to practically wreck the whole system, or anyhow throw it into confusion for some considerable period.

Every part of an electric tramway has received the most careful study by those who are interested in the subject, and at the present day there is absolutely nothing experimental about the whole subject. A very large amount of experience has been gained, and everything has been standardised, so that there need be no hesitation as to the results which will be obtained through the installation of the ordinary direct-current system. It cannot be urged too strongly the importance of using the best material in every branch of the system, and equipping the line in a thoroughly sound and solid manner. The increased capital expenditure is more than counterbalanced by the smoothness of working of the whole system and the freedom from accidents, breakdowns, and such like. The power plant especially should be most carefully designed, so that, in the event of extensions being required in the future, these can be made in a proper manner, so that the enlarged station will work economically and conveniently as a whole, and not, as is sometimes the case, as two separate stations side by side.

In conclusion, I would like to say a word upon traction on main-line railways. Until it may be satisfactorily proved that electric traction will reduce the working expenses, it is certain that no railway company will adopt it unless it is forced to. I do not personally believe that any of the high-speed railways which are proposed to-day can be financially successful for long-distance travelling—it is expense rather than time which will be the determining factor. If railway companies can greatly increase their traffic by increased speed, they can do so at once without adopting electric traction. Thus at the present moment the Pennsylvania Railway Company are running trains at a schedule speed of from 70 to 80 miles an hour for long distances with heavy trains. We are by no means near the limit of speed of locomotives in this country. Thus at the present moment in France, the Northern Railway runs a distance of 184 miles in 3 hours and 10 minutes, as compared to a distance of 183½ miles between London and Manchester run in 4 hours 10 minutes. Capital is easily obtained when a profit is assured. Long-distance electric traction is no doubt a fascinating subject, but should not be at the present moment considered practical. I am convinced that we are entirely unprepared at the present moment to undertake the electrification of main lines, and it has not been shown that it would pay if it were done, and we really do not know how to do it. Given all the schemes which have been so far suggested, there are such serious objections that it is not probable that anyone will be found hardy enough to carry them out. On urban and suburban lines the case is entirely different, as I have so often said. There the traffic is ready-made, awaiting greater facilities which electricity alone can furnish. Here there is knowledge and experience to point the way in which the work should be carried out.

TUBE BILLS IN PARLIAMENT.

LORD WINDSOR'S COMMITTEE.

FRIDAY, MAY 9.

The Select Committee of the House of Lords of which Lord Windsor is chairman, sat specially to consider the competing Piccadilly schemes and the allied North-East London lines.

Colonel Yorke, chief inspector of railways under the Board of Trade, said it had been suggested that the companies should be compelled to deposit with the Board of Trade, or with some public authority, plans showing exactly the line along which the railway had been constructed, and that those plans should be open to inspection so that property owners and others interested might have an opportunity of ascertaining where the line was placed. There was no statutory obligation on railway companies to deposit plans with the Board of Trade, though certain plans were deposited under an arrangement between the engineers of the companies and the Department. The Department suggested, therefore, that some such clauses as that contained in the Waterworks Clauses Act and the Gas Clauses Act should be inserted in these Bills, providing that plans should be kept at the office of the undertakers and that they should be open to all persons interested at all times.

Mr. Pember, K.C., on behalf of the London County Council and other opponents, said he should certainly agree to that suggestion.

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Continuing, **Colonel Yorke** said the attention of the Board of Trade had been drawn to the fact that on the Brompton and Piccadilly-circus line there was a curve of 3½ chains radius. Such a sharp curve would be regarded by him with considerable misgiving, and he should feel it his duty to take exception to it. Even if the radius were altered to 4½ chains, he should regard it as obligatory upon the Board of Trade to put a restriction on the speed of the train on passing over the curve. This would probably have an effect upon the train service run over the whole of the circuit. It seemed to him the tendency of the motorman would be to approach that curve at a higher rate of speed than was desirable. He thought a five-chain curve was the smallest curve that was advisable. If such a curve as 3½ chains were authorised he should consider it incumbent to advise the Board of Trade to limit the speed to 12 miles an hour, and to 13 or 14 miles an hour with a curve of 4½ chains. Then in the case of reverse curves there should be a length of straight line interposed between the two. As to the dimensions of the tube, the Board of Trade would insist on the larger tunnels only in those lines that were now taking parliamentary powers for the first time. He thought that a maximum size of tube might be fixed, up to which the companies might work, and beyond which they might not go. The shape of the tunnel might be left to the Board of Trade. It had been assumed hitherto that tubes must be invariably circular in section, but it had occurrred to him that there would be conveniences and advantages if they were constructed similarly to those of ordinary railway tunnels. There was nothing in the Bills before the committee to render it absolutely obligatory on the companies to make a circular tube.

Mr. Littler, K.C., on behalf of the Brompton and Piccadilly-circus Railway, said they were prepared to place themselves unreservedly in the hands of the Board of Trade as to construction and method of working.

The opposition to the proposed North-East London and City and North-East Suburban Railways was continued.

Mr. J. F. Gooday, general manager of the Great Eastern Railway, expressed the opinion that the proposals for these lines were quite impracticable financially. He estimated that the construction of the railways would take a net sum of £73,000 from the Great Eastern Company.

Mr. Grinling, traffic manager of the Great Northern Railway, said that the service of the Great Northern Railway, supplemented by the arrangements entered into with the Great Northern and Strand and the Great Northern and City underground railways, was sufficient for the needs of the districts to the north and north-east. The proposed railway would have to meet the competition of the North London, Great Eastern, and Great Northern Railways, and the tramways and light railways of the Middlesex County Council.

The committee adjourned.

MONDAY, MAY 12.

Further evidence was taken on the opposition to the North-East London and City and North-East Suburban Railways.

Mr. Dunn, general manager of the North London Railway, expressed the opinion that by the interchanges it was proposed to have between the North London Railway and the lines which had been authorised this session and in previous years, the traffic from the north to the west and east would be amply served. To pay 4 per cent. interest on its capital of £5,000,000, the proposed North-East London line would require to earn £432,713 per annum. This would necessitate the carrying of 151,334 passengers per day, which would involve the running of 631 trains with 240 passengers in each train. He believed it was absolutely impossible to obtain such an average.

Mr. Pember, K.C., then addressed the committee on behalf of the District Railway and the Great Eastern Railway Companies against the proposals of the combined companies for lines from Hammersmith on the west to Waltham Cross and Southgate on the east and of the Central London Railway. The problem was this: were the existing lines of the District Railway, plus their authorised deep-level line, the authorised Brompton and Piccadilly-circus line, and its proposed extensions to Charing Cross and Holborn with the lines of the Great Eastern and other existing line on the east and north-east of London, capable of doing all, or very nearly all, that the proposed rival lines would do? He suggested that the committee should sanction an additional expenditure of £2,404,000, which would be required to link up the authorised lines and complete the route he had sketched out, rather than the £7,000,000 which would be involved in the construction of a new railway from Hammersmith to the City.

Lord R. Cecil, K.C., next addressed the committee on behalf of Mr. Walker, of Southgate, in opposition to that portion of the proposed North-East London Railway which ran from Palmer's Green to Chase Side, Southgate.

The **Chairman** said the committee were agreed that they did not require to go further into the opposition to the bit of line between Palmer's Green and Chase Side, because, on the promoter's own case, they did not think the preamble of that portion of the Bill had been proved.

Sir A. Binnie, who was called by Mr. Frere, on behalf of the Tallow Chandlers' Hall, said he had been consulted upon this point, and he had come to the conclusion that, owing to the age of the Tallow Chandlers' Hall—it had been erected more than 150 years ago—and the nature of the foundations, there would be a considerable risk if the railway were constructed as proposed.

The committee here held a consultation, as a result of which

The **Chairman** said they were agreed that that part of the preamble of the City and North-East Suburban Railway Bill which related to the line running from Whitechapel to the Mansion House under the District Railway had not been proved. The committee wanted to know whether the northern portions of the proposed line would now be proceeded with.

Mr. Page, K.C., said the promoters would like to consider the matter, and he would inform their lordships of the decision arrived at next day.—The committee adjourned.

TUESDAY, MAY 13.

On the committee resuming their sittings, the **Chairman** announced that the committee did not consider it necessary to call for any opposition to the Bill of the Charing Cross, Hammersmith and District Electric Railway Company, as they did not consider the preamble proved.

Mr. Page, K.C., for the City and North-East Suburban Railway, said his clients had considered the declaration of the committee that the preamble of this Bill was not proved as far as it related to the construction of the line from Whitechapel to the Mansion House, and they had determined to proceed with the rest of their scheme to construct a line between Whitechapel and Waltham Cross. The promoters had every hope that next session powers would be given to them to construct some further railway bringing them to the heart of the City from Whitechapel.

Mr. Littler, K.C., hoped the committee would not listen to the suggestion that they should pass an imperfect scheme on the strength of something coming forward next session.

The **Chairman** said they would hear the opposition to the rest of the scheme.

Mr. Balfour Browne, K.C., for the Piccadilly and City combined companies, said the committee would remember that the relations between the Piccadilly and City Company and the City and North-East Suburban Company were so close that they had promised to find two-thirds of the capital for the line to Chingford. He desired to state that, truncated as it had become by their lordships' decision, they no longer regarded the line as part of their scheme.

Mr. Littler contended that this was now a scheme with no financial backing.

Viscount Knutsford remarked that the committee had not gone into the finance of the promoters except as part of a combined scheme.

Mr. Page said that, with regard to finance, it was obvious that their position had been changed very much by the committee's decision and Mr. Balfour Browne's statement. He would ask the committee to defer their decision on the question of finance, at any rate, until to-morrow.

The **Chairman** said the committee were agreed that, the promoters' case having been closed, they could not reopen it. They did not wish to call for further opposition to the northern portion of the North-East Suburban line, but they were ready to hear Mr. Page in reply to-morrow morning before they actually came to a decision. The committee would not call upon the opposition.

Mr. Littler then addressed the committee on behalf of the Metropolitan Railway Company in opposition to the North-East London line, which proposed to run under the existing joint railway of the Metropolitan and District from the Monument to Cannon-street for a distance of 25 chains.

Mr. Clode, for the South-Eastern and Chatham Railway Companies, stated their objections to the proposal of the North-East London Railway to come under the line at Ludgate-hill. The interchange station at Ludgate-hill offered by the Central London Railway, which did not propose to go under the South-Eastern and Chatham line, was infinitely superior to that offered by the North-East London Railway.

Mr. Balfour Browne said he would submit a clause to provide for giving compensation for damage if it was caused by the construction or the working of the railway during two years. They would provide no compensation to anybody whose property had been paid for or who had been paid for an easement. The clause would also suggest a special tribunal—not the ordinary court of arbitration under the Lands Clauses Act—to settle questions of damage.

The **Chairman:** If such a clause were provided it could form the basis of consultation with Lord Ribblesdale and the members of his committee.

The committee adjourned.

WEDNESDAY, MAY 14.

The committee further considered the competing Piccadilly schemes.

Mr. Balfour Browne, K.C., said the committee had been informed on Tuesday that the promoters of the City and North-East Suburban Railway had determined to proceed with their line from Whitechapel to the north notwithstanding that their lordships had rejected that portion of the scheme which ran from Whitechapel into the City. They did not feel, however, that they would be justified in going on with a truncated scheme, and he proposed to ask the leave of the committee to withdraw his Bill, which was granted.

Mr. Balfour Browne then addressed the committee on behalf of the North-East London Railway, which proposes to run from Ludgate-circus to Palmer's Green, the continuation from Palmer's Green to Chase Side, Southgate, having been disallowed. The line provided a through route from the crowded parts of the City to the country. The combination, of which the North-East London Railway formed a part, had been severely criticised; but it was a combination seeking to give the public something it had not got, and was opposed by a railway "ring," which gave its support to the Central London proposals because they wanted to fence themselves in from any competition with their suburban traffic.

The **Chairman** said the committee had given careful consideration to the present position, and they had finally decided to go on with the opposition to all the Bills. They would first of all take the opposition to what had been called the Morgan group, then to the Brompton and Piccadilly-circus Railway, and, finally, to the Central London Railway. When that opposition was finished, the committee would call for the advice of the London County Council and the Corporation of the city of London upon all the schemes before them. That would be followed by the speeches of counsel for the various promoting Bills. The committee had also come to the conclusion that they could not hear the opposition of landowners until they had decided what Bills should not proceed.

Lord R. Cecil, K.C., said he had been asked by Lord Ribblesdale

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to mention that Mr. Moon, K.C., had submitted a general clause for the protection of landowners, and that Lord Ribblesdale had also suggested a clause which might form the basis of argument and consultation. It was understood, however, that no clause should be inserted in any of the Bills before Lord Ribblesdale's Committee until there had been an opportunity of discussion with their lordships' committee of the proposed general clause.

The **Chairman** said he would take an opportunity of consulting with Lord Ribblesdale with a view to the adoption of the same course in both committees.

Sir Douglas Fox, joint engineer to the combined undertaking of the Piccadilly and City and London United Electric Railways, recalled and examined with reference to the engineering features of the Brompton and Piccadilly-circus and the Central London Railways, said his strong objection to the former was to the connecting link with the deep level of the District Railway between Piccadilly-circus and Charing Cross. He should say that that piece would be an unworkable line. The effect of the proposed junction at Piccadilly-circus would be to put four tunnels one above the other. The junction at the Charing Cross end was about as bad as it could be. As to the Central London Railway proposals, he considered that a closed circuit, especially in the centre of London, was most objectionable from both an engineering and a public point of view. The traffic coming from outside the circle must change, and when the trains reached the interchange stations they were invariably crowded.

Mr. F. G. Thomas addressed the committee in the interests of the Metropolitan Railway Company against the proposals of the Central Railway and the combined Piccadilly and City scheme. Their main objection to the Central Railway extension was that it established a new east and west competition with their existing line between Hammersmith and the City. This was not an appropriate time to expose the Metropolitan to new competition, in view of the expense of the electrification of the Metropolitan and the District, which would be effected within the next 18 months.

The committee adjourned.

LORD RIBBLESDALE'S COMMITTEE.

FRIDAY, MAY 9.

The committee presided over by Lord Ribblesdale proceeded with their consideration of the City and Crystal Palace Railway Bill.

Mr. S. Sellon, engineer to the British Electric Traction Company, recalled, stated with the authority of the chairman of his company that they were prepared to give substantial assistance towards the carrying out of the undertaking.

Mr. F. Schenck, chairman of the Crystal Palace Company, said if the Bill passed he would be prepared to find £1,000,000.

After some further financial evidence had been given, the committee decided that they would not proceed further.

The Bill was therefore rejected.

The committee next considered the Great Northern and City Railway Bill.

Mr. Moon, K.C., described the proposal as a short extension of an authorised line rapidly approaching completion, which he hoped would be opened in the course of a year. It started under the Great Northern Station at Finsbury Park, where there would be an interchange station, and the present terminus was provided for at Finsbury-pavement. The Bill would empower the company to erect a generating station at Shoreditch, to construct a passenger station at Highbury, and enlarge the station at Finsbury-pavement, but the main object was to extend the line from Finsbury-pavement to near the Bank.

Sir C. Scotter, chairman of the company, and **Sir H. Oakley**, director of the Great Northern Railway Company, gave evidence in support of the proposals.

Sir Douglas Fox gave evidence from an engineering point of view.

Mr. G. C. T. Bartley, M.P., **Mr. C. Hay, M.P.**, and **Mr. J. Crump**, mayor of Islington, expressed opinions that the proposed extension would be of much public convenience.

The committee adjourned.

MONDAY, MAY 12.

The committee proceeded with consideration of the Great Northern and City Bill.

Sir Douglas Fox, recalled, said the line would not approach nearer to the Bank of England than the southern end of Moorgate-street. The nearest shaft would be 30ft. away. It was proposed to construct five shafts between the corner of the Bank and the end of Moorgate-street for the purpose of lifts.

The **Chairman** said the committee would consider the question of inserting the Bank of England clause in the Bill. In reference to the model clause that had been mentioned earlier, it was not his intention that the appeal to a special tribunal should extend to those who had their right under the Lands Clauses Act. The clause to be submitted by the promoters might prove a basis of agreement.

Mr. Moon, K.C., said the promoters were willing to give a two years' clause, but if, as the result of the consideration of Lord Windsor's Committee, a longer period than two years should be agreed upon, the promoters would amend the clause before the Bill reached the other House.

Mr. Littler, K.C., said the City Corporation viewed this project with disfavour, because the short distance of about 300 yards by which it was proposed to extend the line did not justify the enormous expenditure upon it.

Mr. Freeman, K.C., stated that arrangements were in progress that would render opposition to the preamble unnecessary on the part of the Metropolitan Railway Company.

The committee declared the preamble of the Bill proved, and that the promoters must understand that a clause must be inserted for the protection of property owners, and upon this and in reference to a Bank of England clause, the chairman would consult with Lord Windsor and the Chairman of Committees.

The committee then took up the North-West London Railway Bill, which **Mr. Baggallay, K.C.**, explained was for the purpose of granting an extension of time for three years for the construction of a tube line from the Marble Arch to Cricklewood under the Edgware-road, authorised in 1899. It also asked for sanction to an enlargement of the tubes from 12ft. 6in. to 13ft. diameter.

Mr. Scott Russell, a director of the company, gave formal evidence, and the preamble was declared proved.

Several points raised by the petition of the London County Council referring to the building line, workmen's trains, rehousing of the working classes, and ventilation, were left over to be dealt with on clauses.

The committee adjourned.

TUESDAY, MAY 13.

The committee proceeded with consideration of a number of clauses proposed by the London County Council for insertion in the North-West London Railway Bill. Counsel asked that a provision should be inserted for reducing workmen's fares to 1d. single and 2d. return, and for slightly extending the time within which workmen's tickets can be used.

The committee rejected the amendment.

The promoters agreed to a provision enabling employers to purchase batches of workmen's tickets for distribution.

The Great Northern and Strand Bill was next considered.

Mr. Balfour Browne, K.C., explained that the Bill was for the purpose of extending the time for authorised works. The Act authorised construction of a tube railway between Finsbury Park and the Strand.

The preamble was declared proved.

In discussion of the clauses in the Great Northern and City Bill,

The **Chairman** said the committee were of opinion that what was known as the Bank of England clause should be inserted, with a distinct understanding that it was for the protection of the Bank of England as a special building. The clause did not form a precedent for other buildings.

Mr. Moon, K.C., submitted the terms of a clause the promoters were willing to insert for the protection of persons whose property might be damaged by the working of a tube railway. The clause provided that if before the expiration of two years from the opening of the railway any damage should be caused to his property the owner would have the right of compensation, in addition to any remedy he would have under the existing law.

The **Chairman** read the heads of a clause such as he had in mind as a model clause for insertion in all these Tube Railway Bills. It would provide that if at any time within two years after the opening of the railway for traffic an owner or lessee of land or building complained of damage or annoyance from construction or working in respect to which he could not claim compensation under the Lands Clauses Act, such complaint should be referred to an arbitrator, not being an engineer, to be appointed by the Board of Trade. The arbitrator might be assisted by two engineers, if necessary, and have power to award compensation. He would like to see something drafted to carry out these heads as a model clause, subject to consultation with Lord Windsor and the Chairman of Committees.

The committee eventually decided that the insertion of a clause dealing with the question should be deferred until after Whitsuntide and after consultation with Lord Windsor's Committee.

The committee adjourned.

WEDNESDAY, MAY 14.

The committee practically concluded consideration of the group of Tube Bills allotted to them. The sitting was largely taken up with the settlement of the clauses of the Great Northern and Strand and Great Northern and City Bills, the only new measure being the Baker-street and Waterloo Bill.

Mr. Page, K.C., in opening the case for the Bill, said its principal object was to obtain an extension of time for the purchase of lands and construction of works. He believed that one tunnel from Waterloo to Oxford-street was absolutely finished, and the other was well up Regent-street. Up to December, 1901, practically £1,000,000 had been expended. In March of the present year the contracts of the London and Globe in regard to the line were transferred to the Metropolitan District Electric Traction Company, of which Mr. Yerkes was chairman, and they would be taken over by the Underground Electric Railways Company of London, which had a capital of £5,000,000. Counsel added that the work would be carried out as rapidly as possible, and would shortly be completed.

The preamble of the Bill having been approved,

Mr. Perks, M.P., stated that 60 per cent. of the tunnels had been completed, and all the stations were constructed or in course of construction. He asked the committee not to make any alterations in the fares already sanctioned, as the whole of the fares on the District and allied lines would have to be revised, and any decision by the committee might prejudice that question. He understood that the District Railway should come to Parliament next year for sanction for the new scheme of fares.

The committee accepted the assurance, and left the question of fares untouched. Clauses were then agreed to, and the committee rose.

PHYSICAL SOCIETY.

At the ordinary meeting of this society held on May 9, Prof. S. P. Thompson (president) in the chair,

Dr. P. E. Shaw exhibited a "**Simple Electric Micrometer.**" Two years ago Dr. Shaw described an instrument with which he measured

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very small lengths by the application of electric contacts, and the micrometer shown was a simple form of the original apparatus. A screw, fitted with a milled head, turns in a fixed nut, and its lower end presses upon the extremity of the long arm of a lever. A metal point is attached to the short arm, and the distance through which it moves, on turning the milled head, can be deduced from a knowledge of the pitch of the screw and the ratio between the arms of the lever. In using the instrument, this point is always brought up to a metal surface, and the contact is accurately determined by the telephonic arrangement described in connection with the original micrometer. Dr. Shaw illustrated the use of the instrument for measuring small lengths by describing the following eight applications to ordinary laboratory measurements: (1) The measurement of the thickness of plates, films, or fibres. The object is placed between two metal plates. The point of the micrometer is adjusted to touch the top plate and the reading taken. The object is removed, the point is again brought into contact with the top plate, and the difference between the readings in the two cases gives the thickness of the film. (2) The determination of Young's modulus by the elongation of a wire. Dr. Shaw described experiments on two wires, each 2½m. long, hanging side by side, one of copper and the other of steel. The wires terminated in horizontal platforms, to which the stretching weights were attached. The base of the instrument rested on one platform, while depressions of the other due to loading were measured. In this way any error on account of the bending of the beam from which the wires were hung was eliminated. (3) The determination of Young's modulus by the bending of a beam. (4) The determination of simple rigidity by a static method. Observations were made upon a rod held horizontally by rigid wall brackets. One end of the rod was fixed, and the other held in position by a pin pressed into a hole in the end of the rod. From this end an arm projected outwards. Weights were applied to the extremity of this arm and the twist measured by observing with the micrometer the movement of the end of the arm. (5) Application to the extensometer. (6) Measurement of thermal expansion. (7) Microscopic measurements. In measuring the diameter of a capillary tube the cross wire of the microscope is made to touch one side of the tube, and the point of the micrometer is brought into contact with the metal stage. The stage is then moved by a screw until the cross wire comes to the other side of the tube. The micrometer point is moved into contact again, and the difference in the readings gives the diameter of the tube. In this measurement the full magnifying power of the microscope is utilised, and the work of moving the stage is performed by a rough screw. (8) The direct measurement of the wave-length of light. Newton's rings are formed by a convex lens and a piece of plate glass. The convex lens is fixed to the short arm of the lever, and the distance through which it must be moved to cause a certain number of bands to appear at the centre gives a means of calculating the wave-length of the light employed.

Prof. Everett said the apparatus combined fineness and accuracy of measurement, and expressed his interest in the determination of distances with the microscope.

Mr. R. J. Sowter asked if any special precautions had been taken to prevent deformation in the instrument. If not, then it was optimistic to assume that one or more multiplying levers could be used to measure lengths of the order of a millionth of a millimetre with any physical accuracy, assuming the multiplication of measurement to be according to the law of the lever, as Dr. Shaw apparently did.

Mr. W. Watson said that, in determining the wave-length of light by Newton's rings, it was necessary to measure from the knife-edge of the lever to the centre of the rings. The accuracy of the experiment was limited by the difficulty in judging the centre. The variation of the temperature of the air would distort the lever and produce errors. In reference to the experiments on Young's modulus using two wires of different material, he said that no precautions had been taken to procure a steady temperature, and pointed out that variations in temperature would affect the two wires unequally. In the experiment on the torsion of a rod the twisting had been produced by an unbalanced force. The other arm of the necessary couple must therefore have been unsatisfactorily supplied by the friction of the pin which held the rod in position. In measuring the diameter of a capillary tube with extreme accuracy, it was necessary to have a normal section, which was somewhat difficult to obtain. Dr. Shaw apparently considered the instrument as suitable for laboratory work. If it was for students, it was unnecessarily elaborate, and if for obtaining accurate measurements, there were objections and uncertainties which should be investigated. Mr. Watson said that a similar form of micrometer had been described by Mr. H. C. Russell and used in the observatory at Sydney.

Mr. J. M. Barr said that as errors would be introduced by variations in temperature, it might be advisable to make the instrument of a nickel-steel alloy with a small coefficient of expansion. He asked if the knife-edges and screws used were good enough to give the same reading twice, and said he thought the limit of physical accuracy could be obtained by using a single disc on a screw calibrated throughout its length. He considered $\frac{1}{10000}$in. to be about the limit attainable by such methods.

Dr. Shaw, in reply, said the main justification of the apparatus was in the consistency of the results given by it; these were excellent, as the tables given in the paper showed. The method had been shown to be much more accurate than those in general use. As to the contention that the apparatus, while too sensitive for laboratory practice, was not sufficiently so for research on length changes, he pointed out that the accuracy of all measuring instruments was always on the increase, so that laboratory methods which were considered good recently would not necessarily suffice in the immediate future. Why be content, even for teaching students, with measuring to $\frac{1}{10}$mm. by the microscope when with the simple electric micrometer we get, with little trouble, to $\frac{1}{1000}$mm.? Dr. Shaw knew nothing of the prior publication in Australia mentioned by Mr. Watson; if there were such a method introduced years ago, it was all the more astounding that Mr. Russell and his successors should have allowed such an excellent idea to lapse and remain immature and unknown. Some speakers had suggested that uncertain deformation of the levers might occur during an experiment and vitiate results; but a new strain implied a new stress, and, unless a definite change occurred in the forces of the system, we could not suppose a change in deformation. A like answer was given to the criticism that the levers might expand under heat during a measurement. Why, if sufficient time has elapsed to allow the system to attain temperature equilibrium, should anyone postulate expansions without indicating a new or irregular source of heat? Most of the above supposed evils, of course, existed, but they were of small account. As with every good apparatus ever produced, if ordinary and suitable precautions be taken these errors were reduced to a lower of importance, and could be neglected. In conclusion, the method had been firmly established in University College, Nottingham, and had superseded other apparatus. It would no doubt spread and become general.

Papers on "The Conservation of Entropy," by Mr. J. A. Erskine, and "Rational Units of Electromagnetism," by Signor G. Giorgi were postponed, and the society adjourned until May 23.

FORTHCOMING EVENTS.

FRIDAY, MAY 16.

Institution of Mechanical Engineers.—Annual conversazione.

Royal Institution.—At 9 p.m., Sir Robert Ball on "The Nebular Theory."

WEDNESDAY, MAY 21.

Institution of Electrical Engineers (Students' Section).—At 7.30 p.m., annual general meeting. Paper: "Some Notes on Recent Continuous-Current Dynamo Design," by Mr. F. J. Hiss, jun.

Royal Meteorological Society.—At 4.30 p.m., ordinary meeting. Papers: "Report on the Wind Force Experiments on H.M.S. 'Worcester' and at Stoneness Lighthouse," by Mr. W. H. Dines and Captain D. Wilson-Barker; "The Cornish Dust Fall of January, 1902," by Dr. Hugh Robert Mill.

THURSDAY, MAY 22.

Institution of Electrical Engineers.—At 8 p.m., at the Society of Arts, annual general meeting.

FRIDAY, MAY 23.

Physical Society. — At 5 p.m., ordinary meeting. Papers: "On the Ebullition of Rotating Water: a Lecture Experiment," by Mr. T. C. Porter; "The Conservation of Entropy," by Mr. J. A. Erskine; "Rational Units of Electromagnetism," by Mr. G. Giorgi.

APPOINTMENTS VACANT.

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Draughtsman, for electrical measuring instrument department, G Dept., Ferranti Limited, Hollinwood, Lancashire. Full particulars in our advertisement columns.

Switchboard Attendant, Eccles Corporation electricity works, £62 per annum, May 24. Full particulars in our advertisement columns.

Borough Electrical Engineer and Tramways Manager, Newport (Mon.) Corporation, May 31. Full particulars may be obtained from the town clerk.

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Draughtsman, Leicester Corporation borough engineer's office £135 per annum, May 27. Full particulars in our advertisement columns.

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THE INCIDENCE OF THE FACTORY ACT.

Legislation is generally for the protection of the wicked and the damnification of the good. The Factory Acts are good examples of this state of things, and also of the grandmotherly legislation that assumes humanity unable to take care of itself. Almost every legislative act of interference with trade and manufactures means an increasing weight of millstone round the necks of business men in this country. The Factory Act of 1901 seems to lie heavily upon some of the electrical enterprises of to-day, hence the action of the Institution in calling the conference on Monday last—a report of which appears elsewhere in this issue. To those who understand the working of existing central and sub-stations, some of the clauses in this Act appears ridiculous, and though the Home Secretary may upon representation rescind them in certain particulars, there is trouble and annoyance in getting such recision. But the particular phase of the question to which we wish to direct attention is as regards the old-fashioned system of apprenticeship. Is not legislation mainly answerable that real apprenticeship has gone out of fashion? A few years ago youths were taken into works at an age when their limbs were supple and their minds free, and put through the mill from floor sweeper to foreman. Their responsibilities were increased as their knowledge and experience of the work increased. The result was good, and was generally acknowledged to be good. Assume at the present time that parents desire to apprentice their children to certain branches of electrical work. They certainly could not do so in the manner of years gone by, and if they did and could the result would hardly spell success. If the Legislature stands in the way and forbids the giving of minor or semi-responsibility to a lad of sixteen to eighteen years of age who has had experience, and whose knowledge of the matter is sufficient, in cases where probably such lads are the best possible persons to fit the position, then masters and men ought to combine to compel better counsels to prevail. Take a specific case—the hours during which lads may be employed. According to the present law it is exceedingly difficult to see how lads can gain real experience in central-station working. The time to try the capacity of any one employed in the station is the time of full load, and especially when the whole apparatus is fully loaded because of unfinished extensions and too many lamps wired. If a youngster is not to see the troubles which arise and how they are successfully combated till after eighteen years of age, a large part of his apprenticeship time must be wasted. Perhaps the Legislature has run away with the view that electrical apprentices should commence their work at the age of eighteen, and in order to become a good and efficient station hand an experience of three years only is needed. Putting, however, all such questions on one side, the artificial limitation of hours of work and days worked is a mistake when the demand is one which never ceases. You have an easy and acceptable occupation for a lad of seventeen years; the circumstances of the case often only warrant the employment of one lad per shift of eight hours, yet the lads are precluded from taking meals on the premises, or working holidays or Sundays—so that other arrangements must be made, usually increasing the expense and decreasing the efficiency. It must be remembered that the maximum demand in central stations comes at a time required by a public over which the management has no control—in most factories the management determines the hours of labour—hence restriction to hard-and-fast hours in electrical work is of

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greater importance, and handicaps the organisation most heavily. We object as much as the most emotional sentimentalist to overwork or long hours We say, do all that is possible to build up physical robustness in our youths, but surely there can hardly be named a lighter or healthier occupation than that in which many lads have been employed by some of the electrical companies. The agitation being given to this matter by the Institution and cognate associations will, we hope, lead to a reconsideration of the whole question, especially as regards the electrical industry.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LONDON COUNTY COUNCIL LAMPS.

We have received the following letters from Mr. W. Davenport, the secretary of the National Electrical Manufacturers' Association :

SIR,—I enclose copy of correspondence with the London County Council, which may be of interest to the electrical world.—Yours, etc., W. DAVENPORT, Secretary.

[COPY.]

G. Gomme, Esq., clerk of the London County Council,
Spring-gardens, S.W.

Dear Sir,—Your letter of Jan. 9 last, asking for tenders for electric lamps, together with your specification for same, is before me. In this specification you stipulate that the lamps shall be of English make, and you further bind those who tender to certain labour requirements which can only apply to goods made in this country.

We are informed that you have accepted the tender of the Brush Electrical Engineering Company, whose lamp works are in Vienna.

I am instructed to draw your attention to this, and to ask your assurance that English-made lamps only will be accepted.—Yours faithfully,

(Signed) W. DAVENPORT, Secretary.

The National Electrical Manufacturers' Association,
Ridler-place, Holland-street, Blackfriars,
London, S.E., April 16, 1902.

[COPY.]

London County Council, County Hall,
Spring-gardens, S.W., 23rd April, 1902.

Sir,—I am directed to thank you for your letter of the 16th inst., and to say that the Council were aware that the lamps supplied by the Brush Electrical Engineering Company would be foreign made. On the next occasion of inviting tenders for electric lamps firms will be asked to send in two quotations, one for English-made lamps and the other for foreign-made lamps.—I am, Sir, your obedient servant,

(Signed) G. GOMME, Clerk of the Council.

The Secretary of the National Electrical Manufacturers' Association, Ridler-place, Holland-street, Blackfriars, S.E.

INSTITUTION OF ELECTRICAL ENGINEERS

At the ordinary general meeting on May 8, the following were the candidates balloted for :

Members.—T. J. Fleming, 25, Victoria-street, Westminster, S.W.; S. W. Hulse, Union Elektricitats-Gesellschaft, Berlin.

Associate Members.—H. D. B. How, Royal-chambers, Park-place, Cardiff; A. J. Fippard, Broad Sanctuary-chambers, Westminster, S.W.; J. P. Kemp, 4, New York-street, Manchester; H. C. King, Sunnydene, Elm-road, Wembley; A. F. Rock, Electrical Department, North Staffordshire Railway, Stoke-on-Trent.

Associates.—W. S. Entwistle, Poldhu Hotel, Mullion, South Cornwall; C. H. Haddrell, 16A, Soho-square, W.; A. N. Hazlehurst, 85, London-road, Leicester; R. M. Leonard, 19, Ludgate-hill, E.C.; A. Mansfield, Royapmain, Madras; C. F. B. Marshall, 34, Lexden-road, Colchester; F. L. Moysey, 78, Wellmeadow-road, Catford, S.E.

Students.—J. Gray, Middleton House, Dalry, Ayrshire, N.B.; P. H. Harding, Oreston, Granville-road, Sidcup; M. A. Stoppoloni, 39, Perrymead-street, Parson's Green, S.W.; W. L. Turner, Purley Chase, Atherstone, Warwickshire.

THE FACTORY ACT OF 1901.

A conference of representatives of branches of the electrical industry which are affected by the provisions of the last Factory and Workshops Act was held in the rooms of the Society of Arts, Adelphi, on Monday afternoon under the auspices of the Institution of Electrical Engineers. Mr. W. E. Langdon was in the chair, and about 50 delegates attended from different parts of the country, representing both municipal and private electrical undertakings. Several of the railway companies also sent delegates.

The SECRETARY (Mr. W. G. McMillan) having read the notice convening the conference,

The CHAIRMAN said he might state at once that the object in calling this meeting of representatives of the industry had not been in any way to cast reflections on the Home Department or the Government. They were there merely to consider the incidence of the Factory Act of 1901 in its application to the generation of electricity. They knew that the State had a duty to perform, but at the same time the interests of the industry must be protected. This was a commercial nation, and there could be no doubt but that the electrical industry was destined to be of the greatest service to the commercial and industrial productions of the country. It was very desirable, therefore, that the industry should be relieved of all possible impediments which might in any measure restrict its advantageous application to the manufactures or to the industries of the country. Our merchants and manufacturers had to compete with the productions of other countries, and electricity was being applied in those countries to industrial production with the greatest advantage. They desired, therefore, that this country should not be subject to greater penalties or restrictions in making use of this new application of power in the interests of the community. Hence the desire of the Institution of Electrical Engineers to call together this conference. The views which he had expressed were not, he believed, quite foreign to the Home Department, and it was in that sense that he desired to conduct the consideration of the question that afternoon. As to the Act itself, those provisions which applied to non-textile productions and to some other branches of manufacture might be extremely satisfactory, whereas in their application to the generation of electricity they might be wholly unnecessary. Much, of course, must depend upon the way an Act of this sort was administered, and he could not but think that any views expressed by a representative conference of this kind would have a very powerful influence on the determination of the regulations which had yet to be drafted. They had to bear in mind that the Act, as it stood, was complete, although it was in the power of the Home Secretary to rescind its action in certain particulars. Some correspondence had passed between the secretary and representatives of generating stations with reference to the employment, for instance, of young persons—*i.e.*, youths under 18 years of age—which employment was restricted to certain hours and to other conditions, all of which, he might say from his own experience, were somewhat prejudicial, and tended to create dissatisfaction on the part of other members of the working staff. He would call upon the secretary to give a short summary of that correspondence.

The SECRETARY then read a few of the letters he had received with reference to the employment of young persons in electrical works, and in the majority of cases the writers were in favour of a representation to the Home Secretary in the matter. The secretary stated that there were in all 75 letters sent out by the Institution to central-station engineers asking them to send delegates to this conference, and 60 replies had been received. Of these, 12 stated that their works were unaffected by the Act; 14 that they had given up the employment of young persons in central stations in consequence of the Act; 25 replied to the effect that, in their opinion, the Act was prejudicial to the industry; six stated that they did not consider the clauses in question unreasonable; and three were of opinion that young persons under 18 years of age ought not to be put

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in responsible positions. The secretary next gave a *résumé* of the contents of a number of letters from corporation electrical engineers sympathising with the movement, including the Corporations of Bath, Chester, Greenock, Leeds, Doncaster, Sunderland, Ayr, Coventry, Glasgow, Hastings, Huddersfield, Poplar, and Worcester.

The CHAIRMAN, in calling upon Major-General Webber to open the discussion, said that so far no regulations had been promulgated with respect to electricity stations under the Act of 1901, and up to the present whatever action had been taken had been by the local inspectors under the general terms of the new Act or under the terms of the Act formerly in force.

Major-General WEBBER, representing the London Chamber of Commerce, said there was no doubt that this was a matter of great importance, and one which would daily come more home to those connected with electricity supply; and when one came to think of the large areas which would be covered by the power stations, and the number of transforming points that would have to be established in connection with the generating plants, there could be no doubt that the incidence of this Act might be very oppressive to them, and also to the traction companies in certain circumstances. The wording of the clause which brought transforming stations within the Act was a little bit ambiguous—he should like to say insiduous—but it was certain that every place where electricity was to be transformed to be used by way of trade, no matter how insignificant it might be, came under the Act; and there was a great liability of electrical undertakings being interfered with in such a way as to seriously affect the industry and the standardisation of material. It would also possibly involve the scrapping of what they believed to be perfectly sound machinery when used by those who properly understood it. The object the Chamber of Commerce had in being represented at this conference was to strengthen the hands of the Institution in approaching the Home Secretary. He believed that there was every encouragement in that direction. They knew that the Government had recently appointed an inspector under the 1901 Act, and, also, that the Home Secretary was taking further action in the matter. It was time, therefore, for them to take action also.

Mr. PERCY STILL, representing the Chelsea Electricity Supply Company, said that his company was affected by the clauses regulating the employment of young persons. His experience was that by employing youths in central stations and sub-stations they had been able to educate them up in the particular work they were required to do. The work in sub-stations was, of course, very light, and it was a superior class of work for boys, chiefly consisting of watching. But this Act precluded them from taking their meals on the premises, and they could only be employed for a certain number of hours, and not on Sundays or holidays. In his opinion the application of the clauses referred to would render the employment of young persons on this work quite impossible. He begged to move the following resolution, which was the first on the list to be considered: "That in the opinion of this conference there are clauses in the Factory and Workshops Act of 1901 that are prejudicial to the industry of electricity supply."

Sir HENRY C. MANCE seconded the motion. His experience at Oxford was very similar to Mr. Still's case. In consequence of this Act he was recently forced to employ a number of men for sub-station work at high wages, whereas boys of 14 years of age could easily have done the duty.

Mr. ALBERT GAY, representing the Islington Borough Council, called the attention of the meeting to several clauses which more particularly applied to the industry generally as distinct from generating stations. He supported the resolution, and hoped that representations would be made to the Government which would enable some modification of the clauses which might be positively dangerous to the industry.

Mr. HARMAN LEWIS referred to the provision that the walls of central stations must be whitewashed every 14 months.

The SECRETARY reminded the speaker that Mr. Ferron, one of H.M. factory inspectors, had stated at a recent meeting of the Institution that electricity stations were to be exempted from that provision.

Mr. C. IRWIN, chairman of the Electricity Committee of the Dublin Corporation, stated that within the past few weeks the general inspector of the district had visited their power-house and ordered all the inside walls to be whitewashed. With regard to the provision relating to the employment of young persons, they were not affected by it in Dublin because they did not employ them.

The PRESIDENT then put the resolution to the meeting, which was carried unanimously.

Mr. J. S. RAWORTH next moved the following resolution: "That the Institution of Electrical Engineers be requested to take steps to approach the Home Secretary in order to lay before him the views expressed at this conference as to the prejudicial effects of the incidence of certain provisions of the Factory and Workshops Act of 1901 on the industry of electricity supply, and to pray him to allow the Institution to confer with him when he is framing regulations under the Act." He could not approach this subject, he said, without feeling that they were very much prejudiced by the name of the Act upon which they were called upon to work. Somebody had assumed that an electricity supply station was a factory. In his opinion it was very much more like a cathedral, and he undertook to say that if the Home Secretary had been taken into some of their beautiful electric light stations, he would never have consented to their being called factories at all. As for taking meals in them, he (Mr. Raworth) would just as soon take them there as in any restaurant. With regard to the employment of young persons, there were certain circumstances which made it desirable, for instance, that they should work late into the night in their own interests, for unless a boy could take his place in the shift he could not become a skilled man. Again, often a boy did certain work better than a man; and he was sure that if they did not bring their views on this matter very forcibly before the Home Secretary, they would be failing to carry out that responsibility they held for their working people. As regards the employment of boys on Sundays, he expressed no opinion, as he was not quite clear upon the point.

Mr. R. HAMMOND seconded the resolution, expressing the opinion that the Institution should have moved in this matter 12 months ago. The Factory Act in its application to electricity stations was based upon a misconception by the Home Office of the present-day state of central stations. It would be remembered that it was absolutely laid down in the draft regulations discussed by the Institution a short time ago, that the switchboard should be so built that no one could possibly touch the positive or negative terminal. That meant to this country an enormous amount of money being spent in redesigning switchboards, which would be absolute waste. This idea of covering up dangerous places was a great mistake, and often led to accidents. In those regulations, too, it was provided that no one should be allowed to work behind the switchboard unless he were a skilled electrician. These and other like provisions made it clear that they had been framed by people absolutely ignorant of what an electrical station really was.

Mr. W. A. CHAMEN said it must not be taken that he was representing the Glasgow Corporation there that afternoon, as they had decided that the notice given them was not sufficient to enable them to send a delegate. His own opinion on the matter, however, was that the Home Office was going out of its province in dealing with electrical stations, which should be left entirely to the Board of Trade. He heartily supported the resolution, but thought that they had hardly had time as yet to find out the most troublesome clauses in the Act.

The PRESIDENT felt that what was to be done by the Institution in this matter should be done at once. He further stated that the views of this conference would come before the committee of the Institution which had been appointed especially to deal with the subject, and would be considered by them before any action was taken.

Mr. CHAMEN: Then I support the resolution as it stands.

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Mr. J. GRAY, representing the Crystal Palace District Electrical Company, remarked that their station had recently been remodelled, and the whole of the plant was in accordance with latest practice. About the end of last March an inspector of factories under the Act made a series of recommendations to the company, some of which had been carried out, but there were many others, which had not yet been complied with, and which would involve the company in very heavy expense, including the redesigning of the switchboard, which was now of the latest description. He felt that if these recommendations were to be met they would equally apply to every other central station in the country.

Mr. C. P. SPARKS mentioned the case of Bournemouth, where a similar case existed to that which the previous speaker had cited.

Mr. J. S. RAWORTH pointed out how very futile all these attempts to guard electrical machinery were. In the whole course of his experience he had only had one person injured, and in this case all the high-tension metal was carried overhead a distance of 8ft. above the floor. If a man wanted to kill himself, no one could prevent him.

Major-General WEBBER wanted to make it clear that this conference was by no means final as to what the Institution would recommend. The Council would refer the whole question to a very strong committee which they had appointed, and, if possible, this committee would be made more representative than it was at present. It would be the duty of the committee to move the Council to approach the Home Secretary. The great object they had in view was to fend off the possibility of regulations being passed which would not be in agreement with best knowledge and best practice. He thought that if the Institution approached the Home Secretary in a conciliatory manner, they would convince him that representatives of the industry were the best men to frame the rules. The result would be that all those who had shown interest in the subject that day would have an opportunity of saying another word before the regulations which he believed were coming would be made hard-and-fast.

On the PRESIDENT putting the resolution to the meeting it was carried unanimously.

Mr. SPARKS moved a very hearty vote of thanks to the chairman, which was carried, and the meeting separated.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

481. In a central station in which both batteries are temporarily disconnected, a 350-kw. machine and two 70-kw. steam balancers are on load (lighting and power) connected on + and − respectively of a three-wire system, the 350-kw. being across the outers, with its field excited from the negative bus bars. A slight load comes on to the − side, causing the volts on that side (−) to drop slightly; as the big machine and balancers are fully loaded up, another machine is ordered to be got ready. Before this can be done the volts on both sides suddenly drop to zero, and a total shut down is the result. How can this be explained, and could the shut down have been avoided? I might mention that the two 70-kw. steam balancers were self-exciting two-pole machines.—R. M.

482. Describe exactly how you would calculate the load factor of a lighting and traction station respectively, and in what way would the conditions for a maximum load factor differ in each case?—P.

ANSWERS.

Question No. 475.—Two alternating-current transformers are to be connected in parallel on a low-tension network; it is found that one of the transformers is apparently short-circuited when connected up, but upon changing either the high-tension or low-tension leads they are found to be correct. Why is this, and how could the proper connections be ascertained before connecting up?

Best Answer to No. 475 (*awarded* 10s.).—Fig. 1 gives a diagram of the connections of the two transformers, T_1 and T_2, which it is desired to put in parallel on the secondary mains. S S = secondary switches, P S = primary switches, and F = fuse (on high-tension inner). The terminals of transformer coils are often marked "inner" and "outer," and sometimes even "+" and "−," so it would seem that the only thing to do to put the transformers in parallel would be to see that the ends of coils of like sign were put on the same secondary mains—viz., inner to inner and outer to outer—and then the two transformers would work all right together. This doesn't

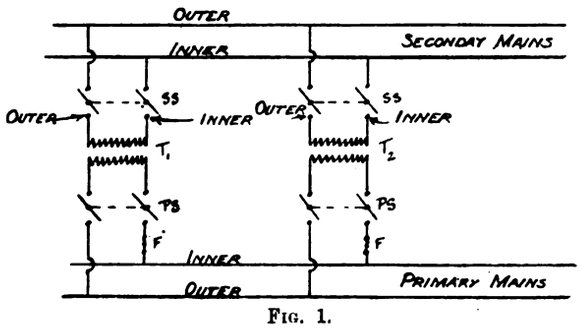

FIG. 1.

always come right, however, as, even with two transformers by the same maker, having to all appearances similarly-wound coils which when put in parallel and all transformer switches closed, blows the transformer fuse or fuses, the result of an apparent short-circuit as stated by "T. H." The secondary ends of one coil, although marked "inner" and "outer," may be marked wrong, or this coil may be wound in opposite direction to the other one, the result being that one coil is short-circuited through the other, thus blowing the fuse. Referring to Fig. 1, let T_1 have its switches all closed and be working on mains. It is desired to put T_2 in parallel with it. If its secondary terminals are connected up, as shown, then the two transformers will work in parallel all right. But should "inner" of T_2 be connected to "outer" secondary main, and "outer" to "inner," due to aforesaid reasons, then T_2 will be short-circuited by T_1, the result being that fuse blows. To make sure that this will not occur before closing the switches, the best thing to do is (with

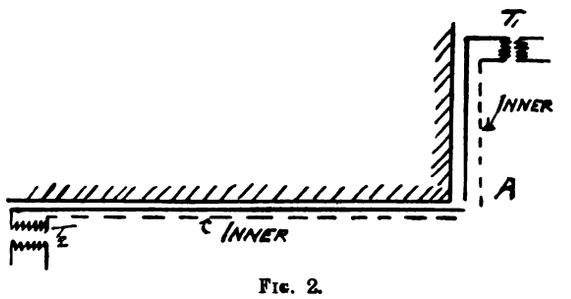

FIG. 2.

all switches open) connect the two secondary "outers" together by means of a piece of light fuse wire, also connect the two "inners" in same way. Then close primary switches, and if nothing happens, then they are properly in parallel. If fuses blow, cross-connect one secondary transformer, and they will be found to be right. Another way would be to connect an "inner" and an "outer" together, then close primary switches, and try two lamps of the secondary voltage in series across the remaining ends of coils If they light up, the transformers are in series, and one secondary requires cross-connecting to put them in parallel. This is all right where the two transformers are alongside each other, but when they are in different streets a considerable distance apart, as shown in Fig. 2, then proceed as follows: T_1 and T_2

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are the transformers. It is desired to put in parallel by jointing up the secondaries at point A. I am supposing that T_1 and T_2 are sunk in pavement and have heavy covers, which it is a trouble to lift, and we wish to avoid blowing either transformer fuse. With both transformers alive, connect the two outers at point A together by means of a piece of fine fuse wire. Connect a piece of fuse wire to one inner at A, and with a gloved hand or by means of a piece of wood touch this fuse wire on to the other inner, and if nothing happens, then the transformers will be right for putting in parallel, and joint may be made at A. Should the fuse wires blow, however, then one transformer cover will require to be lifted and its secondary mains cross-connected, when all will be found right. The cables, of course, will be concentric, but I have shown single lines for clearness.—R. S.

Answer to No. 475 (*awarded* 5*s.*).—A diagram (Fig. 1) will best explain the first question. This causes a dead

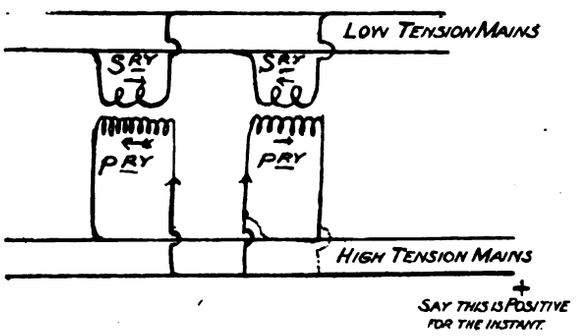

FIG. 1.

short-circuit in both transformers, but if primary winding of right-hand transformer is connected as per the dotted lines, then, if the transformers have both the same ratio, no

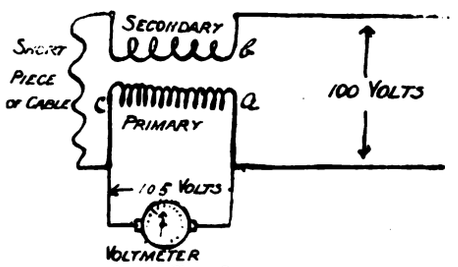

FIG. 2

current will flow between them. Of course, if when connected up with like terminals together and a short is found to occur, then whether you change the primary or secondary

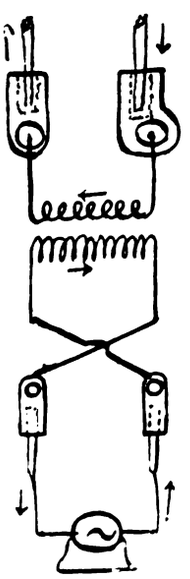

FIG. 3.

leads over on one transformer it will not matter, provided you change over only the high or low tension leads, because what is wanted is for both transformers to feed low-tension mains. The best way that I know, and one I have used for some hundreds of times, is as follows (and is as far as I know original): Two transformers can be used to test each other. If the transformer that we wish to test has a ratio of $\frac{2,000}{100}$ volts, we connect one end of primary to one end of secondary, and then put any convenient alternating voltage across the remaining ends, as Fig. 2. First measure volts across *a b*, which is, say, 100 volts; then, still keeping 100 volts at *a b*, measure across *a c*. This will be less than *a b* (say, 95 volts) if transformer is connected up rightly, and more than 100 volts (say, 105) if connections are wrong. The general standard method of connection is shown in Fig. 3 (as the direction of voltage in the secondary is opposite to that of the primary), and so by this arrangement we have adjacent terminals of like (instantaneous) polarity. It does not matter how they are connected, provided they are all the same, but it is best to stick to one rule, because at some future time another transformer may have to be added. By the method I have described you can test with certainty, without danger and with a very small current, a number of transformers (of any ordinary voltage and ratio) in a very short time. A Cardew voltmeter is quite accurate enough.—A. R. C.

Answer to No. 475 (*awarded* 5*s.*).—The effect mentioned is exactly analogous to what occurs when two continuous-current dynamos are connected in parallel. If brushes of dissimilar sign are connected to the same 'bus bar, the fuses will at once blow due to an enormous current passing through the two armatures in series. In Fig. 1 are shown two transformers incorrectly connected together. The instantaneous directions of the voltages in the voltages in the different windings are shown by the arrows. It will be seen that a complete short-circuit is formed by the two secondary windings in series, and that round this short-circuit the combined voltages of the two secondaries act in unison. This naturally leads to an excessive current in

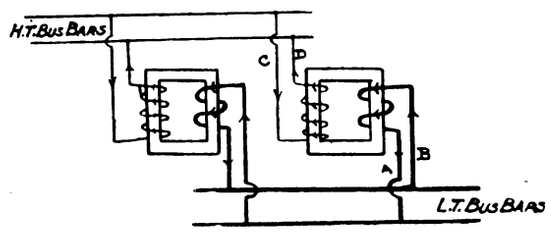

FIG. 1.

the secondaries, which reacts on the primary current and makes that also excessive, so that the fuses blow whether placed in the secondary or the primary circuit. When the leads A and B (Fig. 1) are crossed over (or, which comes to the same thing, the primary leads C and D are crossed over), it will be seen by the arrows that the secondary voltages are in opposition as far as passing current round the two secondary windings in series is concerned, though they are in unison as far as the 'bus bars are concerned, and consequently will now work satisfactorily in parallel.

There are three fairly simple methods of determining beforehand which terminals of transformers intended for parallel running may be connected together: (1) If the transformers are conveniently situated and are not in cases, the direction of winding can usually be followed out, and it is then easy to ascertain by inspection the relative directions of current in the two secondaries with given primary terminals connected to the same 'bus bar. (2) If the transformers cannot be conveniently inspected, the following method can be employed. It requires the use of a galvanometer of any ordinary sort, merely for indicating direction of current, and a small source of continuous current, such as a primary or secondary battery. Connect the secondary of one of the transformers to the galvanometer (shunted if necessary), and switch a small continuous current into the primary, and note the direction of the galvanometer deflection. Repeat with the second transformer, and change the connections until the galvanometer is deflected in the same direction as before. Then those secondary terminals belong together which were connected

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to the same galvanometer terminal, provided that the primary terminals which were connected to the same pole of the battery are connected to the same 'bus bar. (3) The simplest, quickest, and most usual method, however, consists in simply connecting pieces of fuse wire to the secondary terminals of the unknown transformer, and, after connecting the primary to the mains, tapping the secondary on to the live low-tension 'bus bars. If incorrectly coupled, there will be a flash, and the fuse wire will immediately be melted, whilst if correct, a comparatively small current only will pass from the secondary into the circuit.—Q.

Answer to No. 475 (*awarded* 5*s.*).—The reason for No. 2 transformer appearing to be short-circuited, when coupled in parallel on the network with No. 1 transformer, is due to the fact that its primary winding has not been so coupled up to the high-tension

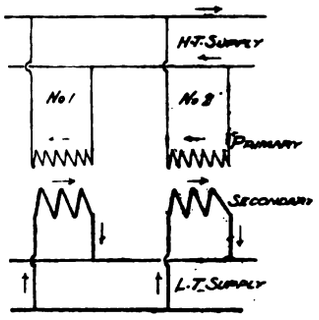

Fig. 1.

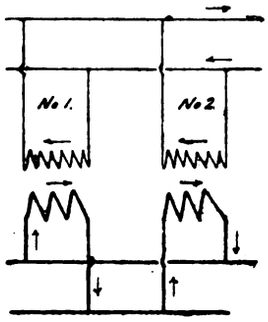

Fig. 2.

supply mains as to cause the induced E.M.F. in its secondary winding to be in the same direction at the same instant as the induced E.M.F. in the secondary winding of No. 1 transformer. The result is that the E.M.F.'s induced in the secondary windings of these two transformers, instead of acting in parallel on the 'bus bars or network (Fig. 1), are acting in series round the closed circuit formed by their secondary windings (Fig. 2), and as this E.M.F. will be approximately double the low-tension supply pressure acting round this closed circuit of low resistance, an excessive current will flow and cause the fuses to melt. Transformers are usually so wound and coupled up to their terminals by the makers that if similar high-tension and similar low-tension terminals are coupled up to the same high-tension and low-tension 'bus bars, the transformers should work properly in parallel, but a polarity just such as explained below should always be made to ascertain that such is the case before putting the transformers in parallel.

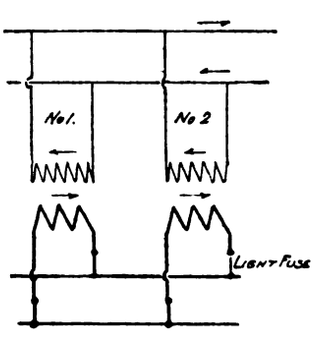

Fig. 3.

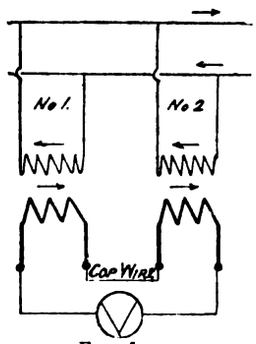

Fig. 4.

Method 1.—If the transformers are not on load, a test may be made by coupling the primary windings of both transformers to the high-tension supply, then coupling up both poles of No. 1 transformer, and one pole of No. 2 transformer by strong fuses, and inserting a small fuse in the remaining pole of No. 2 transformer (Fig. 3), and if they are coupled up properly for parallel working no current should flow between them, and the fuse will remain intact—*i.e.*, assuming that they are properly wound for working in parallel. The small fuse may now be removed and replaced by usual size, and the transformers will be ready to take up the load.

Method 2.—If No. 1 transformer is on load and No. 2 is required to be coupled in parallel, a test may be made by coupling up the primary windings to the high-tension supply, then coupling two of the secondary terminals together by a copper wire, and taking a voltmeter reading across the remaining two secondary terminals (Fig. 4). If the voltmeter does not indicate any difference of potential, the terminals coupled together by the copper wire should be coupled to one 'bus bar, and the two terminals connected to the voltmeter should be connected to the other 'bus bar; but if the voltmeter reading is double, the low-tension supply pressure the terminal of No. 1 connected to the voltmeter should be coupled to the same bar as the terminal on No. 2 connected to the copper wire, and the terminal on No. 1 connected to the copper wire should be coupled to the same bar as the terminal on No. 2 connected to the voltmeter. The transformers may now be plugged up and put to work. If a voltmeter is not to hand, a couple of lamps of the same voltage as the supply, and each of the same candle-power, may be connected in series and used to indicate roughly double the low-tension pressure.

Referring to Fig. 2, it will be seen that if either the high-tension or low-tension leads of either transformer are changed over, the transformers will be connected in proper order for parallel working.—H. F. J. T.

Question No. 476.—In a low-tension three-wire system, after a time the insulation on the negative side displays a persistent tendency to break down. This gradual deterioration is said to be due to osmosis; define the term when applied to the foregoing effects, and explain why the negative should exhibit such a tendency.

Answer to No. 476 (*awarded* 7*s.* 6*d.*).—The term "osmosis" is used to denote the phenomenon which is exhibited by liquids or gases of different specific gravities or viscosities when separated by some membranous substance, the effect being the transference of the lighter substance to the heavier. This phenomenon is very common in nature—*e.g.*, the fluids in plants being thus transferred from the outer to the inner cells, where the contents are more solid, thereby increasing the size of the structure. This can be demonstrated quite easily by taking a small jar full of syrup (treacle), tying a piece of parchment tightly over the mouth and immersing the whole in a vessel of water. In the course of time it will be noticed that the parchment is distended owing to the transition of water to the heavier liquid in the jar. This action would continue until the two liquids assumed the same specific gravity, except that the parchment would burst long before that took place. This action is also noticeable in primary cells having porous pots.

In the case under consideration this phenomenon seems to be accentuated by the electrical action. In a three-wire system the negative wire is at a potential below the earth potential equal to half the pressure across the outers of the system. Thus any leakage which takes place will be *from* earth into the conductor. The moisture in the ground surrounding the cables is impelled, by this "charging" of the negative wire from the earth, through the insulation more quickly than would otherwise be the case. When the cables have been in the ground for some time, a very small amount of moisture may have entered the microscopic pores of the rubber, paper, diatrine, or whatever insulation is used, this being in the direction of flow of the leakage or "charging" current, and a slight electrolytic action would be set up with the copper of the conductor. The conditions for "osmosis" would then be ripe. The copper compounds being of greater density than the water outside the rubber or other insulation, the latter would endeavour to dilute the former. Of course, as there is no exit for the water now inside the insulation, it creeps along the conductor at first until the quantity is so great as to stretch the rubber, etc., forming blisters, or balloons, until at last it bursts, when practically a dead earth is formed.

In a triple-concentric cable, with the "middle" wire as the outer conductor of the three, there is very little liability to this action, especially if the middle wire be not earthed. Even if the cable be lead sheathed there is a liability for this action to set up, for if by any means an appreciable current gets on to the lead, and so to earth, from the middle wire, electrolytic action will corrode the lead at the place where the current leaves for the earth and neighbouring conductors, thus making a way in for the water. If the middle wire be earthed, of course, the negative is subject to the same stress due to the earth potential, as in the case of separate conductors.—Mundy.

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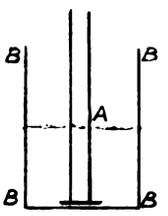
Answer to No. 476 (*awarded* 7*s.* 6*d.*).—This phenomenon has nothing whatever to do with osmotic action, which can only occur when certain liquids or gases are in the presence of a more or less porous diaphragm. The best way to observe osmosis is to get a glass tube, A (see sketch), and close one end of it with a piece of unglazed earthenware, which should be fairly thin, and may be stuck on by sealing-wax. A piece of bladder would do as well as the plate of unglazed earthenware, but it must be tied very tightly on to the tube by cotton. This tube



should then have a strong solution of table salt or sugar put into it, enough to about half fill it. Half a minute's careful observation will show that it does not leak at the joint. This being ascertained, the tube should be stood in a glass, and plain water put into the outer glass, B, as high as the level of the solution in the tube. Diffusion or osmosis will now take place, and the liquid in the tube will rise against the action of gravity, because these two liquids will diffuse through the diaphragm with rapidities inversely proportional to the square roots of their densities, and therefore the water being the least dense, will pass through more quickly than the solution of salt or sugar. A may be a gauge glass and B an ordinary tumbler, while a broken battery jar will furnish the diaphragm. Electric osmosis has also been observed, for if a + wire be put into the glass, B, and a - wire from the same battery into the tube, A, while the liquid in each has the same density, the liquid being part of the circuit will move in the same direction as the electric current, and will, therefore, mount up in the tube.

The cause of the breakdown in the insulation of the negative supply wire is altogether different from the above. In the first place, the wires are probably laid in a damp, underground passage, which is never dry. Moisture, which, of course, is really water, exudes from the earth and either creeps along the supports to the insulators and wires or else it is condensed by them, and so in a short time makes a continuous film, connecting everything inside the culvert. This film is well able to dissolve any alkaline or other salts which may be in the earth and so spread them all over everything on which it rests. The insulation of the wires is not quite impervious to moisture, and, therefore, not to the salts—*i.e.*, which it holds in solution. Water containing alkaline salts is a good conductor of electricity, and so a leak developes on the circuit, and electricity passes through this film of moisture from the positive to the negative wire, performing an electrolytic action as it goes. The first consequence of this electrolytic action is to set free caustic alkalies on the negative wire, and the chemical action of these caustic alkalies is very destructive to the insulation. The result of the electrolytic action on the positive wire is to set free on it gases and acids. These are mostly united by the same action with the copper and are then rendered harmless as a general rule, but in so doing they have, of course, made a certain proportion of the wire unable to conduct electricity, and have, moreover, materially injured it. These copper salts would, when dry, be non-conductors of electricity, and it must be borne in mind that many salts of copper, and notably the sulphate, have the property of solidifying water when crystallising, so that the crystals are sensibly dry and are non-conductors of electricity because they have crystallised with themselves the small quantity of water in contact with them. In this state the insulation of the positive wire might be good for a short time, but, of course, damage is being done, and the acids as they are set free damage the insulation of the positive wire. The total resistance of the positive wire is increasing under this action, which, if allowed to go on, and more especially if it is at all energetic in one spot, will eat away a part of the wire completely. This nuisance I have known happen several times, and it is apt to be very dangerous, because the wire becomes so thin that it might develope heat unduly and set fire to the insulation before it breaks continuity completely. "Student" would do well to get the *Electrical Engineer* for Feb. 14 last and read the answers to question No. 449, which go very fully into this matter, and, in fact, with what I have said above give practically all the information there is on this important subject.—F. G. A.

Answer to No. 476 (*awarded* 5*s.*).—Damp is a great source of danger to cables and tends to lower the insulation, and sometimes causes a tendency to breakdown. When water gains access to the cable it is apt to set up electrolysis, which may even affect lead-covered cables laid directly in the ground or drawn into ducts, as flooding of the ducts with water may occur, or it may get sometimes inside the joint-boxes and attack the cable joints, or some weak spot exists through which water enters. Water even may condense more or less inside, according to the state of the weather, and cause the cable to be alternately wet and dry, and this condition has a disintegrating effect upon the insulation, so that a cable after a time being in use and exposed to these causes may have the insulation resistance lowered. On testing, for instance, it might be found that the insulation resistance of the + conductor was, perhaps, over 160 megohms, and the (-) conductor not more than 30 megohms, with, say, 100 volts between them. Such a condition as this is due to electrolytic action, and it is this which causes such a marked difference in the insulation of the + and (-) conductors. The immediate cause of this is *electrolytic osmosis*, which we define as a phenomenon in which moisture is attracted to a negatively electrified conductor and repelled from a positively electrified conductor, and the reason of the (-) conductor being thus affected and not the + conductor is the attraction the former has for moisture, and the following experiment shows what is meant: If two conductors are taken and joined by means of saturated threads with a vessel of water and the potential of one of them be maintained above that of the water (the natural chemical affinity holding the elements H and O together in water equals an E.M.F. of 1·5 volts), and the other below it, moisture will travel along the threads to the negative conductor and away from the + conductor. The result of this action on a cable is that the insulators supporting the (-) conductors, or if continuously insulated the ends of the cables become damp, the insulation resistance falls, and in time it may lead to a breakdown. Especially is this the case if the water, instead of being pure, is impregnated with mineral salts from the soil and chemical substances from the surface of the roadways. Should there be any Portland cement in solution, this will certainly affect rubber-covered cables. Callender's solid system of laying cables in troughs, surrounded with Trinidad bitumen, excludes all moisture, and so tends to preserve the insulation.—J. A.

Answer to No. 476 (*awarded* 5*s.*).—Electric osmose is the name given to the phenomenon observed when a current passes between two electrodes in a liquid, the electrodes being separated by a porous diaphragm. The liquid in the division containing the positive pole is found to decrease, while a corresponding increase is noted in the division in which is the negative. When the liquids in which the electrodes are immersed are non-conducting, the action is greater than when they are conducting; for instance, the action in the case of water (H_2O) is greater than with dilute sulphuric acid (H_2SO_4), while alcohol (C_2H_6O) gives even an increase over water. Thus the phenomenon appears to vary inversely as the conducting power of the liquid. In the case of electric light mains we have the electrodes represented by the copper conductors, and the porous division by the earth or intervening media. It would, therefore, appear quite to be expected that an accumulation of moisture would gather round the negative lead. This would tend to lower the insulation of the negative side, and facilitate "earthing." It must also be taken into consideration that in proportion to the leakage between the mains we have hydrogen given off at the negative, and that this hydrogen is nascent, thus

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being in a very active condition. I may say that in the plant under my charge the several "earths" that have given us some trouble have been on the negative main; these faults were attributed to some such action as suggested in the question.—M. M.

REDDITCH ELECTRICITY ACCOUNTS.

The total expenditure on capital account to Dec. 31, 1901, under the Redditch electric lighting order amounted to £20,568. We append abstracts of the revenue account and give balance-sheet:

REVENUE ACCOUNT.

Dr.	£	s.	d.
Generation of Electricity.			
Coal, coke, and carting, and town gas	930	5	6
Oil, waste, water, and stores	209	19	2
Wages at generating station	563	4	9
Repairs and maintenance of buildings and plant	86	2	4
Distribution of Electricity.			
Wages	67	13	5
Repairs and maintenance of mains	11	6	9
Ditto meters and switches	4	13	7
Ditto apparatus and sub-stations	1	13	0
Public Lamps.			
Attending and repairs	15	14	10
Renewal of lamps	6	1	10
Rates and taxes	81	17	6
Management Expenses.			
Salaries	198	5	0
Stationery and printing	10	17	4
General establishment charges	52	15	9
Special Charges.			
Insurances	17	3	0
National Electrical Company and Allen and Richards.	41	19	10
Wiring materials and labour	49	2	7
Meters	26	10	0
	£2,429	6	2

Cr.	£	s.	d.
Sale of current	1,301	19	1
Public lighting	815	18	11
Meter rents	57	3	10
Sale of meters	27	3	0
Other receipts	162	18	8
Free-wiring rents	41	10	4
Amount carried to net revenue account	22	12	4
	£2,429	6	2

GENERAL BALANCE-SHEET.

Dr.	£	s.	d.
Capital account—amount received	18,911	0	0
Sundry creditors	2.865	7	11
Balance due to treasurer (revenue account)	686	10	10
Petty cash account (revenue)	0	8	6
Balance at credit of net revenue account	171	9	8
	£22,634	16	11

Cr.	£	s.	d.
Capital account—amount expended for works	20,256	0	8
Stores on hand	109	19	4
Sundry debtors for current supplied	708	10	9
Public lamps	219	0	0
Cash with treasurer (capital)	1,332	13	11
Cash in hand (revenue)	8	12	3
	£22,634	16	11

MORLEY ELECTRICITY ACCOUNTS.

The total expenditure on capital accounts by the Morley electricity department to March 25, 1902, amounts to £24,308. Abstracts of the revenue account, balance sheet, etc., are given herewith:

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Total units generated	133,677
Units sold	99,205
Units magnetising	23,921
Units used in works	10,551

REVENUE ACCOUNT.

Dr.	£	s.	d.
Expenditure.			
Generation of electricity	1,067	2	6
Distribution of electricity	34	15	6
Public lighting	65	5	11
Rents, rates, and taxes	81	12	0
Management expenses	340	19	10
Special charges	34	12	8
	1,624	8	5
Net revenue account	123	14	0
	£1,748	2	5

Cr.	Income.	£	s.	d.
Sale of current		1.175	0	6
Public lighting		346	0	0
Meter rentals		47	16	10
Repairs of apparatus		22	3	3
Cost of steam supplied to baths		157	1	10
		£1,748	2	5

BALANCE-SHEET.

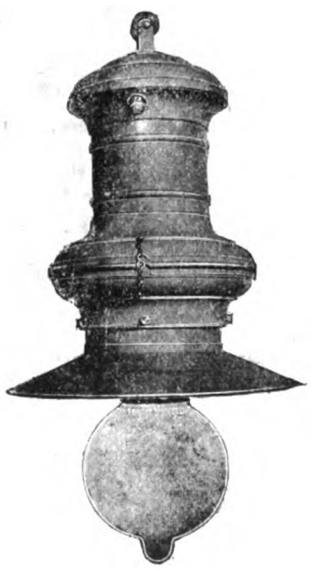
Dr.	Liabilities.	£	s.	d.
Loans		25,500	0	0
Amount due to treasurer		1,081	17	3
Income tax deducted from interest		62	1	0
Surplus		1,308	13	11
		£27,952	12	2

Cr.	Assets.	£	s.	d.
Amount expended on works		24,308	5	5
Sundry accounts due		547	0	6
Sinking fund		2,686	7	8
Stores in hand		410	18	7
		£25,952	12	2

TRADE NOTICES AND NOVELTIES.

Flame "Ark" Lamp.

Messrs. Johnson and Phillips, Victoria Works, Old Charlton, Kent, inform us that they are putting on the market a lamp which will be known to the trade as the Flame "Ark" lamp. The principal feature in regard to this lamp is the long life of the carbons with one trimming. In fact, we understand the average life of the special flame carbons supplied with the lamp is about the same as that of ordinary carbons used in enclosed arcs. The light emitted is of a rich golden colour, possessing, it is stated, high fog-penetrating powers. In some of the lamps which have been tested the amount of light obtained has averaged as much as four candles per watt consumed. As regards construction the lamp combines the same simplicity of mechanism as that obtaining in the firm's ordinary type of "Ark" lamp. To sum up, the advantages claimed for the Flame "Ark" lamp are as follows: moderate first cost, low current consumption, and economy in carbon consumption and attendance. Messrs. Johnson and Phillips have already made a speciality of "Ark" lamps with coloured globes for Coronation illuminations, and their Flame "Ark" is now added as a supplementary means of illumination, being suitable either for interior or outside lighting. Another point in its favour, and a most important one in view of the large demand which will have to be met in connection with the approaching festivities, is that the lamp can be supplied from stock.



The accompanying illustration shows the general appearance of the lamp.

B.T.H. Motors.

From the British Thomson-Houston Company, Limited, Rugby, we have received two descriptive pamphlets. The first—No. 122, which supersedes No. 80, Nov. 21, 1900—deals with slow and moderate speed motors of the B.T.H. "M.P." type. These machines have, we are told, recently been redesigned, and in their new form embody all important improvements known to present electrical engineering practice. They are of four-pole construction, the armature coils being machine made, separately insulated and interchangeable throughout each size and voltage of motor. Moreover, the armature coils are embedded in slots in the face of the core, and are thus protected from mechanical strain or abrasion by the pole-faces. The protecting flanges of the spider support the armature windings, and, besides affording additional radiating surface, protect the windings from oil or mechanical injury. Many other advantageous features

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of construction are enumerated, but for these we must refer the reader to the pamphlet under notice. The slow-speed (800 revolutions down to 470 revolutions per minute) motors listed range in output from 15 h.p. to 85 h.p., and the moderate-speed (1,100 revolutions down to 655 revolutions per minute) machines from 20 h.p. to 95 h.p.

The second pamphlet—No. 123—which supersedes Nos. 95 and 100, issued last year, deals with B.T.H. direct and alternating current fan motors. These motors are claimed to combine economy with durability, the first being secured by a perfect electrical design, and the second by a thorough consideration of the mechanics of the motor. The direct-current fan motors are made for operating on 60, 80, 95 to 115, and 190 to 230 volt circuits. All have regulating switches with four points, providing for three different speeds. Numerous methods of fixing the motors are illustrated and described. For attaching to light partitions which vibrate easily and tend to act as sounding boards, the bracket fan motor is recommended. This consists of an ornamental motor suspended from a brass bracket by means of coiled springs designed to absorb vibrations.

Toothed Gearing.

From the "Buffoline" Noiseless Gear Company, Chapel-street, Levenshulme, Manchester, we have received a copy of their new catalogue of toothed gearing. The firm, we learn, usually make their patent "Buffoline" pinions to gear with machine-cut wheels. These pinions are used for electric motors, pumps, cranes, printing machines, textile machines, motorcars, etc. It is claimed, among other advantages, that they are noiseless, very light in weight, twice as strong as cast iron, and produce no vibration. Various styles of the pinions are illustrated, also a "Buffoline" mallet fitted with a steel shaft. Machine-cut cast-iron or steel spur wheels up to 11ft. diameter are also supplied by the firm.

Tramway Apparatus.

We have received from the International Electrical Engineering Company, of Clun House, Surrey-street, Strand, a copy of their recently-issued bulletin (No. 6) describing electric tramway apparatus. We note that the company laid down the first electric tramway in Belgium so long ago as 1892, and besides carrying out much work on their own account, the Liège works have for many years supplied traction motors and controllers in quantities to other manufacturers. The bulletin contains a description of the firm's latest type of motors, controllers, lightning arresters, etc., and is well illustrated. Particulars are given of the tractive effort, weights, etc., of standard motors, ranging from 7½ b.h.p. to 35 b.h.p. The prices of these motors, and also of controllers, resistances, lightning arresters, automatic cut-out switches, safety fuses, and canopy switches, are quoted.

Motors and Arc Lamps.

We have received from the Westminster Engineering Company, Limited, Victoria-road, Willesden Junction, N.W., a copy of their new illustrated list of motors. The machines listed include motors of the "Westminster" four-pole semi-enclosed continuous-current type, ranging in output from ½ b.h.p. to 40 b.h.p., and enclosed motors of from ¼ b.h.p. to 36 b.h.p. output. The weights and over-all dimensions of the machines are given, in addition to the prices. From the same firm we have lists illustrating two arc lamps of the enclosed type, one of these lamps being designed to burn 90 hours and the other 70 hours with four to eight amperes, singly on 100 to 110 volts, or two in series on 200 to 220 volts, etc.

Glass Shades.

Several new and attractive patterns in glass shades are illustrated in circular No. G 1,004, just issued by the General Electric Company, Limited, Queen Victoria-street, London, E.C.

Date Nails.

From Mr. John Milliken, 2, Belfast Bank-chambers, Belfast, Ireland, we have received a card describing a galvanised date nail which he has just introduced for dating railway sleepers, telegraph and telephone poles, and for general use where wood is employed and renewals have to be made. In railway work the nail is driven into the centre of the sleeper to be placed in the line before it leaves the depôt. The head of the nail bears a figure indicating the year. The nails, we are told, run from about 5,160 to the hundredweight, so that 1cwt. would date on the average, say, 2½ miles of track.

LEGAL INTELLIGENCE.

CITY AND SOUTH LONDON RAILWAY.

Mr. Justice Wright, sitting in the King's Bench Division of the High Court on Wednesday, had before him the matter of an arbitration between the City and South London Railway Company and the rector and churchwardens of the united parishes of St. Mary Woolnoth and St. Mary Woolchurch Haw. It came before the Court on a special case stated by the arbitrator raising the question as to the basis on which the rector and churchwardens of the united parishes of St. Mary Woolnoth and St. Mary Woolchurch Haw were to be compensated for that part of the site of the church of St. Mary Woolnoth which the railway company had taken for the purpose of extending its line from London Bridge to the Angel at Islington. It appeared that the arbitrator arrived at three alternative findings. He awarded against the company £90,628 if all the lands taken belonged to the site of St. Mary Woolnoth and could never be used for any other purpose; or £136,421 if the lands taken might have become at some future time available for building purposes; or £143,548 if the site of the church and the other land could be made immediately available for the erection of buildings other than a church. The company contended that the compensation should be awarded on the basis that all the lands taken formed the site of the church, and could never be used for any other purpose.

His Lordship held that the claimants were entitled to compensation on the basis that the site of the church might at some future date become available as a building site.

HASTINGS TRAMWAYS.

In the Chancery Division Mr. Justice Buckley had before him the case of Bray *v.* the Hastings Corporation, which was an action brought for a declaration that an agreement purporting to be made between the Hastings Tramway Company, the defendants, and Mr. W. M. Murphy was illegal, and also claiming other relief.

Mr. Terrell, for the defendants, said that his clients had communicated with the solicitors who acted both for Mr. Murphy and the tramway company, and they said that they had no instructions from either party, but they added that they would apply for instructions. Under these circumstances it was impossible to proceed.

The case accordingly stood over till next sittings.

ACTION FOR PERSONAL INJURIES.

In the Westminster County Court on Monday, his Honour Judge Woodfall and a jury had before them the case of Marsh *v.* the Charing Cross and City Electric Company, Limited, in which the plaintiff, a wireman, sued the defendant company to recover damages for personal injuries sustained owing to the alleged negligence of the defendant company.

The **Plaintiff** was called, and said that on Oct. 9 last year he was sent to a manhole at Ludgate-hill, in company with another man named Ray, to carry out certain repairs, and whilst so engaged there was a fusing of the wires. An explosion followed, as a result of which he sustained very severe personal injuries, from which he had not yet recovered. His fingers and eyes were severely burned and part of one of his ears was destroyed.

After hearing other evidence **His Honour** said the accident was a most regrettable one, but there was absolutely no evidence of negligence on the part of the defendant company, and in those circumstances he had no alternative but to enter a non-suit. The jury were accordingly discharged.

COMPANIES' MEETINGS AND REPORTS.

BRISBANE ELECTRIC TRAMWAYS.

The annual general meeting of the shareholders in this Company was held on the 8th inst. at Winchester House, Old Broad-street, Mr. H. R. Beeton presiding.

The **Chairman**, in moving the adoption of the report, reminded them that this was the first annual general meeting of the Company, and the accounts comprised a period from its formation on Nov. 20, 1900, up to Dec. 31 last. They showed a net balance available of £42,815. 5s. 4d., out of which they had already paid the debenture stock interest and an interim dividend on the preference shares, and now proposed the payment of a balance dividend of 2s. 6d. on the preference shares, making up the full 5 per cent. per annum, leaving £7,523. 13s. 3d. to the credit of the next account. This Company was formed to acquire the shares of the Brisbane Tramways Company, Limited, all of which they held, with the exception of the 107 shares which were required to be held outside the Company for statutory reasons. The record of the Brisbane Tramways Company had been one of continuous progress since the date, in 1896, when the tramway system was first taken over for the purpose of conversion to electric traction. To-day there was, by universal admission, the first electric tramway installation in Australia, and their manager reported that the omnibus proprietors, who were still lingering on, were now contemplating the disposal of their business. The Company had undertaken to construct certain additional lines, and to extend the equipment of their power station. At the time the Company took over the tramways they had about 20 miles of street and about 33 miles of single lines. Since that time, to the end of last year, they had opened about five additional miles of street or nine miles of single lines, and there remained to be opened a further seven miles of street and about another eight miles or more of single line. From the summary of receipts and expenditure of the tramways company, presented in the report, it would be seen that during the past year they worked at a percentage of 58 per cent., and they had reason to anticipate that a more satisfactory result would be reached in the future. Mr. Badger, the manager of the lines, was not only a very accomplished and experienced engineer, but he was an accomplished and resourceful tramway manager. He was also a most able diplomatist in the conduct of their affairs.

Mr. A. McIlwraith seconded the resolution, which was unanimously agreed to.

CUBA SUBMARINE TELEGRAPH.

Mr. Chas. W. Parish presided over the ordinary general meeting of this Company at the offices, Old Broad-street, and, in moving the adoption of the report, said it did not require much explanation, for of late the Company's half-yearly statements had been very similar to each other, and they contained no special items

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calling for particular attention, but in reviewing the last six months of 1901 with those of 1900 they had two periods of working under the same conditions, and he was pleased to be able to point out that July to December, 1901, yielded the Company a traffic of £9,270, against £8,903 for the same six months of 1900. The broken cable between Cape Cruz and Santiago, referred to in the last report, had been successfully repaired. The Board were still unable to announce the settlement of the Company's claim for damage done to the cables during the Spanish-American war. It was understood that the Bill in connection with the matter was now pending in the House of Representatives, and a communication on the subject had been received from the Foreign Office, who had helped the Company as much as possible. The Board believed that during this month the new Government of Cuba would take charge of the island and all its affairs, and they would then put forward the Company's claim for the overdue subsidy for the coast cables in accordance with the concession. The appeal of the West India and Panama Telegraph Company to the House of Lords had not yet come up for decision, but the directors were informed that it would probably do so in the autumn. He concluded by moving the adoption of the report, which was seconded by **Mr. R. Kaye Gray.**

A **Shareholder** enquired whether any information could be given as to what effect the Marconi system was likely to have on the Company's property?

The **Chairman** replied that, so far as the Board understood the Marconi system, it appeared to be in a very early stage yet, and was not likely to affect the shareholders' pockets in any degree. Scientific gentlemen on one side said that it was a good system, while others declared that it was of no use.

The resolution was carried unanimously, and the proposed dividends for the half-year were also sanctioned—namely, at the rate of 10 per cent. per annum, subject to income tax, on the preference shares, and 4 per cent. per annum, free of income tax, on the ordinary shares.

TELEGRAPH MANUFACTURING.

An extraordinary general meeting of this Company was held on Friday at Liverpool to consider the proposal to amalgamate the Company with the British Insulated Wire Company, Limited. Mr. James Taylor presided.

The **Solicitor** read the agreement, dated April 28, 1902, between the Telegraph Manufacturing Company (the vendor) and the British Insulated Wire Company (the purchaser). The vendor company agrees to sell and the purchaser company to purchase the whole of the assets and undertaking of the vendor, except the sum of £12,354, which the vendor company retains. The purchaser is to pay to the vendor company the sum of £400,000, to be satisfied by the allotment to the vendor company or its nominees of 20,000 fully paid-up preference shares of £5 each, and £30,000 fully paid-up ordinary shares of £5 each in the purchasing company. The sale takes effect as from Dec. 31 last, and is to be completed on May 31. The name of the purchaser company is to be changed into one embodying the distinctive features of the name of the two companies.

The **Chairman,** in moving that the agreement be confirmed, said it had been evident for some time to the directors that competition was increasing, and, therefore, the directors had come to the conclusion it would be better to enter into partnership with a large firm doing this class of work rather than continue competitors, especially in view of the fact that two large companies in the South in a similar business were joining hands. The last four months showed a very substantial increase in the business of the British Insulated Wire Company, and with the prospect of better foreign trade the shares ought now to stand higher in the market.

The resolution was carried unanimously.

WESTERN TELEGRAPH.

The ordinary general meeting of this Company was held at the River Plate House in the City on Wednesday, Sir J. Wolfe-Barry presiding.

The **Chairman,** in moving the adoption of the report, remarked that it was not altogether as satisfactory as the directors could have wished, because the message receipts had amounted to only £209,000, showing a decrease of £43,000 as compared with those for the December half of 1900. The receipts of the six months to December, 1900, however, were the largest that the Company had ever secured, owing, to a large extent, to the interruptions and inefficient working of competing lines. In the period under review they had also been working at a lower tariff than that which was in force in 1900, but the more important consideration affecting them was the fact that general business in South America had been, and continued to be, on a very much smaller scale than it was in the corresponding period of the previous year. There was, however, nothing whatever to discourage the shareholders in the accounts now submitted. The original cable laid along the coast of Brazil had for the last year or two kept their cable ship so constantly engaged in repairs that the directors decided to renew and in some parts divert the course of the cable at several positions where frequent interruptions occurred. The operations had just been carried out by a chartered cable steamer, the expense of which would be shown in the current half-year's accounts. The renewals had greatly improved the condition of these sections, and duplex working had been successfully applied to one of the cables, a measure which was impracticable before. The result of the half-year's working was that the usual first and second interim dividends had been paid, £40,000 had been carried to the general reserve fund, and £2,000 to the maintenance ship's reserve fund, leaving £5,531 to be carried forward. The shareholders would also remember that a dividend of 7 per cent. was paid for 1901, being the same rate as had been paid for many years, and that the directors were able to place £79,000 to the reserves. The condition of the Company, therefore afforded no reason for anxiety. With regard to wireless telegraphy, he saw no reason whatever to alter the opinion he had formed, that, although wireless telegraphy might be a useful handmaid to cable companies, he did not regard it as a serious competitor.

Mr. D H. Goodsall seconded the motion, which was carried unanimously.

WEST INDIA AND PANAMA TELEGRAPH.

Presiding over the ordinary general meeting of the shareholders in this Company on Wednesday, **Mr. W. S. Kingsford** said that the Company had suffered severely in consequence of the Martinique disaster. They had lost their vessel, the "Grappler," with all on board; also the staff on the island, and four of the cables of the Company had been broken, with the result that there was no communication south of St. Lucia. He suggested the passing of a vote of condolence with the relatives of those who had lost their lives in this unprecedented disaster. In the result a resolution was carried authorising the Board to do all that was needful out of the funds of the Company to alleviate the distress of those relatives of their servants who had perished. Dealing with the affairs of the Company, the chairman pointed out that they had chartered a swift steamer for the conveyance of telegrams between the points of interruption, and the delay occasioned was not serious—from 24 to 48 hours. Happily, there had been no loss of life so far as the Company's employés in St. Vincent were concerned. It was too early yet to estimate what the cost of the disaster to the Company would be, or to say whether it would become necessary to trench on the reserve fund to any extent. Referring to the report and accounts, the chairman observed that as compared with the corresponding period of 1900 there had been an increase in revenue of £944 and a decrease in expenditure of £1,125.

The report was adopted.

PRIMITIVA GAS AND ELECTRIC LIGHTING.

The annual meeting of the shareholders in this Company was held at the offices, Bank-buildings, Lothbury, this week, Mr. H. E. Jones presiding.

In moving the adoption of the report, which appeared in our last issue, the **Chairman** observed that it was necessary to call attention to the reconstruction of the capital account, the present being the first meeting of the new company in England. The leading gas companies supplying the metropolis had converted their 10 per cent. stock into £250 of 4 per cent. stock, and this measure corresponded very much with what had been done in the case of their Company. The directors had had to deal with the question of reorganising the management at Buenos Ayres, and for this purpose Mr. W. G. Anderson, a well-known gas engineer in this country, was sent out. They had been able to secure the larger part of the coal which the Company would require in the current year at a very large reduction compared with the figures appearing in the present accounts. A revaluation had been made of the whole of the property, and it would be gratifying to the shareholders to learn that an increased value of nearly £100,000 was shown. About £300,000 of the Company's capital was invested in a very efficient and profitable electric light undertaking, the earnings of which, separately, would well justify a somewhat better dividend than that declared by the directors upon the whole undertaking, but they had felt that it was more prudent to retain the balance in hand. Although no increase had been shown in the past year in the sale of gas, there had been an advance of about 8 per cent. in the sale of electricity.

Mr. W. W. Phipps seconded the motion, which was agreed to unanimously.

ENGLISH ELECTRO-METALLURGICAL.

Presiding over the annual meeting of this Company at Salisbury House, E.C., the **Marquis d'Hautpoul** said the Company had been upon a commercial basis since the month of January, and was gradually increasing its output and extending its connections. The manufacture proceeded without the smallest hitch, and from that he thought they owed their acknowledgments to their colleagues who had brought to Leeds the best of their experience at Dives, and had produced works which already demonstrated considerable advantages over the original from which they had been copied. At the present moment their output was on the basis of 25 tons gross per week, but they were really ready for a turnover of 60 tons. The most important field for their tubes was in the construction of steamships, but for that they required the Board of Trade's certificate as regarded the mercantile marine, and to be accepted on the list of the Admiralty as regarded men-of-war. The Inspector of the Admiralty had tested and approved of their tubes, and for all practical purposes they were placed upon the official list. For steam-pipes, both on the Admiralty list and for the mercantile marine, they had still to await the Board of Trade tests, which began a fortnight ago. They hoped then to obtain an almost immediate augmentation of business. The copper market had got upon a more normal basis, which was of great importance to the Company. Under the advice of their managers the Board had decided to add a small plant for making brass tubes. The plant would be capable of turning out about 80 tons a month, and would greatly facilitate them in taking orders from firms who required supplies both of copper and brass goods.

Mr. A. Demmler seconded the motion for the adoption of the report, which was agreed to.

A resolution was also passed changing the name of the Company to the Leeds Copper Works, Limited.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Shanghai.—The last day for receiving tenders for the proposed municipal tramway and motor 'bus service is June 30.

Beckenham.—The Electric Lighting Committee invite tenders for the supply of incandescent lamps. Tenders by June 6. Details in our advertisement columns.

Dudley.—The Electric Lighting Committee invite tenders for the supply of incandescent lamps and oil. Tenders by June 6. Details in our advertisement columns.

Poplar.—The Electricity Committee invite tenders for the supply of about 130 cast-iron arc lamp columns. Tenders by May 28. Details in our advertisement columns.

Christiania.—The Government Telegraph Department, 14, Karl Johansgade, require tenders for about 60 tons of wire and a large number of insulators. Tenders by May 21.

Poplar.—The Electricity Committee invite tenders for the supply of special armoured cable, suitable for laying under water. Tenders by May 28. Details in our advertisement columns.

Glamorgan.—Tenders are invited for wiring and fittings at Parc Gwyllt and Angelton Asylums, near Bridgend, Glamorgan. Tenders by May 31. Details in our advertisement columns.

Valparaiso.—The Municipality are inviting tenders for electric lighting and tramways. We understand that particulars may be obtained from the Chilian Consul. Tenders by Sept. 1.

Hull.—The Corporation invite tenders for the supply of 20,000 cast-iron holding-down plates (weight, about 42 tons). Full particulars may be obtained at the City Engineer's Office. Tenders by May 30.

Oldham.—The Electricity Committee invite tenders for supplying the cables, troughing, bitumen, and insulators comprised in contract No. 6. Tenders by May 20. Details in our advertisement columns.

Barking.—The Urban District Council invite tenders for motors, pipework, chequer plating, etc. Full particulars may be obtained from the Engineer, Electricity Works, East Barking. Tenders by June 6.

Brighton.—The Town Council invite tenders for the supply of 300 tons of steel girder tramrails. Specifications, etc., may be obtained from Mr. Thos. B. Holliday, tramways engineer, Lewes-road, Brighton. Tenders by June 9.

Bedford.—The Electricity Committee invite tenders for the supply and delivery of economisers. Specification, etc., can be obtained from the Borough Electrical Engineer, Cauldwell-road, Bedford. Tenders by May 17.

Manchester.—Messrs. W. T. Glover and Co., Limited, of Trafford Park, Manchester, invite estimates from makers of electrical transformers for a transformer to give 150,000 volts for cable testing. Particulars on application.

Glasgow.—The Corporation invite tenders for one economiser, with induced-draught fan, and condensing plant. Particulars may be obtained from Mr. W. A. Chamen, the engineer, 75, Waterloo-street, Glasgow. Tenders by June 7.

Bury (Lancs.).—The Electricity Committee invite tenders for the supply and erection of jet condenser and pumps. Specification, etc., may be obtained from Mr. S. J. Watson, engineer and manager, Electricity Works, Bury. Tenders by May 20.

Coventry.—The Electric Light Committee invite tenders for the supply and erection of steam and water pipes and accessories. Particulars may be obtained from the Electrical Engineer's Office, Electricity Works, Coventry. Tenders by May 26.

Stockport.—The Gas and Electricity Committee invite tenders for supply of one water-tube boiler for their electricity station at Millgate. Specifications, etc., may be obtained from the engineer, Mr. S. Meunier, Gas and Electricity Office, Portwood. Tenders by May 21.

West Ham.—The Corporation invite tenders for the construction of about eight miles of route length of tramways. Specifications, etc., may be obtained from the offices of Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster. Tenders by June 10.

Brighton.—The Town Council invite tenders for the supply of points, crossings, tiebars, bolts, and other fittings. Specifications, etc., may be obtained on application at the office of Mr. Thos. B. Holliday, tramways engineer, Lewes-road, Brighton. Tenders by June 9.

Burton-upon-Trent.—The Corporation invite tenders for the supply and erection of three 100-kw. high-speed tramway generators and switchboard, and three Lancashire boilers, steam-pipes, jet condensing plant, economiser, and accessories. Tenders by May 30. Details in our advertisement columns.

Warrington.—The Health Committee invite tenders for the wiring and installation of electrical fittings at the infectious diseases hospital, Monk-street. Specifications, etc., may be seen and all further information obtained from the Borough Surveyor, Town Hall, where tenders must be delivered by 4 p.m. on 21st inst.

Manchester.—The Tramways Committee invite tenders for the supply of cast-iron bases, collars, and finials for tramway poles; and tramway rail bonds. Specification, etc., may be obtained from Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders by May 24.

Govan.—The Council invite tenders for fuse boxes for house services, meters (not electrolytic), demand indicators, manhole boxes and connections, and joint-boxes for armoured cables. Particulars may be obtained from Mr. J. Brown, resident electrical engineer, Electricity Works, Govan. Tenders by May 27.

Astrachan.—Erection of electric generating station and installation of public and private lighting, commencing with 150 arc and 6,000 incandescent lamps. Manufacturers who will undertake to finish the work within two years can obtain particulars from the Municipality. Agents will not be able to tender. Tenders by June 7-20.

Edinburgh.—The Town Council invite tenders for the wrought-iron pipework in connection with the electric lighting of the north-west extension of the City Chambers. Specification, etc., can be obtained at the office of the Resident Electrical Engineer, Electricity Supply Station, Dewar-place, Edinburgh. Tenders by May 17.

Blackpool.—The Corporation invite tenders for the supply and delivery of about 250 tons of slightly defective new or good second-hand steel flat-bottomed rails, about 75lb. per lineal yard, together with fishplates, bolts, and wrought-iron spikes. Specification, etc., may be obtained from Mr. John S. Brodie, A.M.I.C.E., borough engineer, Town Hall, Blackpool. Tenders by May 20.

Swindon.—The Corporation invite tenders for the supply, delivery, and erection at the electricity works, Swindon (Wilts), of 252 accumulator cells and accessories. Specification, etc., may be seen at the offices of the engineers, Messrs. Lacey, Clirehugh and Sillar, 78, King-street, Manchester, and at 2, Queen Anne's-gate, Westminster. Tenders by May 19. Details in our advertisement columns.

Worthing.—The Corporation invite tenders for the supply and erection of one 250-kw. steam dynamo (continuous-current dynamo direct-coupled to a vertical enclosed high-speed engine), and one dry-back marine type boiler, with fittings. The specifications, etc., can be inspected and all information obtained at the offices of Messrs. Burstall and Monkhouse, 14, Old Queen-street, Westminster, S.W. Tenders by May 26.

RESULTS OF TENDERS.

Cardiff.—The Corporation have accepted the tender of Dick, Kerr, and Co. for 20 double-deck double-bogie and 20 double-deck single-truck cars.

Peterborough.—The tender of McKenzie Bros., of Edinburgh, for the supply of arc lamp pillars for electric street lighting, at £445, has been accepted.

Morley.—The Town Council have accepted the tender of the Morley Electrical Engineering Company for supply of two electrical exciters at £104. 2s.

Electrical Plant for South Africa.—The Koffyfontein Mines, Limited, have placed an order with Dick, Kerr, and Co. for complete electrical plant for haulage and lighting at the mines.

Nelson.—The Town Council have accepted the following tenders for the construction of the light railways: R. Blackwell and Co., overhead equipment, £1,660. 18s. 9d., and rails, etc., £5,525. 7s.

Electric Launches.—The Thames Electric Launch Company, Weybridge, have a number of important orders for electric launches in hand for private owners on the Thames, one for use in the Bay of Naples, and an electric pinnace for the Natal Government.

Luton.—The Town Council have accepted tender B of the St. Helens Cable Company, Warrington, for the supply and delivery of distributing cables or mains, at £250. 16s. 4d.; 10 tenders were received. The wiring of the town hall has been carried out by Taylor and Co., at £98. 2s. 5d.

Holwell Ironworks, Asfordby.—This company have placed their order with the Electrical Company, Limited, 122-124, Charing Cross-road, W.C., for erection of a power plant at their extensive works. The tender of Belliss and Morcom, Limited, has been accepted for two 220-h.p. engines.

Broughty.—The Town Council have accepted the following tenders for machinery: Belliss and Morcom, Birmingham, one 60-kw. engine and dynamo and one 30-kw. engine and dynamo, together with spare armature for the larger set and spare parts for both engines, £1,280; and Cooper and Greig, Dundee, for condensers and pumps, £456.

Kensington.—The following tenders have been received for installing the electric light in Warwick-road stables in accordance with the specification prepared by the lighting engineer—viz.: A. Grundy, £379. 10s.; J. E. Spagnoletti and Co., £340; H. Nash, £275. 10s.; Chard and Co. £249; C. Oliver and Co., £205. 10s. 6d. (accepted).

Sheffield.—Messrs. Cravens, Limited, Darnall, have secured the contract for 20 double-deck cars, at £12,800, to be supplied with Hadfield's wheels. The tender of Cole, Marchent, and Morley has been accepted for the supply of one 1,000-kw. generator for the new engine, at £3,200, the firm to be allowed to sub-let to the British Thomson-Houston Company.

Rathmines.—The Council have accepted the following tenders for the extension of the electricity supply works and mains: Dick, Kerr, and Co., one 300-kw. steam dynamo, pipework, and accessories (with Willans engine), £3,547. 10s. 8d.; Kelvin and J. White, Limited, extension of switchboard, £174; British Insulated Wire Company, Limited, supply mains, schedule rates for various cables.

Elland.—The District Council have accepted the following tenders for the plant of the proposed electricity works for the district: Belliss and Morcom, Birmingham, engines; Greenwood and Batley, Leeds, dynamos; Ashmore, Benson, Pease, and Co., Stockton-on-Tees, storage battery; H. H. Wright, Halifax, switchboard; J. Hitchin and Son, Halifax, crane; Anchor Cable Company, Leigh, cables; Thornton and Crebbin, Bradford, condensers.

Hammersmith.—The estimate for the Hythe-road extension work includes three transformer boxes for distributing network, at £60 each. Prices have been obtained from the following firms—viz.: Siemens Bros. and Co., Woolwich, £79 each; Electrical Construction

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Company, Wolverhampton, £70 each; and Ferranti Limited, Hollinwood, £36 each. Messrs. Ferranti have not quoted for the same size box as the other firms, but for their standard pattern. The box is the same size as those at present in use, and three transformer boxes will be purchased from Messrs. Ferranti at the quoted price, and three 50-kw. transformers for working in same at the price of £80. 10s. each.

Cables.—We are informed that the British Insulated Wire Company have received during the past few days orders for cables as undermentioned: Ashton-under-Lyne, extensions; Brompton and Kensington Electrical Supply Company, extensions; Farnworth Urban District Council, extensions; Kensington and Knightsbridge Electric Supply Company, extensions; Dublin Corporation, further considerable extensions; Harrogate Corporation, extensions; Chesterfield Corporation, extensions; Portsmouth Corporation, extensions; Brighton Corporation, extensions; Jarrow and South Shields, tramway cables for the British Electric Traction Company; Ogmore Valley Electric Company, extensions; Glasgow Corporation, telephone cables, further considerable extensions; Willesden, extensions.

Heckmondwike.—The Electric Lighting Committee have received tenders for the supply and erection of the following plant for the extension of the electricity works: (Section A) steam, water, and exhaust piping, etc.; (B) steam traction generator; (C) storage battery and automatic reversible booster; (D) alterations and extensions to main switchboard; (E) condenser and oil separator; (F) water-cooling tower; (G) underground traction and return feeders. Accepted tenders: (Section A) Thornton and Crebbin, Hammerton-street Ironworks, Bradford; (B) Dick, Kerr, and Co., with a Howden engine; (C) Chloride Electrical Syndicate, Clifton Junction; (D) Bertram Thomas, Pulme, Manchester; (E) Thornton and Crebbin; (F) Worthington Pumping Engine Company, Manchester; (G) W. T. Henley and Co., London.

Salford.—The Electric Light Committee have accepted the tenders of the following firms for the annual supply of materials: Belliss and Morcom, Limited, crank chamber oil, 1s. 4d. per gallon; A. Kenyon and Co., cement for joint rings, 7d. per lb.; J. Wrigley, sponge cloths 7d. per gross, best white waste 30s. per cwt., coloured waste 18s. per cwt.; A. Kenyon and Co., packing, at a schedule of prices; J. Smith, rubber insertion, 1s. 4d. per lb.; General Electric Company, rubber solution, tape and wires, at a schedule of prices; Siemens Bros. and Co., Limited, rubber strip and mica sheets, at a schedule of prices; Johnson and Phillips, copper strip, 11d. per lb.; Baxendale and Co., solder and plumber's metal, at a schedule of prices; W. T. Glover and Co., Limited, compound for joints, £2. 6s. 8d. per cwt.; G. Forest, cast-iron boxes 8s. per cwt., frames and covers 7s. per cwt.; G. Clarke and Sons, tee-joint boxes 18s. each, straight-joint boxes 14s. each; Lloyd and Lloyd, wrought-iron pipes and bends, at a schedule of prices; Staveley Coal and Iron Company, Limited, cast-iron pipes and bends, at a schedule of prices; W. Higgins and Son, bricks, at a schedule of prices; Place and Sons, earthenware pipes, 6½d. per yard; Doulton and Co., earthenware specials, at a schedule of prices; Howard Conduit Company, troughing, at a schedule of prices; Albion Clay Company, conduits, at a schedule of prices; Baxendale and Co., buckets, screws, bolts and nuts, steel wire, and shovels, at a schedule of prices; W. Shorrocks, brushes, etc., at a schedule of prices; J. Smith, sheet lead, lead piping, and block tin, at a schedule of prices; Wingfield and Co., paints, oils, soft soap, and sundries, at a schedule of prices. The "deferred payment purchase system" for the wiring of consumers' premises submitted by F. W. Smith and Co., Limited, has been adopted.

BUSINESS NOTES.

TRACTION.

Berlin.—Yesterday the first Pan-American Automobile Exhibition was opened here.

Plymouth.—It is hoped to have the electric cars running to the promenade pier very shortly.

Kirkintilloch.—The Corporation of Glasgow have promised to consider a proposal to run a tramway to this place.

Aberdeen.—It is expected that the Queen's Cross and Bayview section of the tramways will be opened for traffic very shortly.

Belfast.—The Corporation have now definitely decided to oppose the Cavehill and Whitewell Tramways Bill in the House of Lords.

Sheffield.—The City Council have agreed to make a loan of £16,000 out of the tramway profits towards the Angle-street building scheme.

Fraserburgh.—Preparations are being made for making a start with the construction of the Fraserburgh and St. Combs light railway.

Birkenhead.—The Tramways Committee have been authorised to lay a second track in Balls-road between Woodchurch-road and Slatey-road.

North Metropolitan Tramways.—Plans for the electrification of the above tramways have been deposited by the London County Council with the company.

Swansea.—The Light Railway Commissioners will open a local enquiry to-day into the scheme for constructing a light railway between Morriston and Pontardawe.

Colchester.—Messrs. Kennedy and Jenkin have been retained to advise the Town Council in the matter of the construction of tramways under the Colchester order.

Ainsdale.—The Parish Council have decided to approach the Birkdale Urban District Council with a view to getting an extension of the tramways to Ainsdale.

Batley.—An agreement has now been come to between the Corporation and the British Electric Traction Company respecting a lease to that company of the local tramways.

Dingwall.—Information has been received to the effect that the order for the Cromarty and Dingwall light railway has been passed without amendment by the Board of Trade.

Yarmouth.—It is hoped to have the electric cars running on some of the sections of the new tramways in June. The working of the lines on Sundays has already been agreed to.

Rotherham.—The Corporation have appointed a sub-committee with power to approach the Sheffield Corporation and enter into negotiations for a working agreement with respect to tramways.

Cardiff.—The Town Council on Monday reversed the decision come to at the last meeting not to run trams on Sundays, and it was resolved to run the cars on Sundays between the hours of 2 and 10 p.m.

Morley.—The British Electric Traction Company have the arrangements well in hand for proceeding with the laying of the tramways at this place. The plans are now nearly ready for submission to the Town Council.

North Staffordshire.—The North Staffordshire Tramways Bill, which had already received the sanction of the House of Commons, passed through its committee stage in the House of Lords on Tuesday without opposition.

Crewe.—The Town Council have rescinded their resolution to promote a light railway scheme for the borough, on the ground mainly that the recent poll of the townspeople did not truly represent the popular feeling in the matter.

London United Tramways Bill.—It has been officially notified that the London United Tramways Bill is to be considered on Thursday, May 29, by a committee of the House of Commons presided over by Mr. Compton Rickett.

Hastings.—Several additions are being made to the motorcar services at Hastings, which would indicate that this style of vehicular communication with the outlying districts is much appreciated by the residents and visitors to the town.

Handsworth.—The District Council propose to give notice to the South Staffordshire Tramways Company that they propose acquiring that portion of the company's system within the Handsworth boundary within a certain period.

Bordeaux Electric Tramways Co.—The dividend of 5fr. for 1901 is now payable, and registered certificates, coupons, and drawn shares can be deposited with the Comptoir Nationale d'Escompte de Paris, at 52, Threadneedle-street, E.C.

Kensington.—The Law Committee recommend that they be vested with authority to take "all such action as may be deemed expedient in the best interests of the borough" in regard to the Central London Railway and the London United Electric Railway Bills.

Aston.—The District Council are applying to the Board of Trade for sanction to an expenditure of £24,516 for the electrical equipment of tramways, being part of a sum of £65,000 in respect of which an application has already been made to the Local Government Board.

Deanhead Light Railway.—Amongst the light railway orders recently confirmed by the Board of Trade is the Deanhead Light Railway Order, 1902, authorising the construction of a light railway in the county of York, from Stainland-with-Old Lindley to Greetland.

Nelson.—The Tramways Committee recommend the Town Council to support the application of the promoters of the Colne and Trawden Light Railways Order, 1901, so as to empower the promoters and the Corporation to enter into agreements for working their respective light railways.

Doncaster.—The proposed new tramways will run to Bentley, Balby, Hexthorpe, Wheatley, Hyde Park, Avenue-road, and the Race Common. Contracts for the various works have been let, and it is expected that the lines to Blaby and Hexthorpe will be the first to be opened.

Cheltenham.—A final agreement has now been arrived at between the Corporation and the Cheltenham and District Light Railway Company concerning both the existing line and the proposed extensions, which are to form the subject of the Light Railway Commissioners' enquiry this week.

Southend.—On Thursday last week the Light Railway Commissioners opened an enquiry into the application of the Railways and General Construction and Maintenance Company, Limited, for an order authorising the construction of the Southend, Bradwell, and Colchester light railway. The estimated cost of the scheme is about £300,000.

Lowestoft.—Mr. Hawtayne, the Council's consulting electrical engineer, has completed the plans and specifications for the laying of the tramways. The inside of the track is to be laid with basaltic lava, with an outside margin of granite setts. The Council are in negotiation with the Prudential Assurance Company with regard to a tramway loan of £250,000.

Wigan.—The Council have sealed an agreement between the Corporation and the Wigan and District Tramways Company, Limited, for the sale of the company's undertaking to the Corporation upon the terms already arranged, and also a conveyance from the Corporation to the Pemberton Urban District Council of so much of the tramways undertaking as is situate in that township.

Scarborough.—At the request of the promoters of the Scarborough Tramways Bill, which has now passed its third reading, the Corporation have agreed to apply to the Commissioners of Woods and Forests for their consent to the construction of tramways across the new marine

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drive round the castle foot. The drive, which is now in course of construction, will connect the north and south promenades.

Liverpool.—A Liverpool gentleman has recovered £150 damages for personal injuries from the Corporation. He was boarding an electric tramcar at the pier head in July last, when, as he alleged, the car was improperly started by the conductor, with the result that his foot missed the step and he was dragged by the car for some distance, and finally his foot was run over and so severely injured that it had to be amputated.

Newcastle.—A commencement has been made with the erection of the trolley wires along Clayton-street. A meeting has been arranged between the Corporation tramways manager and the representatives of the trades union to consider the alleged grievances of the tramways employés. It is stated that in consequence of the proposed extension of the tramways further into Gosforth the capacity of the power-house will require to be increased.

Liverpool Overhead Railway.—A fire, which fortunately was not of a serious nature, occurred on a train on the Liverpool Overhead Railway on Tuesday night. Shortly after 10 o'clock the end of a train at Toxteth Dock Station was discovered to be on fire. The brigade from the dock was summoned, and the outbreak was extinguished in the course of a few minutes before much damage had been occasioned. There were no passengers in the train.

Wolverhampton.—The new electric tramway to Tettenhall is expected to be opened one day this week as far as the Half-Way House. It is reported that on Saturday last two horses at different times sustained severe shocks by coming in contact with one of the studs forming part of the Lorain surface-contact system in Darlington-street. It is stated that the box in question got out of order, but within half an hour the defect was put to rights again.

Shields and Sunderland Tramways.—The Select Committee of the House of Lords of which the Duke of Northumberland is chairman have found the preamble of the Bill promoted by the British Electric Traction Company to obtain parliamentary sanction to the construction of tramways in South Shields and from that place to Sunderland not proved. The chief opposition to the Bill came from the South Shields Corporation and the North-Eastern Railway Company.

Saddleworth.—The Select Committee of the House of Commons presided over by Lord Glenesk have passed the preamble of the Bill promoted by the Saddleworth and Springhead Tramway Company, one of the objects of which is to connect Saddleworth with Oldham and Mossley, and thereby effect a junction with Manchester. In announcing the decision of the committee, the Chairman said that, if required, the company must sell portions of their undertaking on Board of Trade terms.

Edinburgh.—The negotiations between the Corporation and the Edinburgh and District Tramways Company, Limited, for the settlement of the dispute as to the payment of the rent have unexpectedly fallen through. A proposal was formulated at a private meeting of the Town Council on Tuesday to take proceedings for the recovery of the full amount due by the tramway company, but this was negatived and it was left in the hands of the Lord Provost's Committee and the town clerk to take further proceedings.

Nottingham.—The Corporation Bill, which is to authorise the Corporation of Nottingham, among other things, to construct additional tramways at a cost of £87,500, was before Lord Morley's Committee as an unopposed measure on Tuesday. Eventually the proposed clauses were allowed to go through for the third reading stage, but the formal report was kept back for further consideration with reference to a clause at the instance of the Postmaster-General for the protection of the telegraphic wires.

Southport.—The borough surveyor and the electrical engineer have been instructed to prepare plans and estimates for laying down and equipping the new tramways in Shakespeare-street, Duke-street, Cemetery-road, and Ash-street. The borough treasurer reported at the last meeting of the Town Council that the cost of reconstruction of the lines leased to the Southport Tramways Company, Limited, had been £60,979, and it was resolved that the town clerk be instructed to complete the new lease of the lines to the company.

Private Bills.—In the House of Lords the following Bills have been read a third time: Northumberland Electric Tramways Bill, Newcastle-upon Tyne Electric Supply Bill, Newcastle-upon-Tyne Corporation Tramways Bill, and Cornwall Electric Power Bill. In the House of Commons the following Bills have been read a third time: Metropolitan District Railway Bill, Norwich Corporation (Electricity, etc.) Bill, the Scarborough Tramways Bill, and the Garston and District Tramways and Electric Supply (Transfer) Bill.

Middlesbrough.—The Board of Trade have forwarded the Corporation a copy of revised regulations proposed to be made by them with respect to the use of electrical power on the overhead trolley system of the Imperial Tramways Company. The Hackney Carriage Committee have replied, requesting the Board of Trade to amend the first clause so as to provide for a speed indicator to be fixed in a conspicuous place in each car, open to the public view, and also to add a clause providing for lifting jacks to be carried on each car.

Huddersfield.—Major Druitt, of the Board of Trade, on Wednesday inspected further routes of the Corporation tramways which have been converted for electric traction—viz., the Waterloo, Mold Green, and Stile Common. With these Major Druitt expressed satisfaction, and the lines were forthwith opened for traffic. The Fartown and Sheepbridge sections are practically completed, and will no doubt be opened shortly. It is expected that the whole of the remaining sections will be ready for the electric cars by the beginning of July.

Paris Metropolitan Railway.—The annual general meeting of the Paris Metropolitan Railway Company was held a few days ago in Paris. The total traffic receipts and revenues from side sources, such as advertising and bookstalls, amounted for the year 1901 to £342,008, and the total working expenditure to £161,263. The gross profits, amounting to £180,735, were apportioned as follows: proportion to the city of Paris, according to the terms of the concession, £111,125; company's net profits, £69,610. The dividend voted was 15fr. per share.

Wealdstone.—The following resolution has been passed by the Urban District Council: "That having regard to the rumours abroad in the district that the route of the proposed line of light railway from Harrow will be along Headstone and Harrow View roads, thus practically omitting Wealdstone from the scheme, the County Council of Middlesex be asked to reconsider the whole question, and to arrange in their scheme for the route to be along the main (Station) road and through the High-street, Wealdstone, as proposed in the former scheme."

Ettrick Bay.—The order for the electric tramway promoted by the Rothesay Tramway Company came before the Parliamentary Committee on Friday last in Edinburgh. The order comprises a tramroad two miles three furlongs in length, practically the whole of which will be a double line, commencing at Port Bannatyne, and terminating about 400 yards east of Drumachloy Bridge. Power is also sought to acquire land for a generating station, and for carsheds, the former in Rothesay and the latter in Ettrick Bay. There being no opposition, formal evidence was given proving the preamble, and the order was duly passed.

Eccles.—Last Friday saw the opening for traffic of the first portion of the electrically-equipped tramways. Previously to this the electric cars had only run to the Salford boundary at Ladywell sanatorium, but on the completion of the negotiations and arrangements with the Eccles Corporation the work of extension was proceeded with with commendable promptitude, and within a period of 18 days over a mile of single track, together with its accompanying overhead equipment, had been completed. Thus early on Friday morning the first car, set apart for working-men, was enabled to leave Eccles Town Hall and proceed to Salford and Manchester.

Presentation.—The assistant engineer of the Blackburn tramways, Mr. C. Barber, who has been appointed to the position of works engineer and traffic manager of the Bournemouth Corporation tramways, before leaving Blackburn was presented by the staff and employés of the tramways department with a gold albert, silver cigarette-case, etc. Mr. Giles, in making the presentation, spoke very highly of the way Mr. Barber had carried out his duties, and of the great esteem in which he was held by all the staff. Mr. Barber, in a few well-chosen words, thanked the staff very sincerely for the handsome presents and for the kind feeling that had been shown him during his stay in Blackburn.

London County Council.—Last week we noted in these columns that the Council had acquired the old property of the Gaslight and Coke Company at Pimlico as a site for a generating station in connection with the Council's southern tramways. There now seems to be some doubt as to whether the Council have the power to utilise the site for this purpose, and at their usual weekly meeting on Tuesday the Parliamentary Committee reported that as a matter of emergency they had given the necessary instructions for obtaining powers in the present session of Parliament to enable the Council to build a generating station on the land in question. It is thought that there is still time before Parliament is prorogued to get a Bill through for this purpose.

Dundee.—At a recent meeting of the Tramways Committee on the subject of the kind of cars to be used, Prof. Kennedy reported the result of the negotiations he had already had with the Board of Trade on the subject of the type of car, from which it appeared there was little hope that the Board would consent to the use of the double-decked car already agreed upon. Prof. Kennedy having also made explanations in regard to the different types of car, it appeared to the committee there was no help but to adopt the single-decked car in the event of Prof. Kennedy failing to get the Board of Trade to pass the double-decked car already agreed upon by the Council. It was, however, resolved to make one more effort to get the Board of Trade to sanction the double-decked cars.

Manchester.—The Stockport-road route of the Corporation tramways is now finished, and will very shortly be opened for traffic. At the monthly meeting of the Davyhulme Parochial Committee on Friday plans were submitted of a proposal for the construction of a system of tramways which will connect Barton Bridge with Glossop. It is intended to promote the scheme in the next session of Parliament. The tramways embrace the following places: Northenden, Cheadle and Gatley, Bramhall, Poynton, Hazel Grove, Marple, Ludworth, Chisworth, Charlesworth, Mottram, Broadbottom, and Glossop. The Davyhulme Parochial Committee offered no objection to the proposed tramways, but the plans have yet to be submitted to the Parish Council for acceptance.

Bradford.—The Wakefield-road section of the Corporation tramways was opened for traffic yesterday. Good progress continues to be made with the conversion of the other tramways from steam traction to electric traction. The section between Rawson-square and the grammar school has been in great measure relaid, and the posts erected for the support of the overhead equipment, and a few days will see the junction finished with the completed line in Manningham-lane. The section of the line from Manningham-lane to the North Park gates and on St. Mary's-road has also made much progress, a great deal of the work being already completed. On the Otley-road route poles have been erected for the support of the overhead equipment, but the lines have yet to be relaid and bonded. A start has also been made with the laying down of the new line to Little Horton.

Yeadon.—At the last meeting of the District Council Mr. G. H. Teale reported upon an interview which he had had with the representatives of the syndicate who are proposing to lay a tramway through

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the district. He was told that the project was not yet matured, but the syndicate had in view the laying of a tramway from the Leeds boundary at Kirkstall, through Horsforth, Rawdon and Yeadon to Guiseley Green Bottom, and up Park-road, down Hollings Hill, through Shipley and Bingley to Keighley. In conjunction with the tramway it was also proposed to supply electricity for lighting and motor purposes in the district through which the tramways were run. The deputation were also told that the syndicate would be able to supply electric light at a cheaper rate than the price now charged for gas in the Yeadon district. The syndicate promised that when the scheme was matured they would attend before the respective councils and lay it before them.

Wrexham.—The tramways company propose to make certain alterations in connection with the making of the proposed line, including the substitution of a single for a double-single line in Regent-street, between Cathrall's-lane and Duke-street; and also the substitution of a double for a single line down Vicarage-hill for the safety of traffic, owing to the many turnings in the road. The committee of the House of Lords presided over by Lord Glenesk has had under consideration the Bill promoted by the Wrexham District Tramways Company, the object of which is to extend the authorised tramway from Wrexham to Rhosllanerchrugog so as to carry passengers further in the latter place to a point near Rhos Station. The only opponents to the scheme were the Great Western Railway Company, who have a branch line between the two places. It was stated that the tramway company had now passed into the hands of the British Electric Traction Company. After hearing evidence the committee found the preamble proved.

Clacton.—The Corporation have before them an offer from the British Electric Traction Company to promote a scheme of electric tramways in the district. The Light Railway Commissioners held a public enquiry on Wednesday, May 7, into the application for an order to authorise the Clacton and St. Osyth light railway. The chief objection lodged was that by the Clacton Council with regard to the conveyance of goods. They desired that no goods, cattle, or other trucks should be run on the railway. The Rural District Council and the St. Osyth Parish Council were, however, in favour of the carrying of goods. The promoters were prepared to make any reasonable concession so far as regards time and offensive goods were concerned. The estimated cost of the scheme is £36,987, providing for about 4½ miles of line. With reference to the Council's application to the Local Government Board for permission to let a portion of the cliffs for the proposed electric stairway, a letter has been received from the Local Government Board declining to interfere in the matter, and it is stated that the company are now proceeding with the work.

Stockport.—By an agreement entered into between the Corporations of Stockport and Hyde, Bredbury and Romiley Council, and the Oldham and Hyde Electric Tramway Company, the Stockport Corporation will provide a service of cars between Lancashire Bridge, Stockport, and the Market-place, Hyde, and the company between Market-place, Hyde, and St. Mark's Church, Bredbury. For a period of 12 months from the opening of the tramways the Stockport Corporation and the company shall be entitled to run a service of cars at intervals of not less than 10 minutes, the company over the lines of the Corporation to St. Mark's Church, Bredbury, and the Stockport Corporation over the lines of the company in Hyde. After the expiration of 12 months this provision shall be subject to revision, and in default of agreement settled by arbitration. The Stockport Corporation and the company are each to charge the full authorised fares upon the tramways, with certain fixed through fares. The question of the acquisition by the Corporation of the Stockport and Hazel Grove tramways has been considered at several meetings of the Tramways Committee, but no action has as yet been taken in it.

Camberwell.—At the meeting of the Borough Council on Wednesday the Finance Committee reported the receipt of a letter from the St. Pancras Borough Council stating that an attempt is being made in the House of Commons to amend Standing Order No. 22, the effect of which would be to abolish the veto vested in the local and road authorities in regard to the construction of tramways. A similar attempt was made in the House of Lords last year, when the Camberwell Council, having regard to the fact that the London County Council had become the authority for the tramways and would in future be the largest owner, passed a resolution in favour of the alteration of the parliamentary Standing Orders relating to Tramway Bills promoted by a municipal authority, but that the veto at present vested in local and road authorities should be retained where Tramway Bills are promoted by private companies. St. Pancras urges that combined action should be taken by the metropolitan borough councils to prevent their powers of veto in this respect being taken away. The committee recommended the Council to adhere to their previous resolution referred to above.

Paisley.—At the meeting of the Town Council on Tuesday a communication was submitted from Mr. W M. Murphy in reply to a request by the Town Council that before embarking on any expenditure for supplying the tramways with electricity they should be assured of a minimum annual demand of 500,000 units, and that if the generating machinery was ready before the tramways interest and sinking fund should in the interval be paid on their expenditure. In his reply Mr. Murphy declined to come under any obligation on these points, and stated that if the Corporation desired to be relieved of the liability to supply the company with electricity he was willing to entertain such a proposition. He also stated that he thought it right to add that he only counted on the line from Hawkhead to Johnstone being opened in the first instance, and that the electricity required for that line would be about 200,000 units per annum. After considering Mr. Murphy's letter, a report was prepared by the electric lighting convener (Mr. Fisher) and the engineer (Mr. Parkinson), in which they recommend the laying down meantime of plant to supply the tramways with 250,000 units per annum, the estimated cost being £8,500.

Embankment Tramways.—On Tuesday the Select Committee of the House of Commons charged with the consideration of the London County Council Tramways and Improvements Bill concluded their enquiry so far as the proposal for a tramway along the Embankment is concerned. After conferring in private, the chairman announced that the committee had come to the conclusion unanimously that the tramway should be authorised from Westminster Bridge to Waterloo Bridge. They proposed, however, to ask the promoters to bring up an arbitration clause for the protection of the District Railway. The effect of the decision is to enable the County Council to practically join up their southern and northern tramway systems by way of the underground line they propose to build under the new street from Waterloo and Strand to Holborn. The committee on Wednesday proceeded with the consideration of the other parts of the Bill, and in the result decided to approve each of the tramway proposals. They, however, required the insertion of a clause to carry out the suggestions for providing a more convenient terminus for the Putney line in the Lower Richmond-road, and they also struck out the clause giving power of contribution to the boroughs of Lambeth and Deptford. The committee then proceeded to consider the proposal for the widening of Hampstead-road at its junction with Tottenham Court-road.

Croydon and District Electric Tramways Bill.—This Bill has been before the committee of the House of Commons presided over by Mr. Compton Rickett for several days, being promoted by the British Electric Traction Company, with the approval of the Croydon Corporation. The company are lessees, under the Corporation, of the present Croydon tramway system between Norbury and Purley, and the proposals in the Bill include an extension to Waddon, Wallington, Carshalton, and Sutton. From Sutton continuations are proposed to Belmont and to Mitcham, where junction with the Mitcham light railway is contemplated, and communication with the London County Council system at Tooting. Another line is projected to Beddington, and it is proposed to extend the existing tramway to Penge and the Crystal Palace. Petitions against the Bill from frontagers on the lines of route, from the Surrey County Council in respect to matters in connection with main roads, and from the London, Brighton, and South Coast Railway Company on engineering details were represented by counsel, and a considerable amount of local evidence was given. On Wednesday the committee sanctioned the proposals, with the exception of the Carshalton and Wallington portion of the South and West Croydon extension, and refused to the London, Brighton, and South Coast Railway control over the connection at West Croydon.

LIGHTING AND GENERAL.

Bootle.—A number of proposed extensions have been brought to the notice of the Electric Lighting Committee.

Harrogate.—The Council have resolved to ask sanction to borrow £46,000 for purposes of electric light extensions.

Halifax.—The Town Council are about to appoint a special committee to consider the whole question of lighting.

Salford.—Judge Parry has been asked to conduct the enquiry into matters appertaining to the electricity department.

Norwich.—The Norwich Corporation (Electricity) Bill has been ordered for the third reading in the House of Commons.

Morley.—Two additional transformers are to be ordered for use in Baker-street and Queen-street, at a cost not exceeding £79.

Derby.—At a special meeting next Tuesday the Corporation will take into consideration the question of private lighting in the city.

New Issue.—Letters of allotment for the issue of 45,000 shares in the South Wales Electrical Power Distribution Company have been posted.

Eton.—The Rural District Council have consented to the proposed electric lighting of Slough and Datchet, subject to the provisions made by Mr. Pelham.

Bury St. Edmunds.—During the past month applications for 362 8-c.p. lamps have been received, and 24 street lamps have been connected to the electricity mains.

Chesham.—The Urban District Council have returned, with certain amendments, the draft agreement between them and the United Electric Light and Power Company.

Accident.—It is reported that a young married man named John Flannigan, while at work at Glasgow electric power station last week, fell among some machinery and was killed.

Scarborough.—The Town Council on Monday confirmed the minutes of the Telephone Sub-Committee authorising application for a license for a municipal telephone system.

Berwick.—The proposal to establish a telephone circuit from Berwick to Coldstream, thence to Leitholm, Greenlaw, Duns, Chirnside, Reston, Coldingham, Ayton, Eyemouth, is being revived.

Cowpen.—The Urban District Council have decided to accept the suggestion of the Northern Counties Electricity Supply Company to tender for the lighting by electricity of Cowpen Colliery-square.

Ormesby (Yorks).—The Urban District Council are in communication with the Cleveland and South Durham Electric Power Company, Limited, with a view of obtaining a supply of electricity in bulk.

Heywood.—The Electric Lighting Committee at their last meeting considered a letter from Mr. W. P. Adams, M.I.E.E., as to the free-wiring scheme, and further consideration was deferred until the next meeting.

Carnarvon.—With reference to the order which is being promoted by the Council, it has been reported to the Town Council that the time for the presentation of objections to the order has expired, and none have been presented.

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Glasgow.—A committee of the Chamber of Commerce have asked Sir Wm. Arrol to act in their interest and to call attention in Parliament this session to the desirability of extending the underground telegraph system to Scotland.

Hanley.—The Council will oppose the application proposed to be made by a syndicate anxious to establish a power scheme in the counties of Chester or Stafford. Several increases have been granted to the electricity works staff.

Worksop.—Several recommendations with a view to increasing the number of consumers and the extension of the cables are under consideration. It has also been decided to erect 75 new lamps in the public streets at a cost of £200.

Little Woolton.—Lieut.-Colonel A. C. Smith held an enquiry last week into an application by the Urban District Council to borrow £1,800 for electric lighting purposes. The current will be supplied by the Garston and District Electric Supply Company.

Harrogate.—The engineer's report and estimate as to the extensions required at the electric light station and street-lighting has been adopted, and application will be made for sanction to the borrowing of £46,000 for the carrying out of the works.

Heston and Isleworth.—The Electric Lighting Committee on Monday discussed electric lighting matters with Mr. Enright, their consulting engineer, and it was decided that a scheme should be prepared for the public and private lighting of the district.

Cryselco Arc Lamps.—We are informed by Messrs. Cryselco, Limited, Kempston Works, Bedford, that the increase in their business has compelled them to supplement their means of output by laying down a 100-h.p. Dowson gas generating plant with Crossley gas-engines.

Crook.—The Cleveland and Durham Electric Lighting Company are negotiating with the Urban District Council. The company propose to put in a power station at Witton Park or elsewhere, but the position of the station would depend upon the demand in each part of the district.

London County Council.—At the meeting on Tuesday it was agreed to lend the Battersea Borough Council £2,285 for electric lighting and the Shoreditch Borough Council £37,430 for electric lighting, street-lighting, and meters. A number of electric lighting mains notices were agreed to.

Brighton.—Great progress is being made with the works in connection with the erection of Brighton's electricity generating station, abutting on the foreshore at Fishergate. Messrs. Pedrette and Co., the contractors, have 16 engines in action, either working the crane or in use in pumping operations.

Newport.—Mr. Copland, the borough electrical engineer, has resigned. The working of the electricity works (for light) for the year ended March 31 last shows a total income of £12,422; works cost, £5,892; gross profit, £6,430; paid for interest and sinking fund, £5,571; and net profit, £859.

Hammersmith.—The loan of £7,295 for electric lighting from the London County Council has been completed. Since the last Council meeting 11 additional consumers have been connected, representing a maximum of 638 8-c.p. lamps, and the present number of consumers now taking current from the mains is 999.

Colne.—The electrical engineer's last monthly report showed that 2,745 units of electricity had been metered during the month, that 715 additional 8-c.p. lamps and eight arcs had been connected, and the maximum load on any day was 32 kw. The total number of units sold since the commencement of plant was 10,803.

"The Smart Set."—The June number of the *Smart Set* is just the thing with a roaring big fire, something hot to drink, and a pipe to get through these unseasonable Whitsuntide holidays. One might do worse than to start with "The Rebellion of May" as the most suitable to meet this special case. There are, as usual, a number of good things in the little volume.

Gravesend.—A a recent special meeting of the Town Council in committee, matters relative to the generating station buildings were discussed. The correspondence that had passed between the town clerk and Mr. Trentham was read, in which the engagement of Mr. E. J. Bennett to supervise the work of the new buildings was agreed, also the terms proposed.

Belfast.—Mr. H. M'K Sillars, who is at present the chief assistant in the electric and lighting department of the St. Pancras Borough Council, has been appointed mains distributor at a salary of £150 a year. Messrs. Harland and Wolff, Limited, have applied for electric current at their lower shipyard, and a sub-committee will deal with the matter at an early date.

Grantham.—Sanction has been obtained to borrow £1,500 for a municipal telephone service. The Postmaster-General has granted an extension of the license and wayleave powers so as to include Buckminster, Sproxton, Knipton, Harston, and Belvoir. Application has been made to the Leicester County Council for the consent requisite under the Telegraph Act, 1892.

Morecambe.—At the last meeting of the District Council the chairman of the Electric Light Committee reported a year's satisfactory progress, and said that had his department been a limited company they would have declared a dividend of 4 per cent. Next year they would do with less money from the rates, although they would have more principal and interest to repay.

Cardiff.—The National Provincial Bank of England are issuing on behalf of the Cardiff Corporation £742,000 3 per cent. stock, the proceeds of which will be devoted to the paying off of temporary advances incurred in respect of the purchase, reconstruction, and electrical equipment of the tramways, the new town hall, the new western sewer, and other purposes. The loan is a trust security, and the price of issue is £96 per cent.

Broughty.—Mr. Forbes Waddell, the gas manager, has been appointed engineer and manager of the Town Council's electricity department, at a salary of £50 for the first year. A special committee is to report anent the disposal of the ground at Dundas-street which was recently under consideration as a site for the electric station. The Council have decided to introduce the electric light into all its premises.

Aldershot.—The electric lighting works at Aldershot were officially opened on Wednesday last by Lady Hildyard, who switched on the light and also started up one of the Willans-Parker steam dynamos. The opening ceremony at the station was followed in the evening by a dinner at the Victoria Hotel. We understand that over 2,000 lamps are already connected to the mains, and that applications for connection continue to come in well.

London Gazette.—The last day for receiving proofs in the estate of G. F. Rogers, electrical engineer, 41, Maxilla-gardens, Notting Hill, London, is May 24. Mr. E. S. Grey, official receiver, Bankruptcy-buildings, Carey-street, W.C. The partnership existing between A. E. Ward and D. Fulton, manufacturing electrical engineers and lighting and power contractors, 4, Browne-street, Bootle, has been dissolved by mutual consent.

Worcester.—The electricity estimates, which came out very well last year, showing a surplus of £1,385, are not so good for the coming year, showing a surplus of £350 only, which is included in the general district rate estimate as a grant towards reduction of the rates. The increased amount payable on the new loans for dividends on stock and contributions to loans fund will account for the reduction in the estimated surplus on the accounts.

Manchester. The Stuart-street generating station will be opened on May 27. Recently some letters appeared in the local Press comparing the electricity charges in Manchester and Salford, much to the disadvantage of the former city. Attention is drawn to the fact that not long ago Manchester raised the price of electricity from 5d. to 5½d. per unit, whilst recently Salford has dropped it from 5d. to 4d., so that consumers are now paying 37½ per cent. more in Manchester than in Salford. The long-distance tramway fares in Manchester are uniformly 2d., while in Salford they are mostly only 1½d.

Stock Exchange.—The Stock Exchange Committee have appointed May 22 as special settling day for the following: Isle of Thanet Electric Tramways and Lighting Company, Limited, 30,000 5 per cent. cumulative preference shares of £5 each fully paid, Nos. 30,001 to 60,000; Cape Electric Tramways, Limited, further issue of 40,000 shares of £1 each fully paid, Nos. 440,001 to 480,000; and have ordered the said securities to be quoted in the official list: Milwaukee Electric Railway and Light Company, 397,000dol. additional 30-year consolidated mortgage 5 per cent. gold coupon bonds, 1926, Nos. 7,604 to 8,000 of 1,000dol. each.

Durham.—The County Council have decided to appoint a special committee to investigate and report upon the following points: (1) how far the county of Durham is covered by electric supply companies working under Acts of Parliament; (2) enquire as to any special facilities existing in the county for generating electricity by waterfalls, etc., and as to the practicability of such facilities being employed to advantage in the county; (3) enquire as to the financial results of electric schemes undertaken by municipal bodies; (4) enquire how far it would be practicable and wise to develop a scheme for an electric supply for the county or through the medium of urban and rural councils consistent with Acts of Parliament already obtained by existing companies; (5) report as to the best mode of procedure fo giving effect to their findings and recommendations.

Lighting Orders.—The Electric Lighting Provisional Orders (No. 4) Bill, confirming provisional orders which have been granted for electric lighting purposes to Amble, Leadgate, and Stanley, has passed the committee stage. The Electric Lighting Provisional Orders (No. 1) Bill, which confirms orders granted by the Board of Trade in respect to the supply of electric power to the local authorities of Wood Green, Edmonton, and Tottenham, has been confirmed. The North Metropolitan Electric Supply Company will not be allowed to come into Willesden except for the purposes of a generating station to supply the North London Electric Railway and districts outside Willesden. The committee also decided to give the local authorities an absolute veto for three years on the entry of the company, after the expiration of which the company might, if a local authority unreasonably withheld facilities from consumers, apply to the Board of Trade to be allowed to supply for power purposes.

National Telephone Co.—At the ninth annual staff dinner of the National Telephone Company, Limited, held last week, Sir H. Fowler, M.P., the president, said there were 1,025 exchanges in Great Britain and Ireland, and the Company's subscribers now numbered 226,000. At the present time there was a telephone for every 183 persons in the United Kingdom. In the year that had just closed they had sent 287 million messages, an increase of 75 millions on the figures of the previous year. The number of telegrams sent through the Post Office was 89 millions, showing a decrease of 838,000 messages. Lord Harris, a director, replied. Mr. W. E. L. Gaine, the general manager, spoke of the competition with the municipality of Glasgow. The Glasgow municipality had started with a system which the Company were leaving off. He thought he would be justified in saying that as the Glasgow Corporation went on and added with their *clientèle* their difficulties would increase, and as they went on this company's difficulties would decrease. This Company had spent money like water in Glasgow, but they were on the eve of having their Glasgow system as perfect and up to date a system as experts could make it. He honestly believed that in the competition with Glasgow, if it was to be a competition of efficiency, the Company would win, and the Corporation of Glasgow would have reason to regret that they had not tried the Company's plan instead of the one they had adopted.

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Barnsley.—The salaries of Mr. Barker and Mr. Wright, assistants to the borough electrical engineer, have been respectively increased from £130 to £150. Some time ago the Corporation sanctioned the expenditure of £2,000 in increasing the plant, in order to prepare for the incoming tramlines. Since then the engineer has hit on a scheme which, though involving a capital expenditure of £2,600, promises to save something like £500 a year.

Canterbury.—The surveyor, in conjunction with the engineer, has been requested to prepare a specification for painting the public lamp columns, and advertise for tenders for this and for the annual supplies. The surveyor and electrical engineer are also preparing a joint report as to the provision of an inclined way or other means of feeding the destructor, the working of the dust destructor at a lower temperature, and as to machinery for crushing the clinker.

Bolton.—On the proceedings of the Electricity Committee coming before the Council last week, Dr. Panton called attention to the cost of producing electricity in Bolton. Last year they were seventh on the list with a cost of 1·34d. per unit, against ·97d. per unit in Cork. He pointed out that instead of being seventh on the list, Bolton now stood at the top of the list, with a cost of ·96d. per unit. This was the lowest cost ever recorded in the United Kingdom.

Aberdeen Telephones.—The Telephone Committee of the Town Council have met Mr. Bennett, who expressed great satisfaction at the result of the recent canvass, which has given in 700 favourable answers, representing practically 1,000 instruments. Mr. Bennett said he had not the least hesitation in advising the committee to proceed with the scheme. The committee will meet again at an early date to determine what further action should be taken in the matter.

Explosion.—A little mishap occurred with the electric light at Crewe on Saturday evening. A heavy iron lid covering the cable connections was blown into the road, but fortunately no one was injured. The electric light also failed in the neighbourhood, and owing to the lateness of the hour it was impossible for the chief engineer and his staff to rectify matters the same night, but on Sunday the whole of the installations, both public and private, were put into working order.

Ayr.—The electrical engineer (Mr. A. J. Fuller) in his last report states that the whole of the works have run satisfactorily during the last month. The following figures are given: number of consumers as per last report, 520; number connected during month, 17—total, 537. Number of lamps connected as per last report, 22,302; number connected during month, 513—total, 22,815. Units generated as per last report, 643,293; units generated during month, 60,896—total, 704,109.

Swansea.—The Anglo-French Nickel Company have asked for quotations for the supply of electrical motive power to the extent of 130 h.p. to 230 h.p. The application is considered an important one by reason of the possibilities of extending such power to other works, thus providing a day load for the electric lighting station, and the Council have offered the following terms: 1½d. per unit providing a minimum supply of 150,000 units be taken, and 1¼d. per unit if 200,000 be taken.

The Volcano Outbreak.—When the volcano Mont Pelée exploded the fire from it swept the whole of St. Pierre, destroying the town and the shipping, including the steamer "Grappler," a screw steamer of about 900 tons, belonging to the West India and Panama Telegraph Company, which was engaged in repairing the cable near the Guerin factory. The "Pouyer-Quertier" is trying to repair the cable at Point à Petre. She reports that she finds it has sunk 1,200m. where it was formerly only 800m. down.

Sheffield.—The Electric Light Committee propose to reduce their charges for energy for motive power, and have decided that on and after June 26, 1902, the price of electrical energy used for motors be as follows: for all energy used in motors, driving hoists, cranes, passenger lifts, and similar machinery, 2d. per unit; for other motors, 1½d.; to consumers running their motors continuously through the whole of the working hours of each day, 1¼d.; and to consumers whose motors run continuously day and night, 1d.

Luton.—The resident electrical engineer in his last report states that since April 1 3,942 units had been generated; that 218 8-c.p. lamps and one motor of 9 h.p. were being wired, but were not ready for connection; and that the total number of consumers was 59, with an aggregate of 4,556 lamps and four motors of 8 h.p. The resident electrical engineer has been authorised to extend the cables in Park-street West at a cost of £30, and also to report upon the question of reducing the price of current for light and power.

Paddington.—At the last meeting of the Borough Council consideration was resumed of the scheme of the Electric, Gas, and Water Committee for substituting gas for electric light in Westbourne-terrace. The present 14 arc lamps cost £420 per annum, and it was proposed to substitute for them 50 incandescent gas lamps costing £199. 7s. 8d. to instal and £168. 16s. in yearly maintenance, the saving effected by the change being estimated at £253. 14s. annually. Finally, the consideration of the matter was adjourned for six months.

Crewe.—After paying expenses, there remains a profit on the electric light undertaking of upwards of £900 for the year ending March 31, which will be placed to reserve or depreciation account. A sum of £1,300 is to be borrowed for electric lighting purposes, and electric light consumers will be given the option of electing to be charged at the uniform rate of 4½d. per unit or at the present rate of 6d. and 3d. provided that whichever method of charge any consumer selects shall continue in operation for not less than 12 months.

Basingstoke.—The Urban District Council have asked the Board of Trade for an extension of time for their electric lighting order, which expires in June next, in view of the fact that the Council are heavily engaged in arranging new schemes of water supply and sewage, and that if a new sewage system is adopted the present pumping station may be available for the purpose of an electric lighting station. The Board have replied that they will defer consideration of the question of revoking the order for one year from June 25 next.

Rotherham.—The charge for electric lighting for the ensuing year is to be reduced as follows: flat rate of 4½d. per unit, with rebate scale, to be agreed upon. The last report by the engineer, Mr. Edward Cross, on the completion of the first financial year, states that, taking into consideration the small number of consumers connected during the greater portion of the period the works had been in operation, the amount sold was fully satisfactory. There is a small profit on the year, but it had been generally anticipated that there would be a loss.

Hartlepool.—At the last quarterly meeting of the Town Council a lengthy discussion took place on the draft license and agreement for the proposed municipal telephone undertaking being submitted for approval. Ultimately the matter was referred back. A letter from the Northern Counties Electric Supply Company relating to the terms for public and private lighting, equipment, and power has been deferred for further information, and application has been made to the West Hartlepool Corporation for terms for the supply of electric energy and fittings for public and private consumers.

Darwen.—The result of the last year's working of the electricity department shows a profit of £126. The production, which in the year ended March 31, 1901, was 266,000 units, reached during the past year 546,000 units—more than double. A great part of the power thus generated had been utilised for traction. There had been about 30 per cent. increase of current for lighting, about 10 per cent. increase in street lamps, and 2½ times increase in the current used for traction. The average selling price for the year ended March 31, 1901, was 2¾d. per unit. Last year it was 2·418d., a reduction of over ¼d.

Lowestoft.—Sanction has been obtained to the loan of £7,143, which the Council applied for recently for a new 500-kw. set and condensing plant. All places of worship are to be supplied with current at a fixed rate of 6d. per Board of Trade unit, and a cable is to be laid from the Grand Hotel to the new Congregational Church at a cost of £45. The resident electrical engineer (Mr. Bruce) in his last report states that there are now 11,495 8-c.p. lamps connected to the mains, representing 243 consumers, thus giving a total of 310 extra 8-c.p. lamps for the month. Applications for about 1,100 lights have been received.

Ealing.—The annual report of the electric lighting department of the Town Council contains the following very satisfactory paragraph: "A profit and loss account and balance-sheet of the undertaking has been prepared for the year ending March 31, 1902, and shows that the department has at least reached the profit-earning stage, and after meeting all charges, both for working expenses and interest and principal repayments, has made a profit of £420. 10s. 11d." Mr. Knight, the engineer, and Mr. Lewis, the business manager, are both to be congratulated for it—a fact which was well recognised at the last Council meeting.

Emden-Vigo Cable.—The working of the German Marine Telegraph Company's Emden-Vigo cable suffered many interruptions during the past year. The first fault arose on Jan. 28 and continued until March 13, while the second interruption was of shorter duration, having extended from Nov. 1 to the 9th of the same month. The repair of the cable at the first break occupied a considerable time in consequence of the unfavourable weather, and greatly increased the expenditure. The net profits for 1901 amount to £6,189, as compared with £12,058 in the previous year, and the dividend declared is at the rate of 3 per cent. as against 5 per cent. for 1900.

Pacific Cable.—The Prime Minister of the Australian Commonwealth has been advised by the Pacific Cable Board that it is proposed to pay off the loan money required for the cable—which will carry interest at the rate of 3 per cent.—in terminable annuities spread over 50 years. Great Britain, which finances the scheme, is responsible for five-eighteenths of the cost—estimated at £2,500,000—and Canada, Queensland, and New South Wales are responsible for the balance. In the event of the receipts not being sufficient to meet the working expenses and interest, the contracting countries will have to make good the deficiency in proportion to their obligation.

Tonbridge.—The Electric Lighting Committee of the Urban District Council have re-elected Mr. Race as their chairman for the ensuing year. Twelve further applications for the supply of electricity have been received. The contractors are proceeding satisfactorily, nearly one-half of the whole of the trenching has been done, the boilers have been completed, and the pipework is about to be commenced. The committee have asked Mr. Hammond to prepare a specification and obtain tenders for the purpose of wiring the electricity works. The work of providing a supply of electricity in the Dfive and Yardley-park will be proceeded with in due course.

Electric Launch Stations.—The Thames Valley Launch Company, Limited, Weybridge, Surrey, have already branch works and charging stations for electric launches and cars at Maidenhead, Hurley, Henley, Pangbourne, and Shillingford Bridge, and they will shortly open two new stations, one at Windsor and one at Reading. The ordinary price charged for current is 1s. 6d. per unit, but to purchasers of their own boats the company, besides allowing the free use of their stations for storage purposes, reduce this charge to 8d. per unit, which makes the cost of running the smaller size boats approximately 2d. per mile. We notice that the company have now a large number of specially-fitted electric launches for hire.

Burnley.—The electrical engineer has been asked by the Electricity Committee for instructions as to the charges to be made against the Tramways Committee for the supply of electrical energy for traction purposes. The committee, after carefully considering the matter, resolved that the electrical engineer send in an account for the energy used at the rate of 1⅞d. per unit for energy supplied within the

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borough, and 2d. per unit for energy supplied in Padiham and Reedley Hallows, he estimating the energy used within and without the borough as equitably as he could. When the matter came before the last meeting of the Council it was moved to take back that minute for further consideration. A portion of each committee is to meet to discuss this and other matters.

Kensington.—The Works Committee are about to purchase seven electric arc lamps and columns for Kensington High-street, between Wright's-lane and Earl's Court-road, at £171. 10s. Notices and plans received from the undermentioned electric lighting companies relative to proposed extensions of their mains in the borough have been agreed to—viz.: Kensington and Knightsbridge Electric Lighting Company—Young-street, Ball-street, King-street, and Burden-mews; Notting Hill Electric Lighting Company—Ladbroke-road and Bedford-gardens; and Brompton and Kensington Electricity Supply Company—Cromwell-road. Amongst the conditions we note a very sensible one, which we trust will soon become universal—namely, that the proposed main in Ball-street be laid at the same time as the Post Office telephone pipe, sanction for which has recently been given by the Council.

Cable Ship.—The steamship "Colonia," recently completed by Messrs. Wigham, Richardson, and Co., of Low Walker-on-Tyne, has been handed over to her owners—the Telegraph Construction and Maintenance Company—after a successful trial trip off the Tyne. The *Eastern Morning News* says the "Colonia" has the reputation of being the largest cable ship afloat, and she is a pretty model to boot, which is more than can be said for some of the older cable ships. In her four cable tanks she can stow 4,000 miles of deep-sea cable, and her equipment includes very complete installations of dynamometers and other plant necessary for the work of cable laying. After receiving her stock of cables she will at once proceed to the Pacific to complete the all-British cable round the earth between Vancouver and Fanning Island, thereby joining the cable laid *via* Fiji and New Zealand to Brisbane.

Huddersfield.—A further meeting of business men has been held at the offices of Messrs. Armitage and Norton, chartered accountants, Huddersfield, at which additional information as to the scope of the proposed electricity undertaking was given. Mr. Witting and Mr. Kolben were introduced to the meeting, and gave their reasons for the belief in the success of a business of the nature already described by us if it were set up at Huddersfield. Several questions were asked and answered, and Mr. Witting intimated that his firm would be prepared to put £20,000 into the concern. A sub-committee was formed to further interview Messrs. Witting and Mr. Kolben, with the object of getting all the necessary information to lay before a public meeting of the townspeople. The following is the committee: the Mayor, Alderman J. A. Brooke, Mr. John Sykes (Lindley), Mr. W. H. Armitage, and Mr. E. Crowther, with power to add to their number.

Fulham.—We understand that the Council on Wednesday rescinded the following resolution of the late Vestry: "We have adopted the following report from our Permanent Sub-Committee—viz.: We beg to report that we have had submitted to us information obtained by the clerk and consulting engineer from the various electric light undertakings in the Metropolis, and after full and careful consideration we recommend . . . and that 2½d. per unit be the charge for current for power or heating purposes." And adopted the following charges for energy supplied for motive power: to all consumers having motors installed of a power up to and including 25 b.h.p., 2½d. per unit; to all consumers having motors installed up to and including 50 b.h.p., 2d. per unit; and to all consumers having motors installed of over 50 b.h.p., 1½d. per unit, the brake horse-powers being the aggregated rated powers of the motors.

Limerick.—The minutes of the Electric Lighting Committee presented to the Corporation at their last meeting contained the following recommendations: "That the appointment of Mr. Baker, C.E., gas engineer, as assistant engineer and clerk of works, in connection with the generating station and the foundations, be recommended. That the Council pass the financial control of the electrical works to the care and management of the Gas Committee of the Borough Council. That a committee of five members be appointed who should meet regularly and deal with Mr. Enright and Mr. Baker on all points that may arise during the progress of the works, and who will act as superintendents, and visit the works periodically and report to Council on all matters in connection with the undertaking and the lighting of the city generally." As there appeared to be a legal difficulty as to whether they could give the control of the finances to the Gas Committee as at present constituted, it was decided to adjourn the further consideration of this point until legal advice had been obtained.

Bristol.—The water-softening plant (which has not been enlarged since the initial installation in 1893) is now inadequate for the demands made upon it. The electrical engineer has prepared a scheme for the erection of additional plant capable of softening 8,000 gallons per hour, and for the provision and erection of additional feed-water filters, feed and general service pumps, which, with the plant already laid down, will meet all demands likely to arise from the present works, at an estimated cost of £2,915. Plans are being prepared for extension of Avonbank works in consequence of the rapid growth of the undertaking. The Sanitary Committee have passed the following resolution: "That the gas company be requested to state, having regard to the extension of the electric lighting which the Council have determined to carry out, the price per lamp per annum at which they are prepared to supply gas to the public gas lamps, including maintenance and repair, it being understood that the Council will not bind themselves not to still further extend public electric lighting."

Dutch-German Cable.—The report of the committee of the Second Chamber of the Dutch States-General on the convention between Holland and Germany regarding telegraph cables to the Dutch East Indies shows that some members of the committee consider that the Government places too high an estimate on Dutch interest in the proposed new cable communication. The majority, however, is convinced of the importance of the scheme, especially in time of war or when there is danger of war, but several of the members are opposed to the means by which it is proposed to carry out the project. They ask why it is necessary to co-operate with Germany, a course which would mean the payment of a considerable subsidy for 20 years, and would impose dangerous obligations in Holland, while at the same time entailing the danger of a preponderance of German influence in the subsidised company. These members suggest that a cable between Menado and the Philippines, or, better still, a cable between Batavia and the Philippines, might be preferable. It is also pointed out, however, that the interest of Germany and of the United States of America in the proposed cable would guarantee the safety of communication in time of war.—*The Times.*

Presentations.—At a smoking concert at Middlesbrough last week the staff of Middlesbrough Corporation electricity department presented Mr. Harold W. Clayden, the late borough electrical engineer, with a handsome chiming travelling clock on the occasion of his marriage and leaving to take up a new appointment in South Africa. The presentation was made by Mr. W. Telford, the chief assistant engineer, on behalf of the staff, and Mr. Clayden, in responding, thanked the staff for their kindness shown to him during his residence in Middlesbrough and for the assistance they had given him in placing the electricity undertaking in its present prosperous position. Several other toasts were given during the evening, Councillor Main responding on behalf of the Electricity Committee. On Friday evening, the 9th inst., the engineering staff and employés of the Manchester Corporation electricity works held a convivial gathering at the Albion Hotel, Manchester, the principal item being the presentation to Mr. W. F. Long with a token of their esteem, in the shape of a handsome dressing case, prior to his leaving to take up the important position of chief electrical engineer to the Corporation of Capetown. The presentation was made by Mr. S. L. Pearce, the deputy chief engineer, who, in a few well-chosen words, alluded to Mr. Long's good work in Manchester during his six years' stay, and expressed the sincere regret of the staff in now having to wish him good-bye.

Coronation Illuminations.—Albemarle-street is to be decorated and illuminated in a very novel manner, real and artificial flowers, in combination with electric lighting, having been chosen by Messrs. Defries and Sons for the approved design. On Tuesday the General Purposes Committee of the London County Council reported with regard to the Coronation that the Embankment would lend itself to a very effective scheme of illumination. Reference was also made to the proposal of art students, already described, to decorate Westminster Bridge. Including the cost of this scheme (£500), the committee proposed to spend £3,500, and on the motion of Lord Monkswell the necessary power was given them. The Electric Lighting Committee of Edinburgh Town Council have agreed that electric current for the purpose of illuminations on the occasion of the Coronation rejoicings should be provided at 2½d. per unit, on conditions to be arranged by the electrical engineer. In Barnsley, electric light is to be supplied free of charge for the purpose of the illumination of the Harvey Institute, the town hall, the municipal buildings, and the corn exchange, on the occasion of the celebration of the King's Coronation. The following are the conditions as to the free supply of electricity for the purpose of illumination at the Coronation at Morley: (*a*) the supply to be given to then present consumers; (*b*) the supply to be given on June 26, 27, and 28 from 10 to 12 p.m.; (*c*) the connections and all work to be done at the consumer's expense and to the satisfaction of the engineer. The Brighton Corporation have resolved to spend £1,500 towards Coronation decorations and illumination; the County Council £50. Hove will also contribute an amount.

Salisbury.—Acting upon the advice of Messrs. Frankland, Phillips, and Co., of Poplar, the dean and chapter have decided to place a new and efficient system of lightning conductors on the cathedral. The present conductor attached to the spire will be replaced by a copper band. Additional conductors will be fixed on the western turrets, and it is also proposed to place points on the east and the transept gables, the lead covering the roof of the cathedral forming a connecting link between the whole of them. The building will thus be afforded the greatest possible protection against injury by lightning. The cost of the work, which will probably be commenced soon after Whitsuntide, is estimated at £300. It may be remembered that at the December meeting of the Town Council a resolution was passed by which the Salisbury Electric Light and Supply Company, Limited, were allowed to temporarily erect and light two specimen arc lamps in the city. The gas company obtained a similar privilege. Each company has now taken advantage of the permission thus conferred, and has put up two lamps in the Market-place. The electric light company's lamps are of 1,500 c.p. each, and two side lights of 25 c.p. each are attached to the same poles. The side lights are used after 11.30 p.m. The company has also erected a specimen 32-c.p. lamp for incandescent lighting. Tenders for public lighting will be submitted by both companies for consideration by the Town Council at their June meeting. To meet the great growth of telegraph traffic in the Salisbury district, a new wire fitted with improved "duplex" apparatus has just been completed from Salisbury to London, at a cost of upwards of £1,300, making in all eight complete telegraph circuits, which are capable of being enlarged to a total of 12 circuits available for the direct transmission of public telegrams passing between this city and the Metropolis.

Cleckheaton.—Substantial progress has been made in regard to the combined electric generating station and refuse destructors which the Urban District Council have in hand in accordance with plans and specifications prepared by Messrs. Baker and Appleby, the consulting engineers, and Mr. Lund, the Council's surveyor. The works, approached from the Dewsbury road, are situated on a plot of land near the existing gasworks at the south-eastern end of the town in

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close proximity to the Syke Beck, along which many of the other important works of the district are located, and from which the necessary water supply is taken. The chimney shaft, 129ft. high and 9ft. diameter, is completed, and is now a prominent landmark visible from either of the existing railways. The buildings, constituting boiler, engine, and accumulator rooms, with office for the staff, are roofed in. The water-tank is erected and ready for use, whilst the economiser, accumulators, and overhead traveller are delivered and now in course of erection. Two of the steam dynamo sets (Belliss-Morcom-Johnson-Lundell) are ready for testing, and it is expected that the third set will be also ready before the end of the present month. The switchboard is mounted at Messrs. Dorman and Smith's works, where they are busily engaged in putting together the whole of the component parts prior to dispatch the first week in June. The boilers, condensers, pumps, and steam-piping in like manner are well in hand, so that by the end of June there is every probability that the whole of the machinery and accessories will be at the generating station, where, we are assured, no time will be lost in making the various connections between the separate portions to have them in working order. Outside the station the feeders and distributing cables are now being laid in the main streets, and as the Council hope to supply energy to the tramway company for the cars running through the district, as well as for lighting and power purposes in the town, the prospects are extremely encouraging, a comparatively large return being secured from the commencement. It is anticipated that the works will be opened in September next.

PROVISIONAL PATENTS, 1902.

MAY 5.

10269. Improvements in electric arc lamps. Veritys, Limited, and William Reginald Ridings, 11, Burlington-chambers, New-street, Birmingham.

10271. Improvements in apparatus for automatically supplying electric power to operate mechanism in clocks and other instruments or machines. Herbert Scott, 6, Selborne-terrace, Bradford.

10302. A portable apparatus capable of being concealed by a doormat or other covering which completes a circuit of electricity when trodden on. Jesse Landon, 134, Queen's-road, Watford.

10309. Improvements in or relating to plate, die, printing, and metal presses by electric-kinetic power. Frank Charles Frederick Knaak, 65, Imperial-buildings, Ludgate-circus, London.

10329. Improvements in secondary batteries. Eugène Lespagnol, 53, Chancery-lane, London.

10335. Improvements in dynamo-electric machinery. Albert Henry Midgley, Norfolk House, Norfolk-street, Strand, London.

10342. Improvements in armature windings and in the method of producing same. Thomas Joseph Murphy, 55, Chancery-lane, London. (Complete specification.)

10357. An electric tinder-box. Manuel Simonet Lombardo, 40, Chancery-lane, London.

MAY 6.

10369. Improved electric light switch. John Crawford Macalester, Box 23, Athenæum, Glasgow.

10357. An improved adjustable trolley for electric tramcars and the like. John Reynolds, 3, Berkeley-place, North-road, Plymouth.

10444. Improvements relating to electric measuring instruments. Carl Beez, 27, Chancery-lane, London.

10452. Improvements in wireless telegraphy and means therefor. John Edward Evans-Jackson, 19, Holborn-viaduct, London. (De Forest Wireless Telegraph Company, United States.) (Complete specification.)

10457. Improvements in storage batteries. Jerome Redding, Llewellyn Day Lothrop, and Isaac William Deering, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

10459. Improvements in controllers for electric motors. Herbert John Haddan, 18, Buckingham-street, London. (David Bergman, Sweden.)

10460. Improvements in trolley collectors for electric traction systems. Thomas Joseph Murphy, 55, Chancery-lane, London.

MAY 7.

10466. Electrical appliance for working pile drivers. James Garvie, 69, Victoria-street, Westminster, London.

10473. An improved glass globe for use with electric glow lamps. George Davis, 34, Victoria-street, London.

10512. An improved electric conduit. George William Jones, 4, Bishopsgate-street Within, London.

10529. Improvements in or relating to overhead electric trolley traction systems. James Watson, 111, Hatton-garden, London.

10532. Improvements in portable, secondary, or other electric batteries, accumulator plates, and the like. Lars Bristol, 33 Cannon-street, London. (Complete specification.)

10533. Improvements relating to electric jacquard card punching and similar machines. Oscar Zerkowitz, 27, Chancery-lane, London.

10534. Improvements in Rontgen tubes. Friedrich Dessauer, 6, Lord-street, Liverpool.

10538. Improvements in or connected with trolleys for use with overhead conductors in electric traction. Carl Stoll, 70, Chancery-lane, London. (Complete specification.)

10541. Improvements in and relating to electric clocks and the like. William Edgar Palmer, Palace-chambers, Westminster, London. (Complete specification.)

10546. Improvements in or connected with electric conductors, and attaching devices for lamps or other current takers. James Grieve Lorrain, Norfolk House, Norfolk-street, Strand, London. (Hector Alan Macdonald, France.)

MAY 8.

10581. Improvements in electric lamps of the Nernst type. William Richard Wynne, 3, New-court, Lincoln's-inn, London.

10590. Improvements in incandescent electric lamps. George Sweetser, 11, Southampton-buildings, Chancery-lane, London.

10594. Cleats for fastening electric wires or cables in casing or other carrying arrangement temporary or otherwise, or for permanent fixing to walls, ceilings, roofs, and the like. Victor Watson Riley and Herbert William Rowing, 1, St. George-street, London. (Complete specification.)

MAY 9.

10695. Improvements in or connected with attaching metallic connections to the plates of electric batteries. John Crisp Fuller, George Fuller, and Dyson Fuller, 33, Chancery-lane, London.

10701. Improvements in incandescent electric lamp fittings. Arthur Albert Guest, 128, Colmore-row, Birmingham.

10710. Improved switchboard for effecting telephonic intercommunication. John Young, 21, Gloucester-walk, Campden Hill, Kensington, London.

10733. Improvements in automatic electric regulating or controlling devices or systems. Wilhelm Stockmeyer, 18, Buckingham-street, Strand, London.

MAY 10.

10755. Improvements in electrical switches. John Henry Tucker, Sampson-road North, Birmingham.

10758. The speedy trolley wire catcher for electric tramway cars. Alfred Ernest Bailey, 51, Salisbury-road, Plymouth.

10788. Improvements in or in connection with wireless telegraphy for signalling between stations either fixed or moving. Charles Ernest Wisner, 6, Lord-street, Liverpool.

10800. Improvements in electrostatic instruments. Sebastian Ziana de Ferranti, 18, Southampton-buildings, Chancery-lane, London.

10811. Rotary carbons for electric arc lamps. Albert Ernest Carter, 64, Church-street, Brighton.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published May 29.

1901.

9770. Electrical sparking devices for firing the charges in internal-combustion engines and for similar purposes. Brown.

9781. Insulator for use with bracket suspensions of overhead trolley systems and the like. Quin and Smith.

10869. Manufacture of incandescence bodies for electric lighting. Abel. (Siemens und Halske Aktiengesellschaft.)

11003. Apparatus for transmitting and receiving electric signals or for firing explosive mines. Blochmann and Bichel.

11584. Lightning conductors. Hedges.

12552. Electric arc lamps. Crompton and Co., Limited, Hodgson, and Ewart.

12739. Driving of centrifugal and other machines by means of electric motors. Pott and Williamson.

12835. Electric cranes and other electric lifting appliances. Stothert and Pitt, Limited, and Stothert.

13732. Method of and apparatus for effecting electric traction on tramways. Abel. (La Soc. Anon. pour la Transmission de la Force par L'Electricité.)

15833. Armatures for electric clocks. Wise. (Actiengesellschaft "Magneta," Electrische Uhren ohme Batterie und ohme Contacte.)

21942. Process for the electrolytic treatment of tin and apparatus therefor. Nauhardt.

1902.

1888. Systems of electrical distribution. Hopkinson.

3224. Intercommunication telephone systems. Cerebotani and Baumer.

4520. Electric batteries. Apple.

7361. Method of connecting continuous-current motors to the supply network on starting. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

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TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	May 7	683	652	+ 30	33,977	31,841
Birmingham Tramways	,, 10	4,723	4,402	+ 321	88,079	79,099
Blackburn Corporation	,, 9	705	701	+ 4	12,076	10,661
Blackpool Corporation	Apr. 19	278	269	+ 9	3,601	2,242
Blackpool-Fleetwood Tramways	May 10	332	335	- 3	4,575	4,285
Bolton Corporation	,, 11	1,511	1,425	+ 86	25,756	23,870
Bradford Corporation	,, 4	2,786	930	+ 1,856	38,796	14,308
Bristol Tramways Company	,, 9	4,103	4,305	- 202	—	—
Carlisle Tramways Company	Mar. 15	122	123	- 1	1,282	1,192
Central London Railway	May 10	7,088	6,514	+ 574	126,884	117,538
City and South London Railway	,, 11	3,050	2,022	+ 1,028	56,507	57,858
Cork E. T. and L. Company	,, 8	615	514	+ 101	7,327	7,034
Darwen Corporation	Mar. 22	169	154	+ 15	1,951	1,844
Darwen-Hoddlesden	,, 14	26	—	—	—	—
Dover Corporation	May 10	182	197	- 15	3,371	3,268
Dublin & Lucan Electric Railway	,, 11	103	97	+ 6	1,752	1,607
Dublin U. T., electric cars	,, 9	3,669	3,523	+ 146	—	—
Dublin S. District, Electric	,, 9	807	779	+ 28	—	—
Dundee Tramways Company	,, 7	623	701	- 18	—	—
Glasgow Corporation	,, 10	11,711	10,691	+ 1,020	—	—
Halifax Corporation*	—	-	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 10	1,608	1,597	+ 11	9,814	9,742
Liverpool Corporation	,, 3	9,521	8,964	+ 557	161,023	146,242
Liverpool Overhead Railway	,, 11	1,419	1,616	- 197	26,657	29,167
Newcastle-on-Tyne Corporation	,, 10	2,558	—	—	—	—
Portsmouth Corporation	,, 10	1,281	522	+ 759	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 18	3,734	—	—	—	—
Southampton Corporation	Mar. 27	775	537	+ 238	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £603 decrease.
Barcelona Ensanche y Gracia, £53 increase. Barcelona, £2,113 increase.
Brisbane, £344 increase (month of March, £10,334; increase, £1,789).
Buenos Ayres and Belgrano Electric (month of April, receipts £11,872; decrease £613), £179 decrease.
Calcutta, £20 decrease.
Cape Town (month of March), receipts, £17,888; expenditure, £7,343.
Isle of Thanet Electric, £60 increase.
Mexico Electric (month of April), receipts, £19,350; expenditure, £10,620.
Perth Electric, £226 increase.
Port Elizabeth (month of March), receipts, £3,818; expenditure, £1,947.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	½-¾
—— Ordinary, 1-125,000	1 ..	⅜-½
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-5⅝
—— 5 per cent. Mortgage Debentures	100 ..	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5¾-6
Brush Electrical Engineering, Ordinary	2 ..	¾-1¼
—— Nos. 90,001-105,731	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-2
—— 4½ per cent. Debenture Stock	100 ..	101-104
—— 4½ per cent. 2nd Debenture Stock	100 ..	95-100
Callender's Cable, Debentures	100 ..	111-115
—— Ordinary	5 ..	17-18
—— 5 per cent. Pref.	5 ..	5½-6
Crompton and Co.	3 ..	3-3¼
—— 5 per cent. Debentures	— ..	103-108 p.c
Edison and Swan United, Ordinary	3 ..	⅝-¾
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	75-80
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-1⅜
—— 7 per cent. Cumulative Pref.	2 ..	2⅝-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	98-101
W. T. Henley's Telegraph Works, Ordinary	5 ..	17-18
—— 4½ per cent. Preference	5 ..	5½-6
—— 4½ per cent. Debentures	100 ..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	99-102
Parker, Thos., Limited, Ordinary	10 ..	15½-16½
Telegraph Construction and Maintenance	12 ..	34-37
—— 5 per cent. Bonds	100 ..	103-106
Telegraph Manufacturing, Ordinary	5 ..	10½-11¼
—— 5 per cent. Cum. Pref.	5 ..	5½-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	8¼-9¼
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6½-6⅝
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107
Electric Railways.—		
Central London, Ordinary	100 ..	103-106
—— 4 per cent. Pref.	100 ..	103-106
—— ,, ,, deferred	100 ..	100-103
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-118
City and South London, Consolidated Ordinary	100 ..	71-73
—— Ordinary	10 ..	—
—— 4 per cent. Debenture Stock	100 ..	113-117
—— 5 per cent. Pref. Stock '91	100 ..	128-133
—— ,, ,, ,, '96	100 ..	124-127
—— ,, ,, ,, '01	100 ..	120-124
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	¼-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	100-104
Bournemouth and Poole, Ordinary	10 ..	11-12
—— 4½ per cent. Cum. Pref.	10 ..	9¼-10¼
—— Debenture Stock, Red.	100 ..	103-105
Brompton and Kensington, Ordinary	5 ..	9-9¼
—— 7 per cent. Preference	5 ..	9-9¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	8¾-9¼
—— Nos. 20,001-30,000	5 ..	8-9
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
—— ,, ,, ,, £10 Ord.	6 ..	10⅝ xd
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	106-108
Charing Cross and Strand	5 ..	9-10
—— Nos. 50,001-70,000	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5-5¼
—— 4½ per cent. Debentures	100 ..	110-113
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	103-106
County of London and Brush Provincial, Ordinary	10 ..	8-9
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6¼-6⅜
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4-4¼
—— 5 per cent. Debenture Stock, Red.	100 ..	101-104
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5⅜-6¼
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10-11
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10½
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	95-100
Metropolitan, Ordinary	10 ..	16-17
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	97-100
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	14-15
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7¼-8
—— £4½ Shares, New	4½ ..	6⅝-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	98-101
River Plate Electric Light and Traction, Deb.	100 ..	65-70
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1⅜-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2¼-2⅜
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15¼
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	98-101
Westminster, Ordinary	5 ..	11¼-12¼
—— 5 per cent. Cum. Pref., 110,101-138,241	2½ ..	3¼-4
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	125-130
Blackpool and Fleetwood Tramroad	10 ..	13¼-14¼
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	3-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	104-107
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6¾-7¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¼-10
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	102-104 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13¼-14½
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12¼-12⅝
—— 5 per cent. Perpetual Debenture Stock	100 ..	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1¼-1⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4⅜-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4⅜-5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2⅜-2⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11¼-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	96-99
Imperial Tramways, Ordinary	all ..	22-22¼
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10 ..	10⅜-11¼
—— ,, ,, ,, ,,	5 ..	5⅜-6¼
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	104-106
—— ,, ,, Prov. Crts.	50 ..	53-55
New General Traction, Ordinary	5 ..	2-3
—— 6 per cent. Cum. Pref.	10 ..	3¼-4¼
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10⅜
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	99-102
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	9¼-10¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	106-109
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	10s. ..	¼
—— £50,000 ,, ,,	1 ..	¼
—— £500,000 4½ per cent. Debenture Stock	50 p.c. ..	50 p.c.
Telephones.—		
National Telephone, Preferred	100 ..	95-99
—— Deferred Stock	100 ..	55-59
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— Preferred, 590,001-790,000	3½ ..	3¼-3⅜
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-5¼
—— 4 per cent. Deb. Stock, Red.	100 ..	94-97
—— 3½ per cent. Deb. Stock, Red.	100 ..	103-107
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

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Supplement to "The Electrical Engineer,"

MAY 16, 1902.

CARDIFF ELECTRICAL TRAMWAYS.

May 1, 1902, will be recorded as an eventful day in the history of Cardiff, for on that day the town inaugurated its new system of electrical tramways with considerable pomp and ceremony. In delightful weather 12 gaily-decked cars conveyed the guests of the Corporation in procession over the various routes to be inaugurated, and incidentally provided a test on the trolley sections severer, perhaps, than they will ever be called upon to withstand in ordinary working. It speaks well for the design and quality of the materials employed that no hitch of any kind occurred, especially when the incomplete state which was revealed at the power station is considered. However, it is not our intention to dwell upon the morning's proceedings, nor upon the luncheon given by the Mayor which followed, but rather to devote our space to the practical side. In doing this we have considerable pleasure, since the plant installed is undoubtedly one of the best which has come to our notice for some time past. Both in the power station and outside there is evidence of originality in design which is refreshing, and at once proves the capacity of the Corporation engineers. Hitherto the experience of Cardiff in electrical matters has not been of a too prosperous nature, but the new enterprise upon which the Corporation have embarked should tell another tale. In a town bustling with energy like Cardiff, the time-saving advantages offered by the electric car service are bound to be appreciated. The new power station is destined, however, not only to supply current for traction purposes, but also for general power and lighting purposes. A separate network of mains is in hand for this purpose. A sub-station will, we understand, be constructed on the site of the fish market, from which the docks will be supplied with electrical energy in bulk. The applications from this source of demand already represent the promising aggregate of some 1,000 h.p. It will be some time, however, before the whole scheme is complete: hence we shall confine ourselves in the following to a description of the tramways portion The site of the new power and lighting station is at the opposite end of the town to that of the old lighting station. The latter, which contains an alternating-current plant, will be retained for supplying the outlying districts. It is noteworthy that the Corporation's own engineers have been responsible for the design of the new scheme throughout. Mr. Arthur Ellis,* upon whom the responsibility for the design of the whole of the electrical equipment devolves, has, it should be mentioned, been ably assisted by Mr. T. T. Davies. There is one blemish in the tramways—namely, in the centre of the town—where, owing to a very narrow stretch of street, the track has to make a wide detour. Some seven years hence the leases of the property in this street expire, when the opportunity will, perhaps, be taken of remedying the defect. We have so often referred to the enterprise of the Cardiff municipality that it is unnecessary to labour the more recent proof of that enterprise—the electric tramways. Fortunately, Cardiff has in Mr. Harpur (the borough engineer) and Mr. Ellis (the electrical engineer) two gentlemen of great ability and experience, and to the combined efforts of these gentlemen the successful inauguration of the tramways system is due. Our description of the system is so lengthy and complete in most of the details that no object would be served in a longer introduction. We wish the latest work of the municipality all success.

COUNCILLOR T. ANDREWS, CHAIRMAN TRAMWAYS COMMITTEE, CARDIFF.

COUNCILLOR F. J. BEAVAN, THE MAYOR, CARDIFF.

MR. WILLIAM HARPUR, BOROUGH ENGINEER, CARDIFF.

Historical.

In 1898 the Corporation obtained parliamentary powers to construct about 15 miles of tramways and also to purchase and alter the Cardiff Tramway Company's lines, Mr. W. Harpur, M.I.C.E., the borough engineer, being the engineer for the scheme. The Corporation on Dec. 11, 1899, decided to construct the track work by their own

* **Arthur Ellis, M.I.E.E.**, the electrical engineer, served his apprenticeship with Messrs. C. A. Parsons and Co., Newcastle-on-Tyne, after which he took a position with the Newcastle and District Electric Light Company in order to secure a practical training in electric light station work. In August, 1892, he left this company to join the Cambridge Electric Supply Company as resident engineer during construction, under the chief engineer. Shortly after the completion of this plant he took over the duties of chief engineer, and held this office until October, 1893, when he left the company to act as outside manager for Messrs. C. A. Parsons and Co. In April, 1894, he was appointed to the post of borough electrical engineer to the Corporation of Southport, and in April, 1896, he was appointed to Bolton, and in October, 1899, was appointed general manager of the tramways. In June, 1900, he was the successful candidate for a similar position at Cardiff. In December, 1900, he was appointed engineer and manager of the electric lighting department, in which capacity he has since acted, in addition to designing and carrying out the complete scheme of tramways herewith described.

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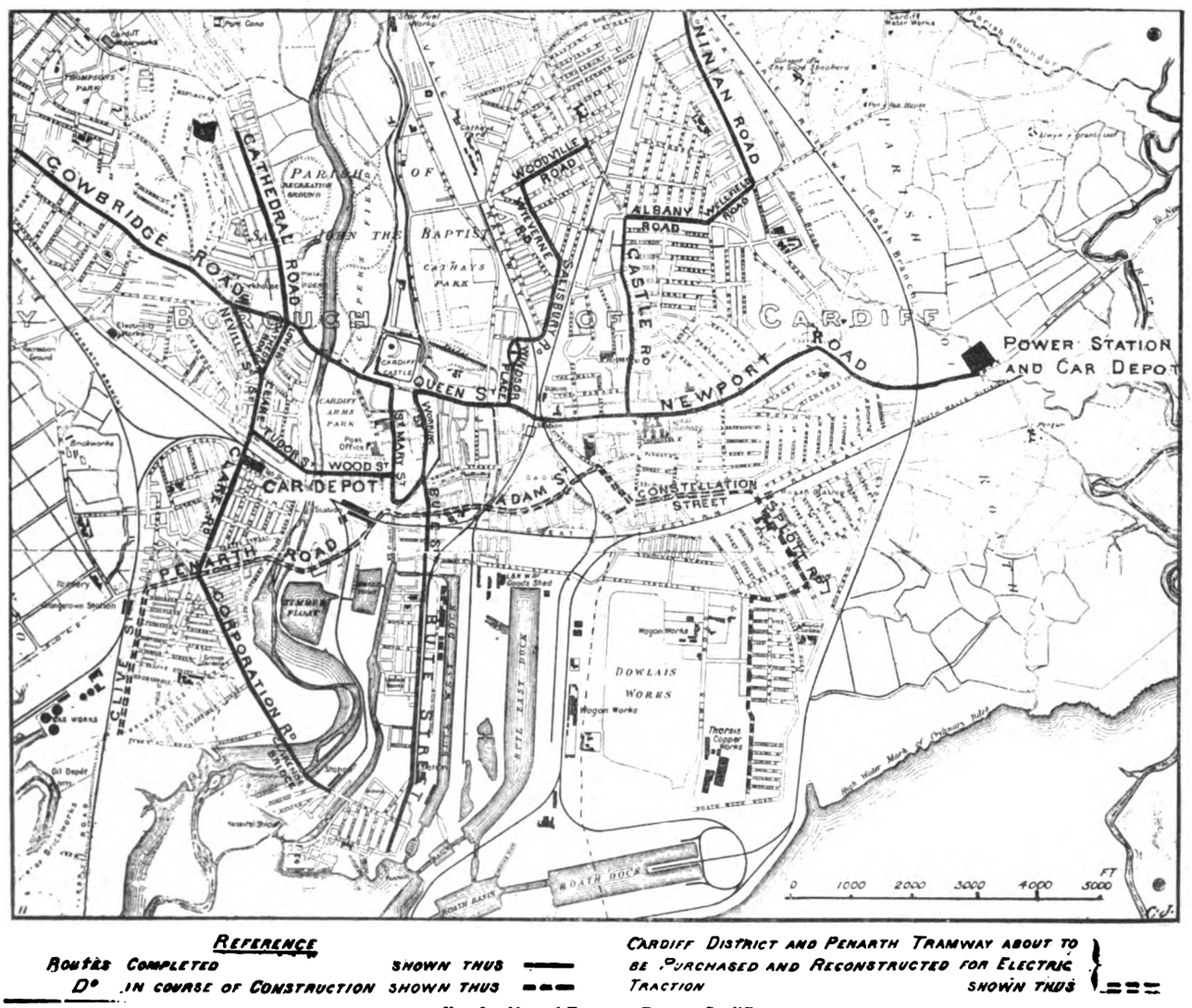
workmen, and entrusted Mr. Harpur with the carrying out of the work in question. The work was commenced in Cathedral-road on Dec. 18, 1900, with the object of getting the line in that road open in time to accommodate the traffic to the Royal Agricultural Show on June 26, 1901, and this was successfully done, the line being provisionally passed by Major Druitt, R.E., the inspector appointed by the Board of Trade, on June 18, 1901. In the meantime, Mr. Arthur Ellis, M.I.E.E., was appointed to design and carry out a complete scheme of electrical tramways for the town, involving an expenditure of £300,000, and the borough engineer received further instructions to proceed with the remainder of the above-mentioned route to its terminus near the Clarence-road railway station at the docks, and also with the branches therefrom along Wood-street and Neville-street, and likewise with the construction of a tramway along Castle-road, Albany-road, etc., to the end of Ninian-road at Roath Park; the whole of these tramways, with the exception of that along Neville-street, being provisionally approved for horse traction on Jan. 3, 1902. On Dec. 12, 1901, after long and protracted negotiations with the Cardiff Tramway Company, terms were arranged whereby the tramway company agreed to hand over their lines to the Corporation at 12 p.m. on Dec. 31, 1901. The borough engineer had in the meantime prepared plans for the reconstruction of the old tramways, which reconstruction, reduced to single line, represented a mileage of about 12 miles of single track. The Corporation asked the borough engineer to name a time in which he would undertake to get this length of line reconstructed, and he undertook to do so in six months—*i.e.*, by June 30 next—and up to the present time 11½ miles have been completed, and this, together with the new lines mentioned above, makes a total length of 20 miles of finished track.

The reconstruction of these tramways has, of course, necessitated a lot of special work in the way of junctions and crossings, etc., on the track work, and also of various street alterations, notably the lowering of the roadway under the Bute-street bridge, which compelled extensive alterations to the sewers under the said bridge, and also pumping arrangements to keep the surface of the road under the bridge clear of water, and this difficulty is being met by electrically-driven centrifugal pumps, which are being placed under the roadway at that point. The pumps are in duplicate, and are being supplied by Mr. Napier Prentice, of Stowmarket, Suffolk. They are arranged to start automatically directly the water commences to rise in the pump well. The following is a detailed description of the undertaking.

Buildings.

The tramway power station is situate on the northern side of the Newport-road at the extreme end of the Roath route (see Fig. 1), and is a plain but substantial red-brick building, treated with pleasing architectural effect. An exterior view of the station is given in Fig. 2. Entering the buildings at the principal entrance, which is at the further end from Newport-road, we pass through a spacious hall and enquiry room, to the right and left of which are placed the men's messrooms and storerooms, smiths' shops, general repair shops, etc., while on the first floor are the engineer's offices and rooms. A few yards from the entrance hall we enter the engine-room, which is 104ft. long, 60ft. wide, and 56ft. high, is cool and well ventilated, and is lined throughout with cream glazed bricks. At intervals along the side walls are built substantial piers, with semi-circular arches, carrying the travelling rails of the 10-ton gantry crane, which runs the whole length of the room. At the side of the engine-room is the boiler-house, which is the same length as the former—56ft. wide and 48ft. high—



REFERENCE
ROUTES COMPLETED SHOWN THUS ——
D° IN COURSE OF CONSTRUCTION SHOWN THUS - - -
CARDIFF DISTRICT AND PENARTH TRAMWAY ABOUT TO BE PURCHASED AND RECONSTRUCTED FOR ELECTRIC TRACTION SHOWN THUS =====

FIG. 1.—Map of Tramway Routes, Cardiff.

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while beyond the boiler-house are placed the coal bunkers, into which the coal trucks will be brought direct from the Taff Vale Railway (Roath branch). The roofs throughout are supported by mild-steel principals and framing of neat design, composed of angles and flat tiebars. It should be mentioned that the building has been erected by Messrs. W. Symonds and Co., Cardiff, at a contract price of £16,100; Messrs. A. D. Dawnay and Sons, of London and Cardiff, being the contractors for the steelwork. The octagonal chimney stack, also of red-brick construction, is 160ft. high, and is surmounted by a heavy granite capping, each of the eight stones of which weigh nearly 1½ tons. The hoisting and fixing of these stones at such a height was a matter of considerable difficulty. The stack was erected by Messrs. Clark and Co., of Cardiff, at a contract price of £1,563, while Mr. W. Irwin acted as clerk of works for the whole of the buildings. It is intended at an early date to duplicate the boiler-house and coal bunkers on the opposite side of the engine-room, and the whole of the buildings are finished with a temporary end with a view to further extension towards Newport-road as the necessity for the same arises.

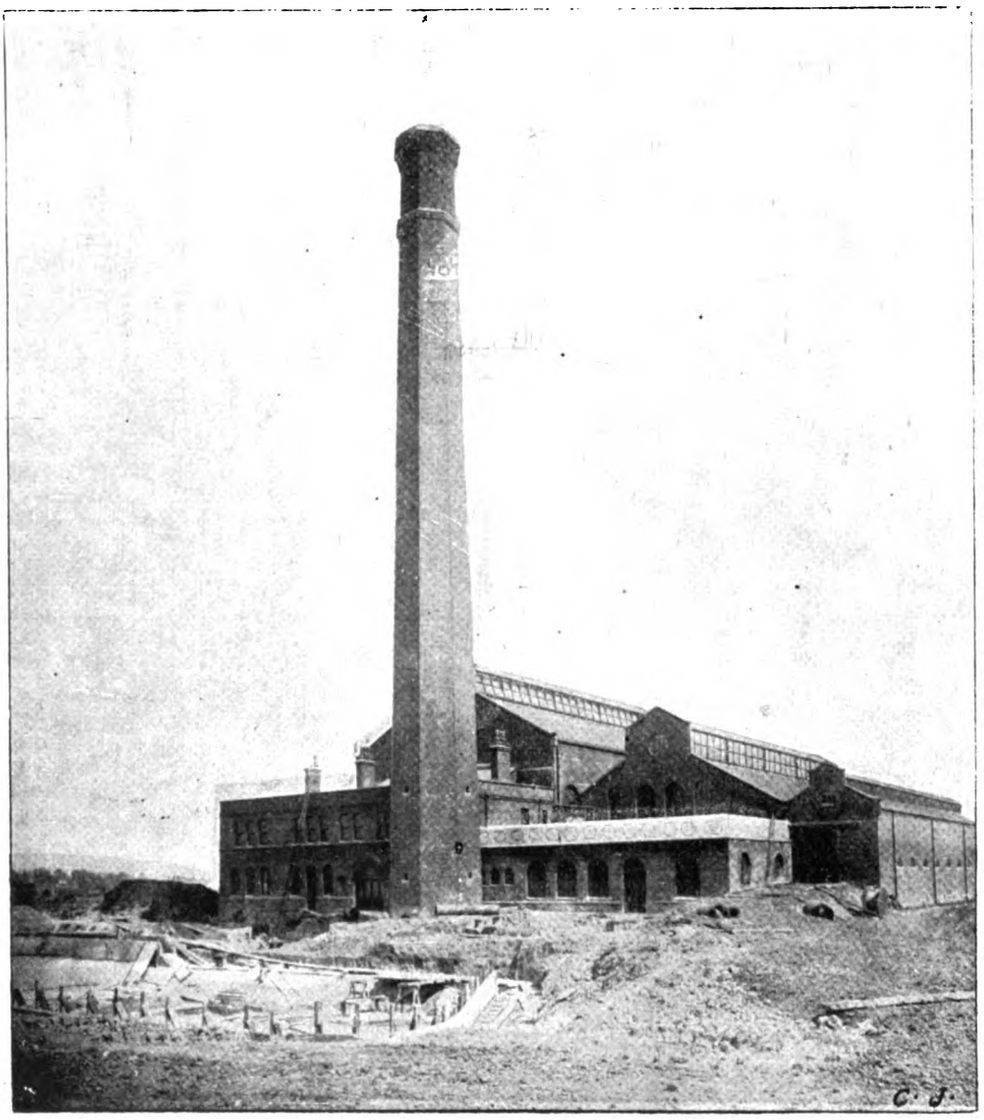

Fig. 2.—Exterior View of Tramways Power Station, Cardiff.

Close to the power station and facing the Newport-road is situated the Roath car depôt, a spacious building consisting of a car-shed, 320ft. by 136ft.; machine shop, 120ft. by 66ft.; painting shop, 90ft. by 33ft.; smithy, 29ft. by 25ft.; carpenters' shop, 29ft. by 25ft.; messroom and kitchen, suite of offices, cloakroom, and large store columns. It is also equipped with a complete sand drier, wet and dry sand stores, etc. The arrangement of the various shops, etc., beyond the car-shed proper is shown in the plan (Fig. 3). An island office provided with glass panels, and situated as shown, enables the foreman in charge to keep an eye on the staff. The rails in the car-shed are carried on cast-iron columns, thus forming a pit 4ft. deep under the cars for the purpose of inspection of motors, etc. At the top end of the shed an electric traverser is arranged, so that a car can be transferred from one track to any other without leaving the car-shed. There are four tracks leading in and out of the shed, the facilities provided for the rapid handling of the cars being therefore admirable. In the machine shop there are two travelling gantry cranes, each 32ft. span, and capable of lifting a complete car body. The buildings are built in red pressed brickwork with red Wilderness, Forest of Dean stone dressings, the main car entrances being fitted with Kinnear's patent rolling doors. When complete the car-shed will be capable of accommodating 70 cars. The buildings are being erected by Mr. D. W. Davies, of Cardiff, at a contract price of £21,988; Messrs. A. D. Dawnay and Sons being sub-contractors for the steelwork, and Mr. Irwin acting as clerk of works. A longitudinal section, front elevation and section, and details of the roof principals and steelwork of the Roath car depôt are shown respectively in Figs. 4, 5, 6, and 7. The glazing on the car-shed will be on the patent "Eclipse" system, supplied by Messrs. Mellowes and Co., of Corporation-street, Sheffield, and London. The principle of this system of glazing is shown in Fig. 8. Another car depôt is situated at Clare-road. This is of similar construction to the above, though somewhat smaller. It provides accommodation for 27 cars, and is replete with workshops, offices, and messrooms, etc. This depôt was built and completed last year by Mr. D. W. Davies (the contractor for the Roath car depôt), Mr. T. Williams superintending its erection. The whole of the buildings, including the

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structural steel and iron work, were designed by Mr. Wm. Harpur, M.I.C.E., the borough engineer. Their design throughout bears evidence of the great care which has been bestowed by Mr. Harpur on details conducive to the efficiency of the buildings as a whole. Among other things, we noticed when inspecting the buildings recently that the question of ventilation had received special attention. In the power station, for instance, vertical roof windows are provided, which can be opened simultaneously along the whole length of the engine-room from the switch-board gallery, while the end walls are also furnished with ventilating windows. The general appearance of the engine-room is, moreover, particularly fine, the proportions being generous and the finish uncommonly effective.

Boiler-House Equipment.

Steam Generating Plant.—In the boiler-house there are at present installed four boilers, but the extensions now in hand provide for a further six. The boilers are of the Lancashire two-flue type by Messrs. John Musgrave and Sons, Limited, Globe Ironworks, Bolton, and are fitted with mechanical stokers. Each boiler is 30ft. long by 8ft. diameter, and designed for a working pressure of 160lb. per square inch. The fittings throughout are by Messrs. J. Hopkinson and Co., Limited, Huddersfield. A superheater is provided at the back end of each boiler. These were also supplied by Messrs John Musgrave and Sons, Limited, and are arranged so that they can be easily raised and withdrawn from the flue after being disconnected from the steam-pipes. An economiser by Messrs. E. Green and Son, Limited, Manchester, combining the latest improvements, is erected in the main flue of the boilers. The scrapers of this economiser are driven by an electric motor in the usual manner.

Mechanical Stokers and Coaling Arrangements.—The boilers are fired by means of Vicars's patent self-stoking smokeless furnaces. In these machines the fuel is first pushed on to dead plates by reciprocating rams or plungers, and then on to the moving fire-bars, which gradually take the mass further into the furnace and ultimately discharge same on to bottom of flue, where combustion is completed, and the clinker and ash periodically removed. The action of the furnace necessitates the volatile hydrocarbons passing over the incandescent coke, thereby insuring smokelessness. The grates are proportioned so that no difficulty is experienced in maintaining 14 per cent. carbon dioxide in the products of combustion leaving the furnace, without any carbon monoxide. The driving gear for each furnace is entirely separate, also for the coal feed and bar motions, and the stroke on the latter is variable. The hoppers are divided in the centre so that gauge glasses can be brought to the front. Coal is fed into the hoppers of the stokers from an overhead steel bunker having an inclined base, and which is fitted with dampers or sluices for regulating the supply of fuel to the hoppers. These dampers are opened and closed by means of a screw actuated by the fireman through chain wheels. The bottom of the bunker is made of $\frac{5}{16}$in. plate stiffened with 5 by 3 H girders; the vertical side of $\frac{1}{4}$in. plate stiffened with 4in. by 3in. tees, and the top of $\frac{1}{8}$in. plate stiffened with 3in. by 3in. tees. The bunker is designed to hold about 250 tons of fuel, and is supported by 18in. by 7in. girders built in wall at one end, and by strong cast-iron columns at the other end. The fuel is brought direct into coal-store by railway wagons, and can be discharged either into the bunker or into the reserve coal-store, which latter extends the full length of the boiler-house under the railway lines,

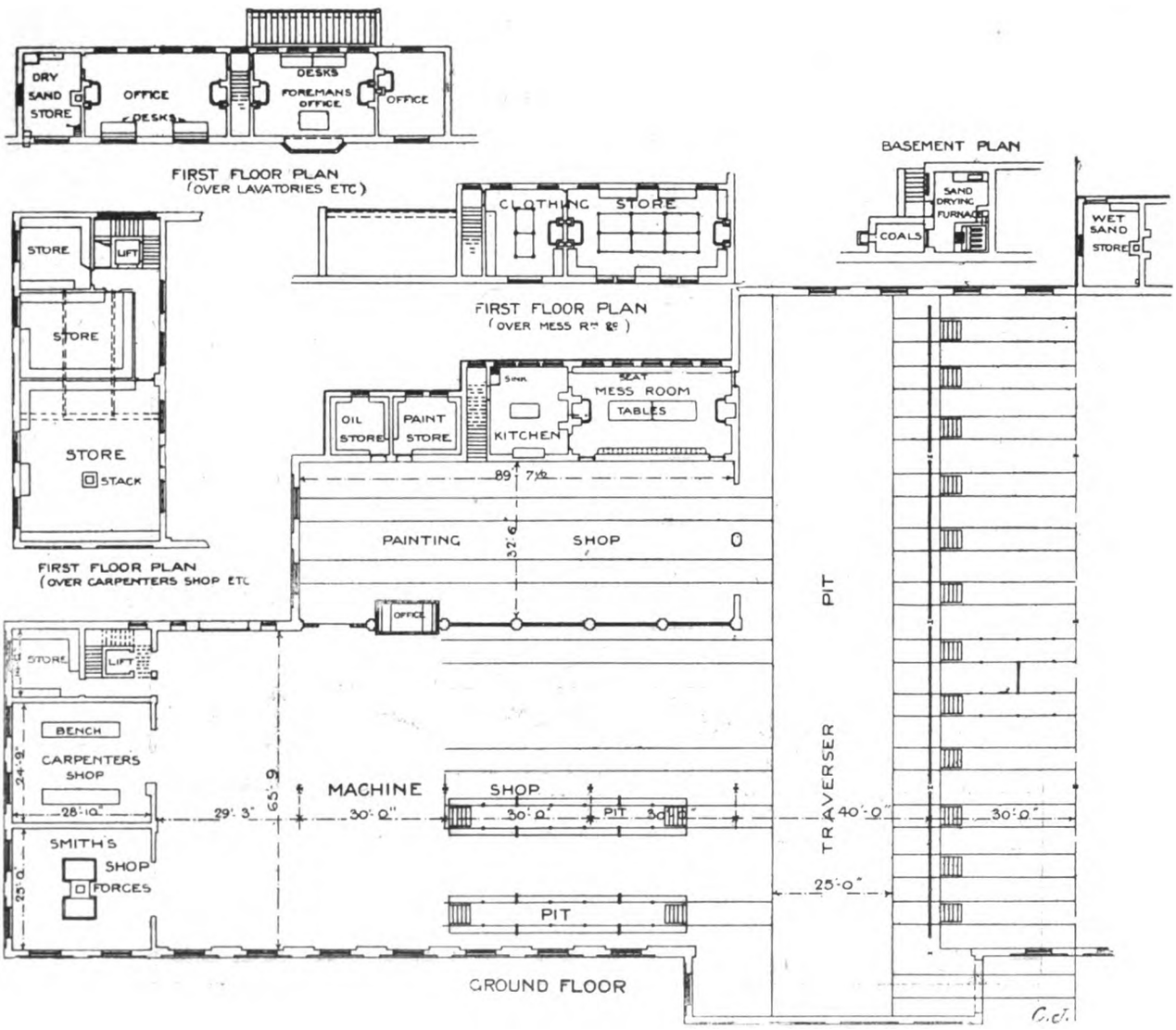

FIG. 3.—Half-plan of Roath Car Depot, showing Arrangement of various Shops, Cardiff Tramways.

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openings being provided opposite each boiler, so that fuel can be easily withdrawn when required. A trench is built just forward of the ordinary blow-off trench for the ash conveyor. This consists of a heavy section cast-iron worm (moulded by Vicars's patent system, which ensures true casting) working in a cast-iron U-shaped trough. Grids are provided opposite each flue, through which the clinker is fed to the conveyor. The framework of these grids is

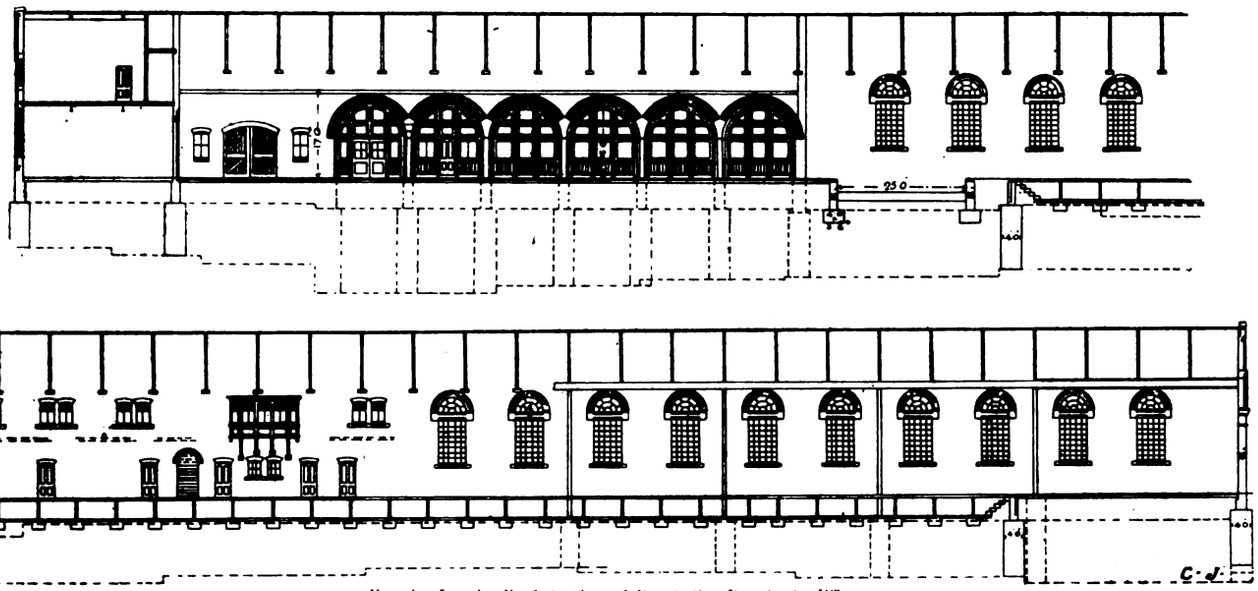

FIG. 4.—Longitudinal Section of Roath Car Depot, Cardiff.

of heavy cast-iron section, so that large clinker can easily be broken on same. The conveyor delivers the clinker and ash to a Vicars's double-chain type elevator, which discharges into a railway wagon standing on the same siding, by which fuel is brought into the stores, so that fuel can be conveyed to the boiler-house, consumed in the furnaces, and the residue removed from the site practically automatically. The general arrangement of this plant is shown in Fig. 9. It is driven by an electric motor through

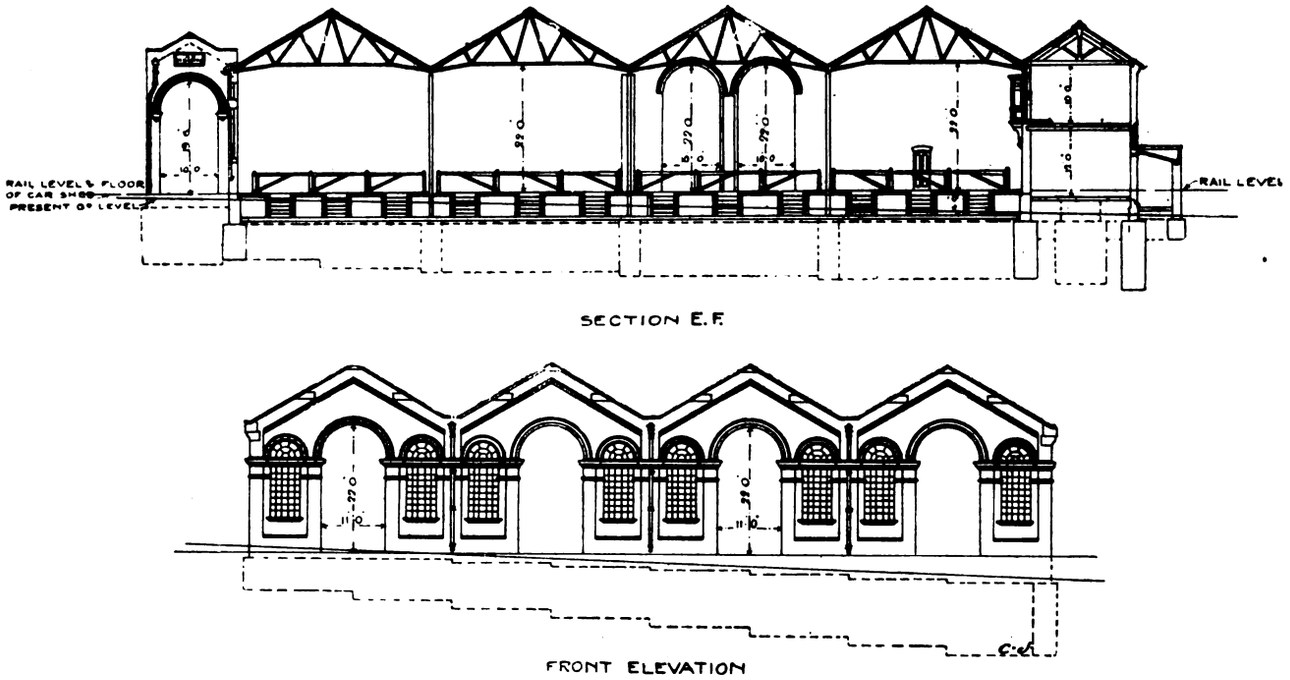

FIG. 5.—Front Elevation and Section of Roath Car Depot, Cardiff.

suitable countershafts, and was supplied by Messrs. T. and T. Vicars, 20, Bucklersbury, London, E.C.

As the coal-laden trucks are moved on to the station siding they are weighed bodily, a weighbridge being provided for this purpose upon the siding, with an office adjoining. After discharging their contents the trucks are reweighed, and an accurate check thus kept upon the amount of coal entering the station. No auxiliary weighing apparatus is employed, nor is it needed. It will be seen that the coaling and stoking arrangements have been carefully devised with a view to economising labour and providing an absolutely reliable check on the amount of coal consumed.

Boiler Feed Pumps.—In the pump-room there are installed three boiler feed pumps. These are of the single-cylinder direct (double) acting type, and were supplied by Messrs. G. and J. Weir, Limited, Cathcart, Glasgow. Each has a pump cylinder 8in. diameter and a steam-cylinder 10½in. diameter by 24in. stroke, its normal capacity being 6,000 gallons of water per hour when delivering against a boiler pressure of 160lb. per square inch. While the normal speed of the pump is reckoned at 12 double strokes per minute, should occasion demand it, this speed may be considerably increased in order to make up any abnormal deficiency in the feed supply. Fig. 10 illustrates one of these pumps. The pump ends are of cast iron, fitted with gunmetal liners, while the pump rods are of cold-rolled manganese bronze. The water-valves are of the Weir patent group type, of special bronze in gunmetal seats. The water pistons or buckets are of gunmetal, with ebonite packing rings. The valve gear is positive—*i.e.*, the steam-valve can never be in such a position that the pump will not start immediately when the steam is turned on. In these pumps the steam is used expansively, and the cut-off can be regulated from the outside while the pumps are working, thus making them extremely

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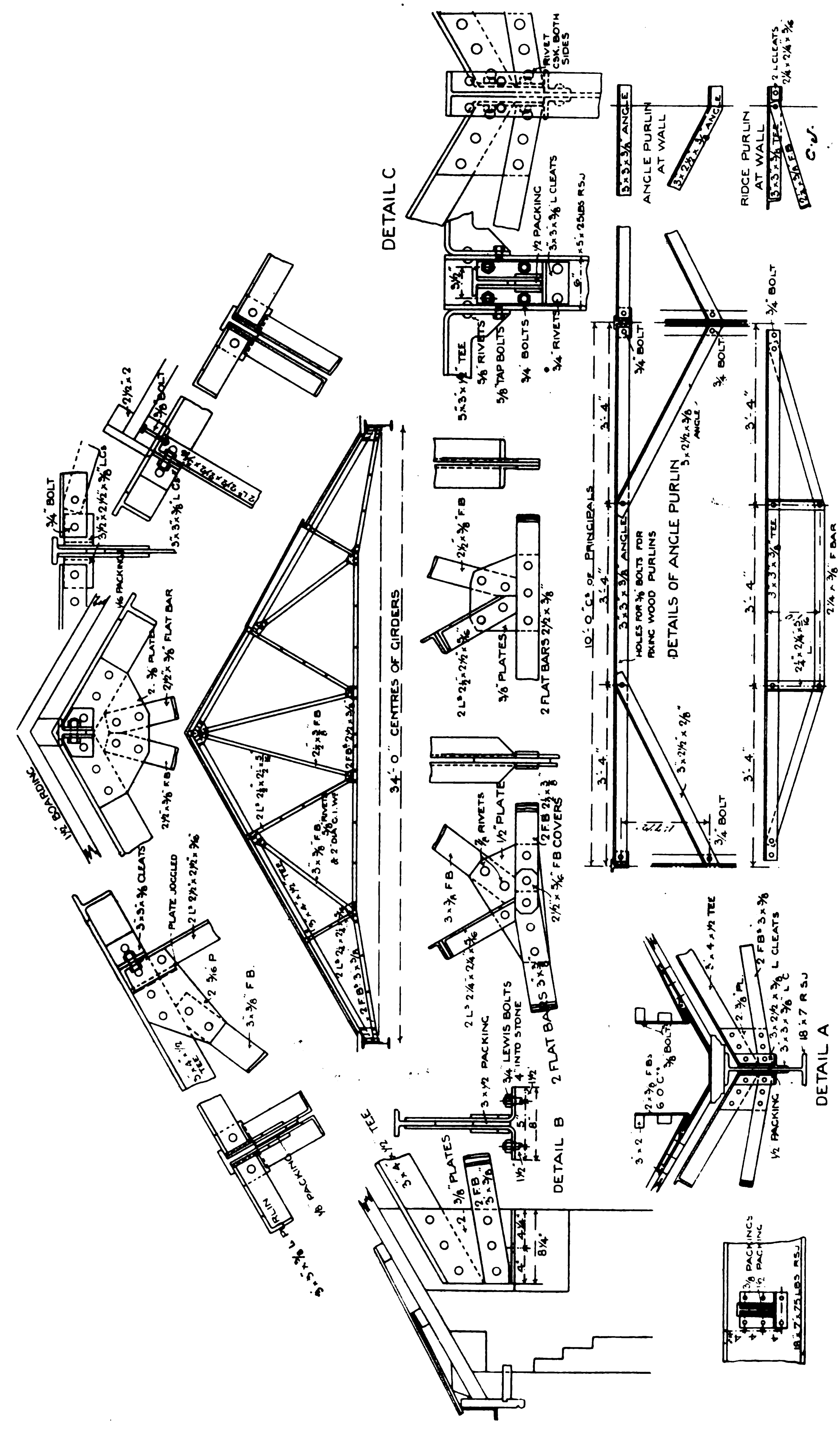

FIG. 6.—Details of Roof Principals, Roath Car Depot, Cardiff.

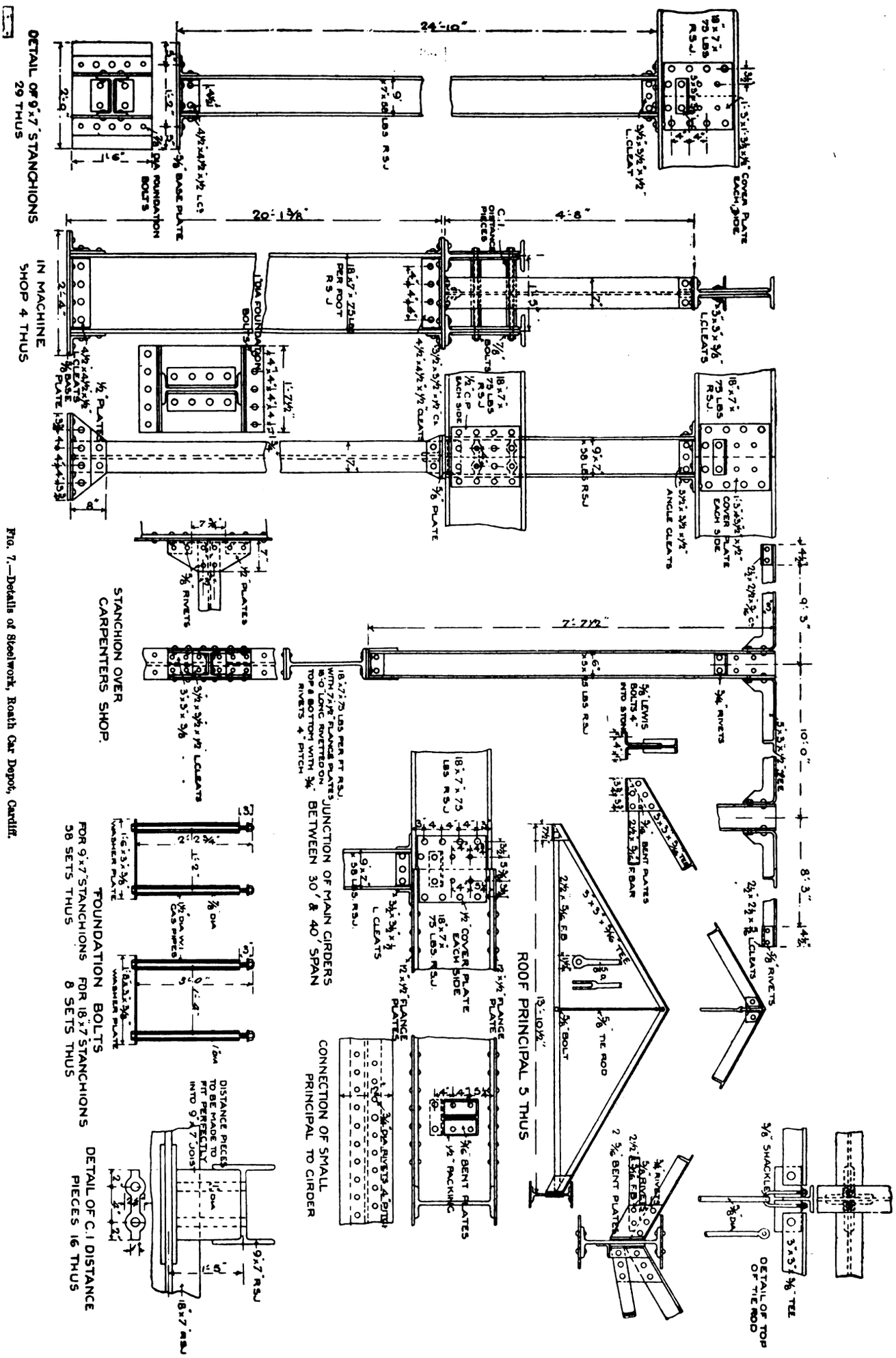

Fig. 7.—Details of Steelwork, Roath Car Depot, Cardiff.

economical pumps as regards steam consumption. All the working parts are readily accessible. There are also fitted in connection with these pumps three Weir economisers. The purpose of these economisers is to heat the feed water

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by using the exhaust steam from the feed pumps. They are of the coil type, of cast iron, with coils of solid-drawn copper tubing. The arrangement of pipes in the pump-room is shown clearly in Fig. 11. It should be mentioned that these pipes were supplied by the Sir Hiram Maxim Electrical and Engineering Company, Limited. The pumps draw their supply of water from a large storage tank erected on the roof of the pump-room—either direct or through the Green's economiser as the exigencies of the moment demand. This storage tank is shown in Fig. 2. It is replenished from the town's service mains, no alternative source of water supply fit for boiler feed purposes being available on the site.

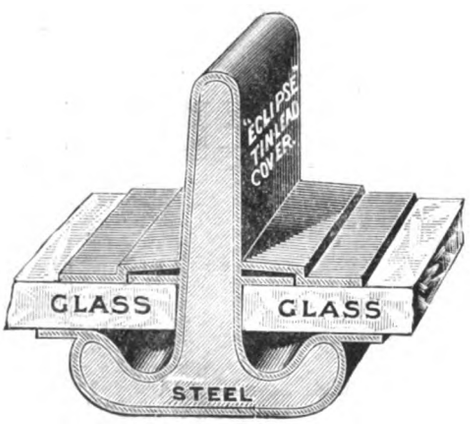

FIG. 8.—System of Glazing, Roath Car Depot, Cardiff.

Main Steam-Piping and Condensers.

The general arrangement of the steam-piping between the boiler-house and engine-room is shown in plan and elevation (Fig. 12), while the elevation (Fig. 13) shows the method of suspending the atmospheric exhaust piping. On referring to Fig. 12 it will be seen that the two main steam-pipes from the boilers are taken to the centre of the engine-room adjoining, where they connect—one at either end—to a two-way main, from which branch pipes are taken to the engines, the latter being arranged in two parallel lines to the right and left of the centre gangway. Thus it will be seen that the main steam-pipes form what may be described a semi-double ring, the double portion being suspended along the centre of the engine-room between two parallel rows of engines. Either of the branches constituting the double portion can be completely cut off, if necessary, without affecting the other. Expansion bends are provided in the centre of each of the branches, forming the double way, as shown in Fig. 12, while cones from which drain pipes are taken are provided both in the centre and at the ends. Along the centre of the engine-room the steam-pipes are suspended

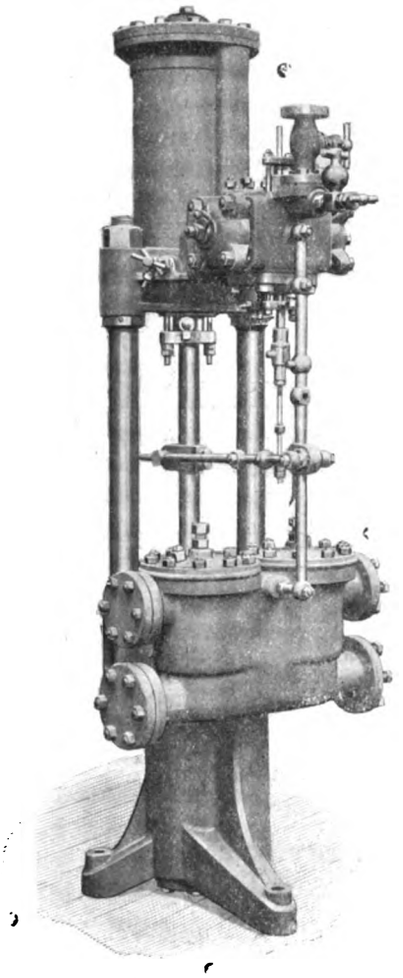

FIG. 10.—Weir Boiler Feed-Pump, Tramways Power Station, Cardiff.

from a gangway, the platform of which is on a level with the switchboard gallery, which it joins at one end of the room. The spindles of the main valves pierce the platform of this gangway, terminating at a convenient height above it in handwheels of the usual pattern. Thus ready access may be obtained to these valves from the switchboard gallery in an emergency. Access is also provided to the gangway from the engine-room floor level by means of

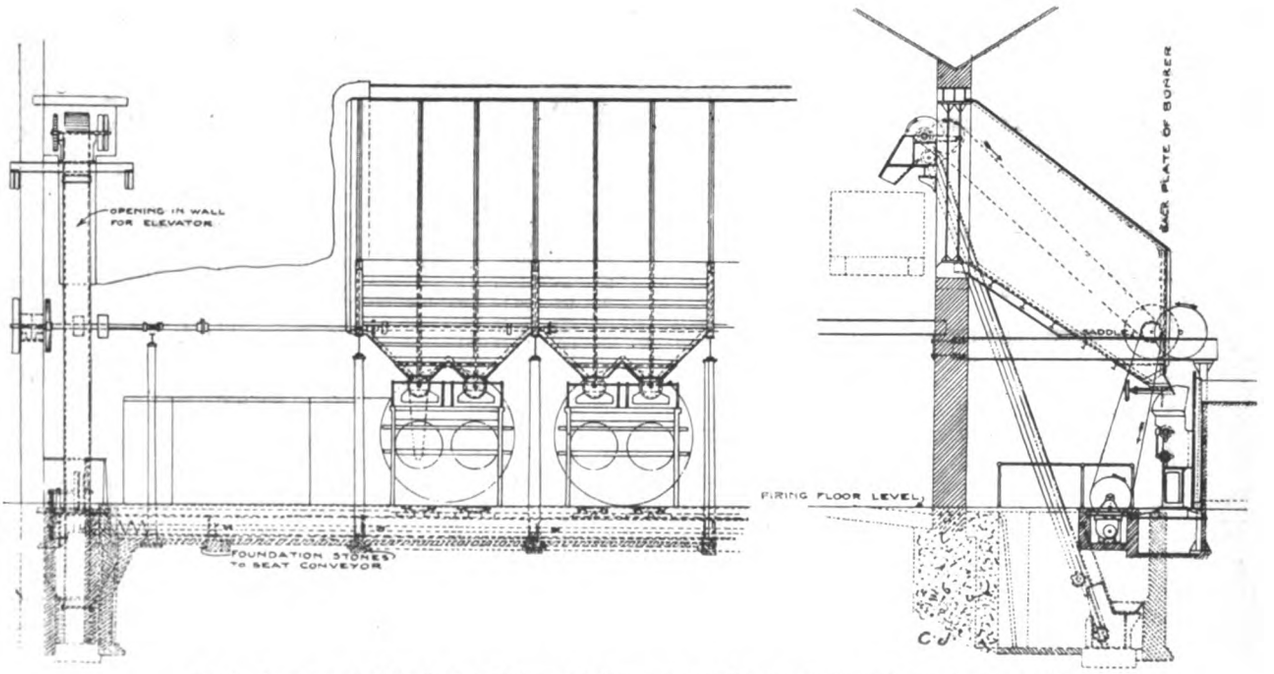

FIG. 9.—Arrangement of Mechanical Stokers, Ash Conveyor, and Elevator, Tramways Power Station, Cardiff

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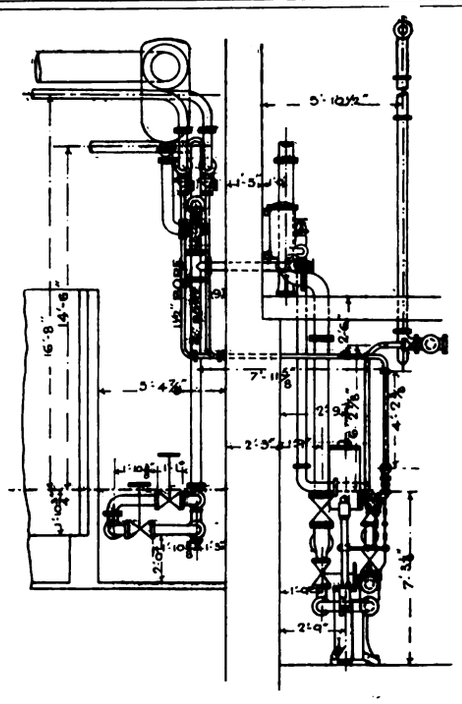
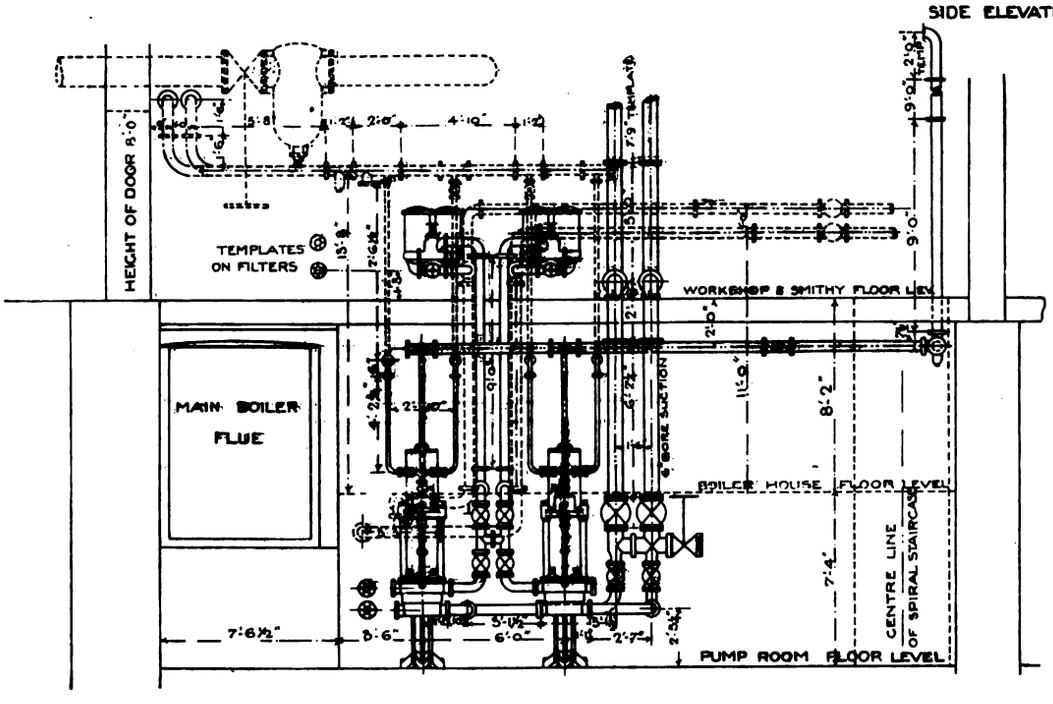
double stairways at either end. The whole arrangement is exceedingly neat, and provides maximum accessibility to the valves. From the switchboard little evidence of the steam-piping is seen, since it is hidden from view partly by the centre gangway and partly by the switchboard gallery itself, under which latter one of the branches from the boiler-house is suspended. We must not forget to mention that the main steam-pipes, both in the boiler-house and engine-room are steel sheathed over their asbestos lagging. The sheathing, which is composed of of oxidised steel, is put on in broad bands and screwed where the convolutions overlap at the edges. It is continued up to within a few inches of points where leakage is liable to occur—such as branch flanges and valves—the pockets provided for drainage purposes being also encased. The useful purposes of the sheathing are obviously, in the first place, to preserve, and in the second to protect, the lagging from mechanical injury or injury from dripping water. But it incidentally serves another purpose—that of lending an excellent finish to the pipes. Nowhere have we seen pipework which looks better than that under notice. It should be mentioned that all the steam-pipes were supplied and erected by the Sir Hiram Maxim Electrical and Engineering Company, Limited, Gracechurch-street, London, E.C., whose contract also included the exhaust pipes, circulating water and blow-down pipes,



SIDE ELEVATION



FRONT ELEVATION

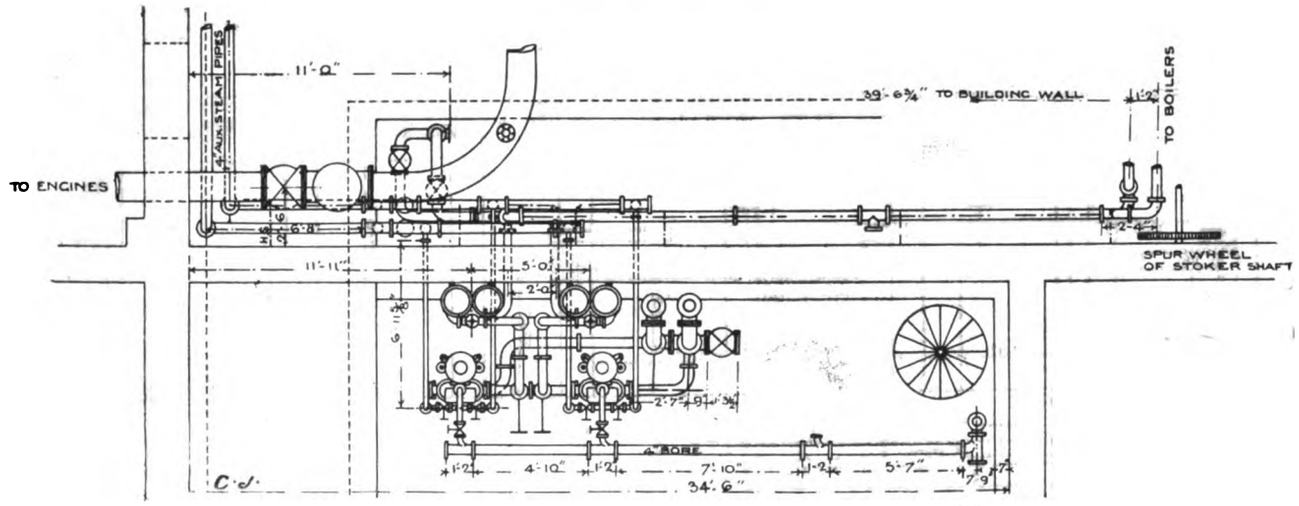


FIG. 11.—Arrangement of Pipes in Pump-Room, Tramways Power Station, Cardiff.

feed-water filters, central gangway in the engine-room, cast-iron flooring and girders for supporting same to the floor of the engine-room, besides the feed pipes, as previously stated. We have purposely omitted the dimensions of the different pipes from the above description, since these are given in the illustrations referred to. Details of the construction of the central gangway in the engine-room are given in Fig. 14.

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Now we come to the condensers. At present this portion of the plant is very incomplete. For the time being, in fact, the engines are exhausting direct into the atmosphere, the pipes conveying the exhaust steam outside the building being carried along the walls of the engine-room—one at either side—at a considerable height above the floor level. These pipes are not a temporary arrangement, but will eventually form an auxiliary means of exhaust. Jet condensers are in course of erection, into which it is intended that the engines shall exhaust under normal conditions of working. These condensers are placed below the level of the engine-room floor, each engine having its own condenser

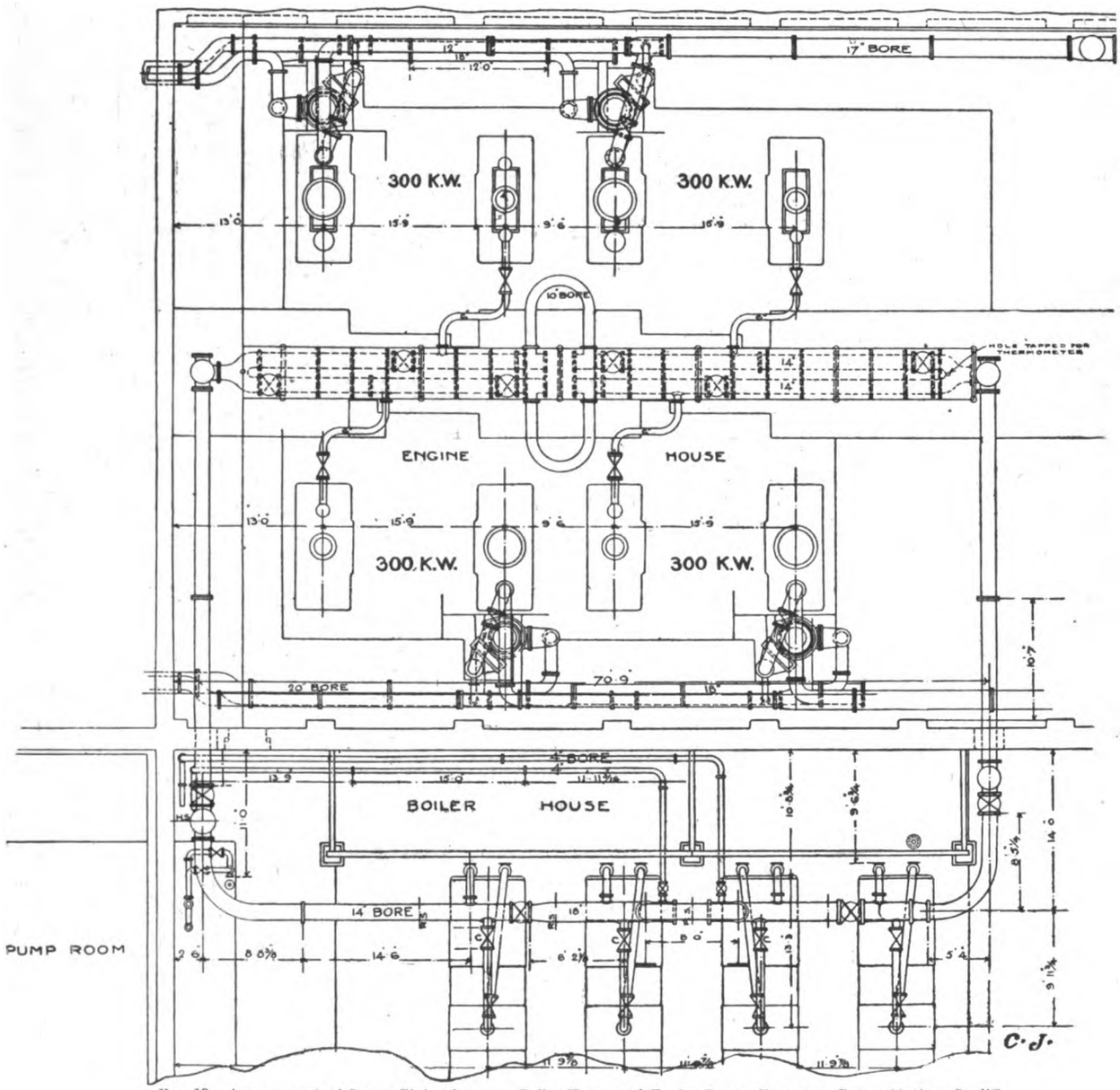

FIG. 12.—Arrangement of Steam Piping between Boiler-House and Engine-Room, Tramways Power Station, Cardiff.

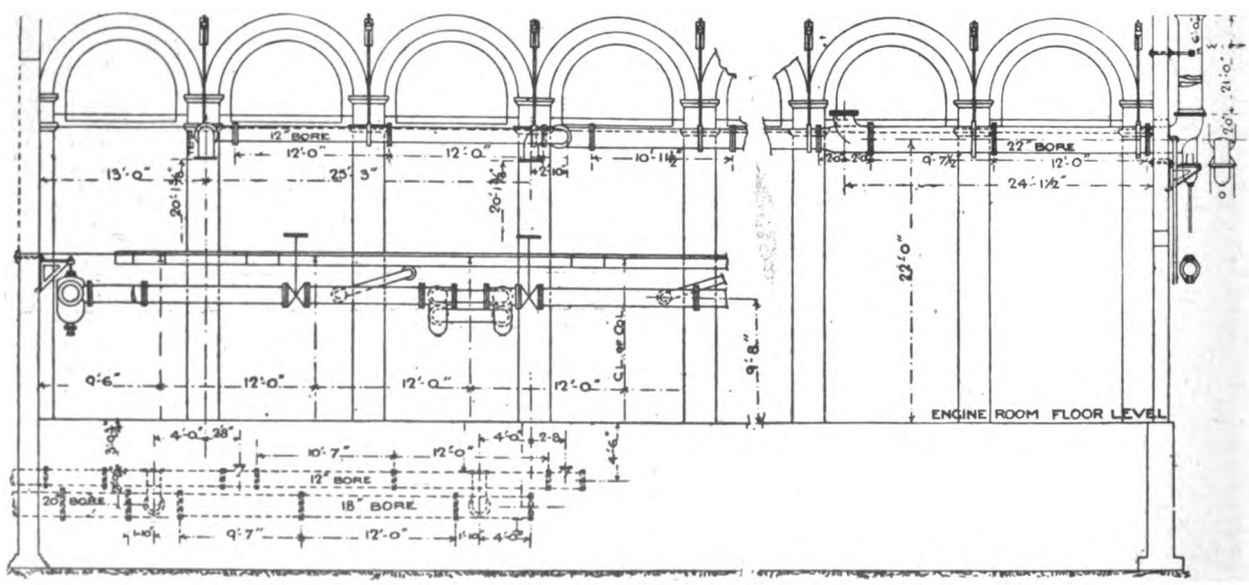

FIG. 13.—Atmospheric Exhaust Piping, Tramways Power Station, Cardiff.

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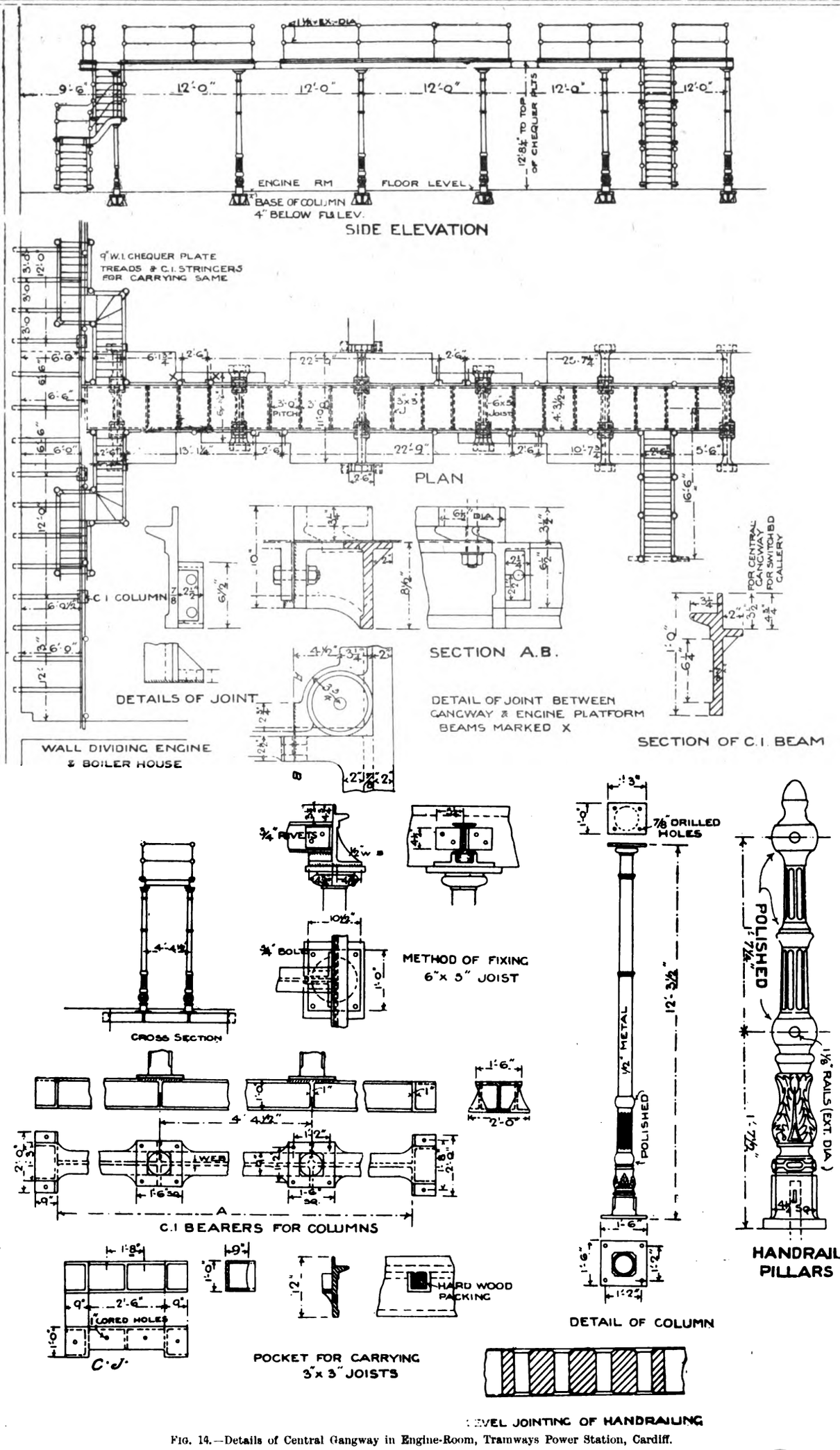

Fig. 14.—Details of Central Gangway in Engine-Room, Tramways Power Station, Cardiff.

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driving from the cross-head. The necessary circulating water will be drawn from a huge cooling pond, the excavation of which is already completed, and the cement concrete lining nearly so. Around the upper margin of this pond there will be a shallow channel, which the partially cooled water from the condensers will enter on the side nearest the engine-room, and flow thence to the opposite side, where it will enter the pond through the channel provided, ready to be passed through the condensers again. The shallow channel round the pond serves, of course, to increase the cooling surface. A brook flows past the station, from which the pond will be replenished when necessary, but since its water is unsuitable for boiler feed purposes the condensed water will not be reused in the boilers. The cooling pond is seen in course of construction in foreground of Fig. 2.

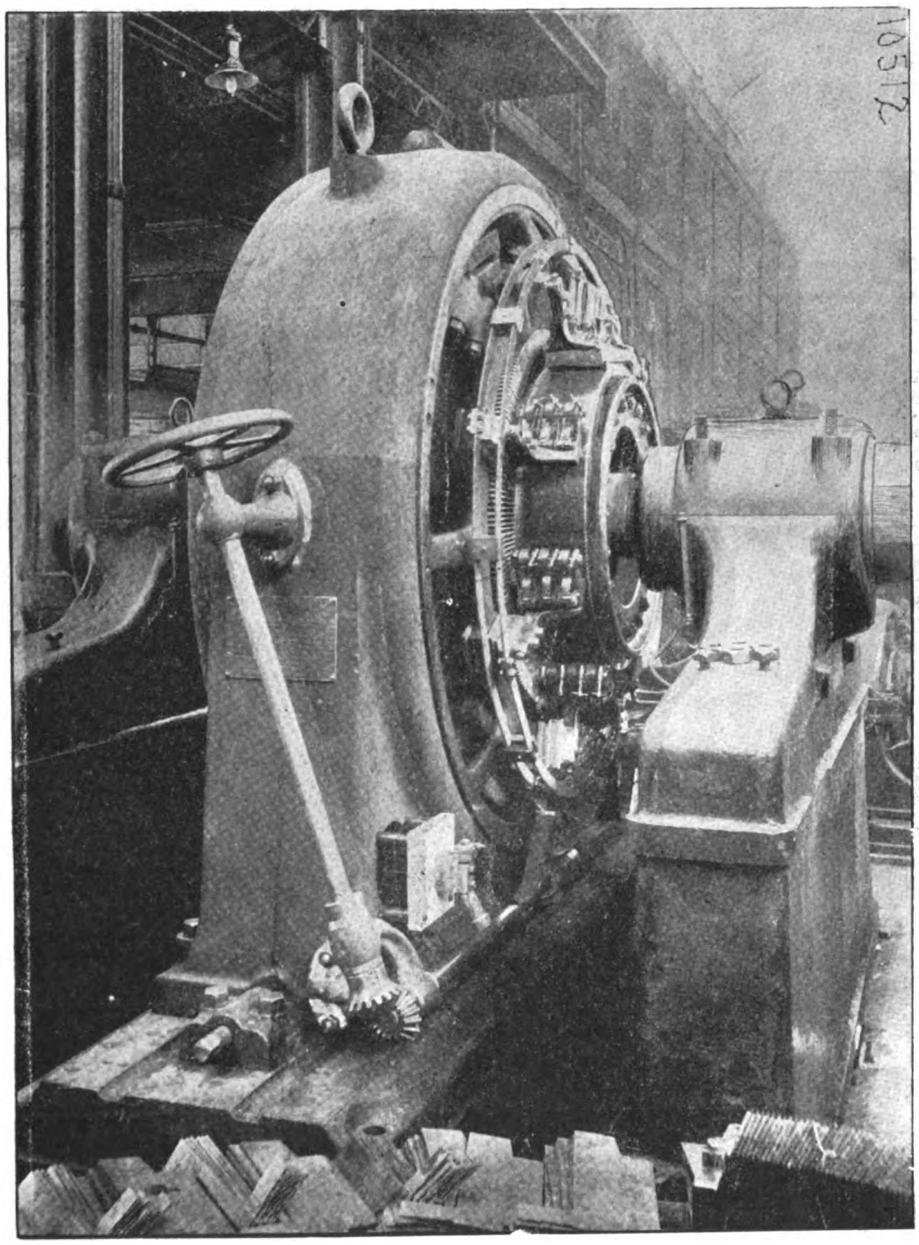

FIG. 15.—Westinghouse Generator, Tramways Power Station, Cardiff.

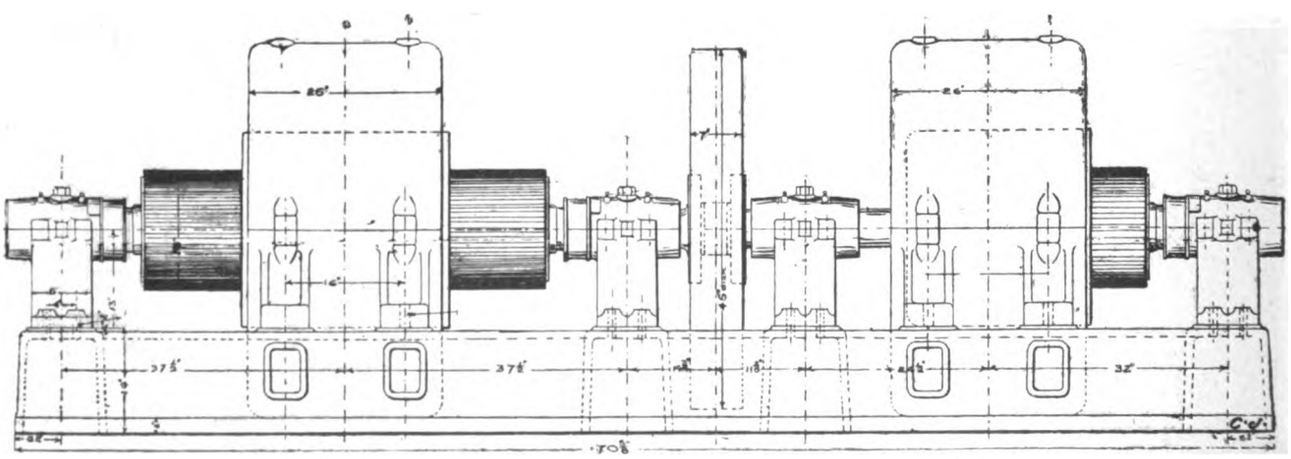

FIG. 16.—General Arrangement of Motor-Generator Set, Tramways Power Station, Cardiff.

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Engine-Room Equipment.

Main Generating Plant.—There are at present installed four steam-driven generating sets, each consisting of a 500-h.p. engine coupled to a 300-kw. continuous-current dynamo. The engines are of the two-crank, cross-compound, vertical, condensing type, and were supplied by Messrs. John Musgrave and Sons, Bolton. Each has its own condenser driving from the cross-head. A steam starter is also provided to each engine, the spur wheel of which engages in a heavy flywheel. The generator is placed in the centre of the common shaft between the high-pressure and low-pressure sides of the engine, with the heavy fly-wheel adjoining it. These engines are of massive construction, looking big for their work. Bulkhead fittings containing electric incandescent lamps are attached to the inside faces of the vertical columns enclosing the cranks.

The generators are of the Westinghouse Company's multipolar railway type, each yielding 300 kw. at a pressure of 500-550 volts, when running at a normal speed of 100 revolutions per minute. They are of the direct-connected engine type—that is, the armature and the commutator are built on one cast iron spider, which is pressed and keyed direct on to the shaft of the driving engine. The generators are all exactly similar in size and construction. The armature of each is built up of soft-steel laminations, dove-tailed into the cast-iron spider and clamped between cast-steel end plates, the periphery being slotted to receive the armature coils. The latter are of copper bar, being forged to shape and insulated before being placed in the core slots; they are of such a form that they can be placed in position on the core without any bending or hammering, and they are held in position by hard wedges of insulating material driven axially into notches in the slots above them. This form of armature construction ensures the best and most permanent form of insulation, and also renders any part of the armature winding readily accessible, without interfering with any other part of the winding than the coil actually to be got at. There is an important feature in connection with the armature winding of the Westinghouse railway generator which ought not to be overlooked, and that is the provisions which are made therein for securing a perfect magnetic balance of the machine circuits, with the consequent acquisition of sparkless and cool running and the equalising of the magnetic stresses on the machine parts. Certain points of the armature winding, which are normally of equal potential, are joined together by additional conductors, so that in the event of there not being perfect balance in the respective armature

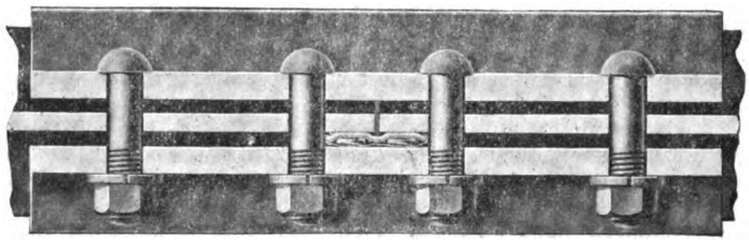

FIG. 17.—Arrangement of Plastic Bond, Cardiff Electric Tramways.

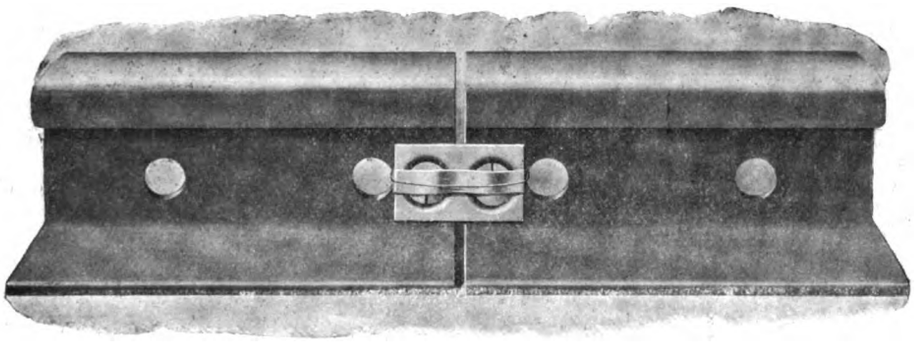

FIG. 18.—Arrangement of Plastic Bond, Cardiff Electric Tramways.

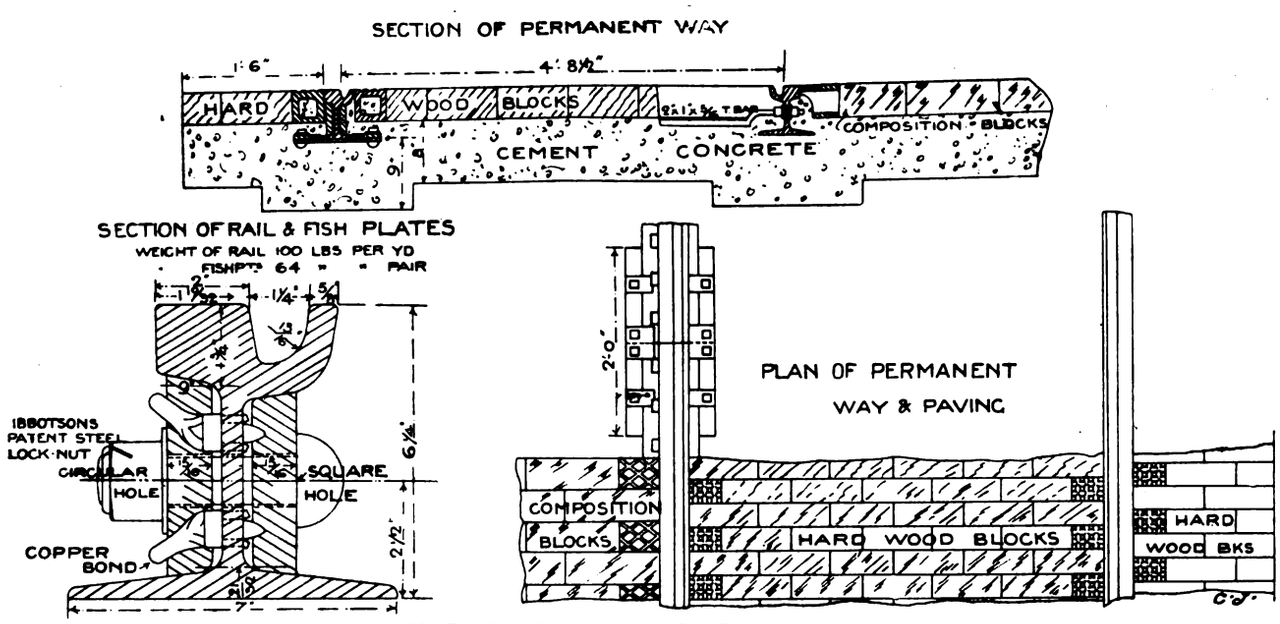

FIG. 19.—Details of Permanent Way, Cardiff Electric Tramways.

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coils, the resultant current between them does not pass by way of the brushes, whereby injurious sparking and heating would be produced, but passes along the additional leads provided. The current in these conductors is of an alternating character, leading in some and lagging in others, so that only a very small current is really required for the perfect balancing of a machine. This method of balancing is particularly advantageous where, by wear in the bearings or any other cause, the armature of a machine becomes decentralised in the field. In this case, not only are the armature circuits balanced and sparkless running secured, but the heavy magnetic pull on the side of the armature nearest to the pole-pieces is eliminated. The balancing arrangement gives excellent results in practice, and has no doubt done a great deal towards making the Westinghouse railway-type generators so popular. The generator field consists of a series of pole-pieces, built up of soft steel laminations and cast on the inside of the enclosing field ring. This field ring is vertically divided, the two parts being set on guide plates. Gearing is fitted so that they can easily and quickly be drawn, thus throwing the whole of the machine open, and rendering all parts of either the armature or the field readily accessible. The fields are compound-wound, the windings being over-compounded to give a 10 per cent. rise in pressure between no load and full load. The shunt coils and the series coils are machine-wound on separate formers before being placed on the pole-pieces, over which they slide easily into position, and are held fixed by set-screws passing through lugs on the formers into the field ring. The commutator is built of the best materials for securing high conductivity and even wear under the brushes. It is carried, as stated, on an extension of the armature spider, and is of ample size for the current output of the machine. The brushes are of carbon, the brush-holders being of a strong and serviceable spring pattern, supported by brackets from a ring concentric with and, in its turn, supported by the field ring. The usual form of hand-wheel and gearing is used for moving the brush ring and adjusting all the brushes simultaneously. This is shown in Fig. 15, which is a view taken of one of the generators before it left the erecting shop.

Motor-Generator.—This was supplied by Messrs. D. Bruce Peebles and Co., Tay Works, Bonnington, Edinburgh, and consists of two of their multipolar four-pole continuous-current machines, coupled end to end, and mounted on a combination cast-iron base-plate, the heavy flywheel being supported by intermediate bearings between the armatures. The combined set runs at a speed of about 500 revolutions per minute when supplied with current at a pressure of 500 volts across the motor terminals, the generator developing an output of 600 amperes at any voltage between 100 and 140. The set is also arranged so that by supplying current at a pressure of 100 volts to the terminals of the low-tension machine, the high-voltage machine will be capable of developing its output at a pressure of 500 volts. The set is used for the following purposes: (1) when receiving current at 500 volts from the tramway 'bus bars and running as a motor, the generator to be used for charging the battery of accumulators; (2) when running as above, the generator to be used for lighting the power station and car depôt direct and independent of the battery; (3) when receiving current from the battery at 100 volts, the generator to develop current at 500 volts for line-testing purposes and shunting the cars in car depôt, when the motor-generators are shut down.

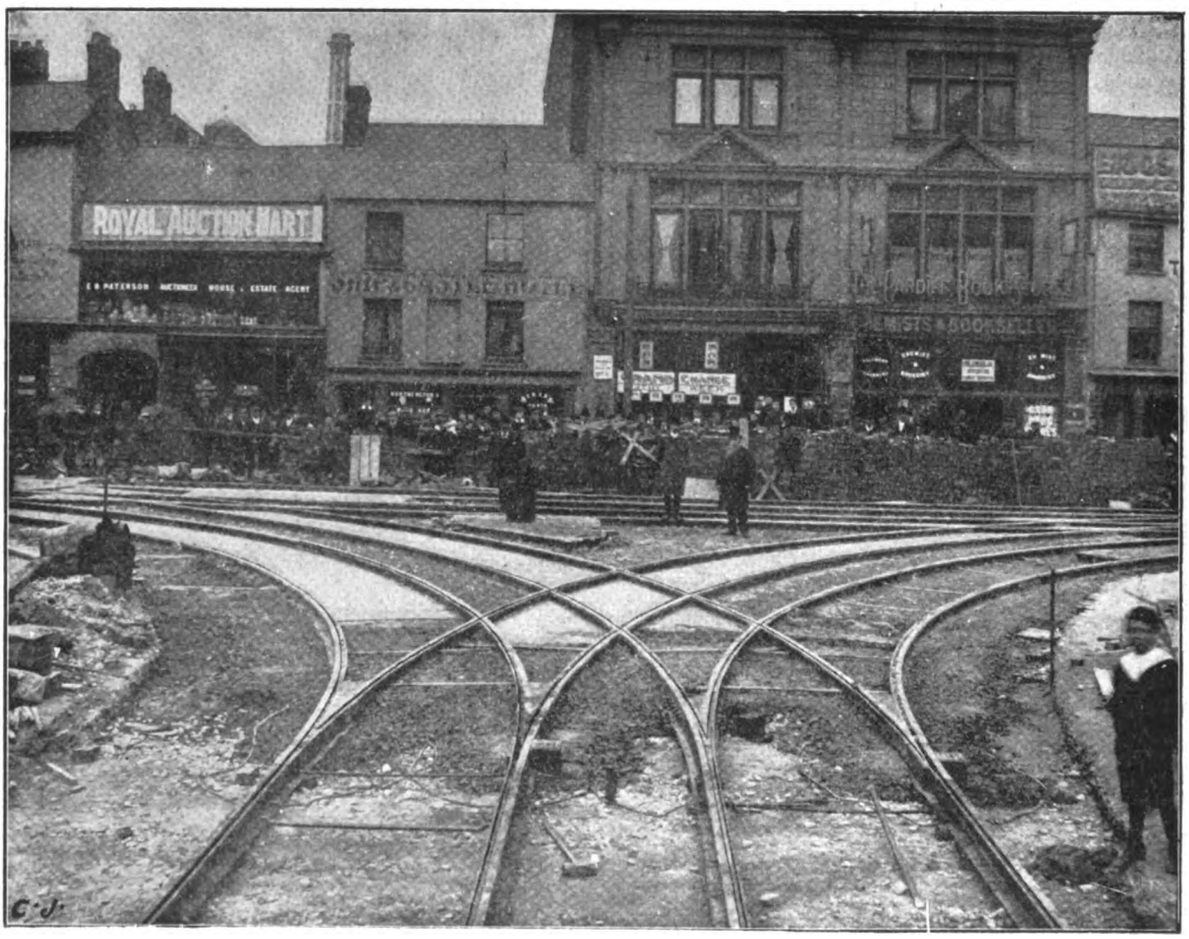

FIG. 20.—Junction with St. Mary-street and Wood-street, Cardiff Electric Tramways.

Both the high and low voltage machines are of Messrs. D. Bruce Peebles's standard construction, the magnets being shunt-wound in each case. The armatute is of the multipolar slot-wound type with cylindrical winding built up on spider of rigid design, and having fan blade ventilating ducts distributed at equal distances throughout the core, thereby ensuring ample ventilating surface. The core plates are of annealed Swedish charcoal iron individually papered and varnished, the slots being thoroughly insulated and tested at a pressure of 5,000 volts. There are no joints at the back end of the winding, and each coil is previously prepared and shaped on machine jig. There are no joints in the whole armature except in the commutator end. The commutator is a special feature of these machines,

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being built up of high-conductivity drawn-copper bars, constructed under heavy hydraulic pressure and insulated with pure India mica. The magnets are of cast steel, and are split on a horizontal plane, so that ready access may be obtained to the armature. By means of the firm's special non-sparking pole-tips, the machine is rendered sparkless at all loads from no load to 25 per cent. over full load without alteration in the position of the brushes. The brushes are of carbon having a low current density. The bearings are of the self-aligning type, fitted with automatic oil ring lubrication. The whole machine has a handsome and workmanlike appearance, and is a sample of the many other well-designed and constructed machines turned out by the firm in question. Fig. 16 shows the general arrangement of the set.

Main Switchboard.—The traction switchboard is erected in a deep recess in the permanent end wall of the engine-room adjoining the offices, and on a level with the engine-room gangway previously described. It is of the standard type introduced by Messrs. Ferranti Limited, Hollinwood, Lancs., being a fine example of its kind. The switchgear is of particularly solid construction, its arrangement, moreover, combining the many advantages, both as regards electrical efficiency and economy of space occupied, so well defined in the Ferranti type of switchboard. Seven feeders are at present connected to the board, and four generators, but it provides for a large increase in the number of feeders, and also for the extension generators now on order. The measuring instruments are of the edgewise pattern, and the field resistances, which latter are erected below the switchboard gallery, of the Westinghouse circular type. We hope to refer to this switchboard again in a subsequent article.

Station Lighting.—The wiring of the station buildings was done by the Corporation's own staff, Simplex conduits being used. Davy arc lamps are installed in the engine-room, and owing principally to the height at which they are suspended, a remarkably uniform diffusion of light is obtained. The station lighting switchboard is built in a separate recess along the main switchboard gallery.

Accumulators.—A battery, consisting of 56 cells of the Tudor L B 31 type, capable of giving 210 amperes for 10 hours or 540 amperes for three hours at 100 volts, has been installed. The cells are contained in lead-lined wood boxes. This battery will be used exclusively for the station lighting and purposes indicated in the paragraph headed "Motor-Generator." A milking booster set is provided, this being placed in the corner of the engine-room nearest the accumulator-room.

Engine-Room Telegraphs.—A complete system of engine-room telegraphs has been installed. The switch by which these telegraphs are operated is attached to a pillar facing the traction switchboard. The signals appear as illuminated figures on an oblong panel, behind which the illuminating lamps are fixed. The figures represent the different engines, and may be illuminated individually at will from the switch pillar according as it is desired to start up or slow down any particular set. There are three receiving panels, two at the switchboard end of the room and the third on the opposite end wall. The switchboard attendant is, therefore, enabled to give the necessary instructions to the engine-drivers without leaving his post.

FIG. 21.—Crossing and Junction, Bute-road and Euston House-street, Cardiff Electric Tramways.

Extension Plant.—The extension plant on order includes two steam generators, each set consisting of a 1,000-h.p. Musgrave engine coupled to a 900-kw. Dick-Kerr dynamo. The foundations for these sets are already in. As explained elsewhere, the station will eventually supply current not only for traction purposes, but also to an extensive network of lighting and power mains. However, this portion of the scheme is yet in its initial stages, although the same generating plant will serve to supply both networks.

Outside Work.

Track.—The trackwork is laid on a cement concrete foundation 8in. in depth, with an extra depth of 3in. under the rails and for a distance of 6in. on either side of same. A rail of the girder type has been used throughout, weighing 100lb. per yard. The rails are 6¼in. in depth, and the width of the bottom flange is 7in., the groove of the rail being 1¼in. wide and 1¼in. in depth. The rails are jointed

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with fishplates, each pair weighing 64lb., and are bolted to the rails with six 1in. fishbolts fitted with Ibbotson's patent lock nuts. The rail joints are also further secured by Askham's patent sole-plate, 2ft. by 11in. by ½in., fastened with four single and two double clips by ⅞in. bolts. The tiebars first used were of the ordinary type of flat bar section, but those used more recently and on the reconstruction are of cranked T iron specially designed by Mr. Harpur for the purpose of permitting the wood paving between the rails being carried over same, thus enabling the paving to be more expeditiously executed, and also giving the same a neater appearance when finished. The points and crossings used on the new routes were obtained partly from Messrs. Askham Bros. and Wilson, of Sheffield, and partly from Messrs. Hadfields, of Sheffield, oak, the latter being obtained as prismatic oak blocks, which blocks are used on inclines where a better foothold for horses is required. A considerable portion of the spaces between the up and down roads is paved with a composition block obtained from the Sanitary Block and Tile Company. The Jarrah and deadened redgum timber is obtained in 9 by 3 planks by the Corporation, who have laid down a sawmill for converting same into blocks, one of Temperley's patent automatic cross-cut saws being used for the purpose, a special equalising machine obtained from Messrs. Ransome and Co. being also used for planing the planks to a uniform thickness. The blocks are all cut to a uniform depth of 4in., and are laid with close butt joints. In order to minimise the great wear of the blocks along the sides of the rails, chilled cast-iron blocks are laid

FIG. 22.—Plan of Feeders. F.P., Feeder Pillar; N.F.P., Negative Feeding Point; S.B., Section Box; Cardiff Electric Tramways.

the latter firm supplying all this class of material for the reconstructed portions of the routes and manufacturing same out of their patent manganese steel. To secure the electrical continuity of the rails, the joints are bonded with copper bonds outside the fishplate and plastic bonds between the fishplate and the web of the rail. The rails are also cross bonded with copper bonds. The greater part of these bonds were supplied by Messrs. Robert W. Blackwell and Co., Limited. The plastic bond used is of the latest type. Its arrangement is shown in Figs. 17 and 18.

The different sections of the tracks are paved with the following timbers: Jarrah, Alcott's deadened redgum, and alternately with the wood and other blocks along both sides of each rail. Details of the permanent way are shown in Fig. 19, while Figs. 20 and 21 show the track in course of construction.

Mains.—What may be termed the feeder point and distributor system of mains has been adopted in connection with the Cardiff electric tramways, the feeder pillars to which the feeders from the main switchboard are run being really distributing boxes, from which the distributor cables radiate to the actual feeding points The positions of the various feeder pillars and section boxes are shown on the accompanying plan (Fig. 22).

(Continued on page 690.)

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NOTES.

Western Society of Engineers.—We beg to acknowledge the receipt of the above society's *Journal* for April, which is published bi-monthly in Chicago. The present issue contains reprints of some useful papers with the discussions thereon, including one on "Mechanical Filtration" by Mr. R. E. Milligan.

Standardisation.—A commission has been formed in connection with the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, and the Iron and Steel Institute, to consider the question of standardising tramway rails and other sections. Among those composing the commission are Sir John Wolfe-Barry, Sir Douglas Fox, Mr. W. Harpur (of Cardiff), and Mr. C. F. Wylie (of Sheffield).

Effect of Light on the Eyes.—It will be interesting to electrical engineers to hear that a Russian specialist has decided that the electric light has less damaging effect on the eyes than other forms of artificial light. Taking as his basis of deduction the number of times the patient closed the lids of his eyes, he found that the electric light was even less effective than the sunlight. To give the actual figures, the lids closed 6·8 times in a minute with candle light, 2·8 times with gas light, 2·2 times with sunlight, and 1·8 times with the electric light.

Multiplex Telegraphy.—A Berlin message says that a new system of multiplex telegraphy, which is the invention of Dr. Donald Murray, is being tried at the Berlin central telegraph station, and should the German Telegraph Department report favourably on it, the system will first be installed between London and that city. It is said that Dr. Murray claims to be able to send 12 messages at a time, and among other advantages which he makes for his apparatus he claims that it does away with the necessity of transcribing the messages received from the Morse code into ordinary writing.

Book Received.—"The Generators of Electricity at the Paris Exhibition of 1901," by C. F. Guilbert. We have received from the publishers, of 3, Rue Racine, Paris, the above volume, which will be of enormous interest to all electrical engineers concerned with the design of dynamos and other electrical apparatus. The volume, which consists of almost 800 pages, contains illustrations of all the large machines on view at the exhibition in question, with a large number of diagrams of their details of construction. As a work of reference this book may be looked upon as indicating the exact state of the art at the end of the nineteenth century.

Telephony in Canada.—The principal clauses of the Bill recently brought in by the Dominion Government for regulating telephones and telegraphs in Canada are now available. It seems that the Government reserve the right after two months' notice to assume possession of the property of any telephone or telegraph company carrying on business in that country; and in the event of a difference arising as to compensation, reference is to be made to three arbitrators. Another provision is that the lines shall be so constructed as not to interfere with the public use of roads and highways, or impede free access to any building. Tolls may be fixed for either the whole or any particular part of a company's line, but such tolls are to be uniform to all persons, and must be approved by the Governor in Council. Another clause makes it compulsory upon a telephone company to supply telephone connection to any applicant upon the payment of lawful tolls.

Measure of the Electrolytic Diffusion of the Ions.—In the current number of the Chemical Society's *Journal*, just issued, will be found a short account of a method brought forward by Mr. Paolo Straneo for measuring the coefficient of diffusion, D, the transport number, n, and the relative mobilities, u and v, of the ions of an electrolyte, which obviates the use of diaphragms and requires only very small differences of concentration, besides being very rapidly carried out. The principle of the method is to place the electrolyte to be examined between two horizontal electrodes at a short distance apart, and by means of an electric current of convenient density to cause a displacement of the electrolyte from the top to the bottom; from the variations of the concentration of the electrolyte in the neighbourhood of the electrodes, the values of D, n, u, and v can be calculated. A test experiment with zinc sulphate solution between amalgamated zinc electrodes has given good results.

Electric Fire Appliances.—At the sixty-sixth annual general meeting of the Liverpool, London, and Globe Insurance Company, Sir Wm. H. Tate, Bart., the chairman of the company, made some remarks which, we trust, are original, as we should not like to think that the expert advisers of the above company agree with their chairman. He stated that "the extended use of electricity had no doubt been one cause of the increased number of fires, especially abroad, as faulty installation was sure, sooner or later, to result in an outbreak." That there have been electrical fires due to faulty installations we should be the last to deny, but all the statistics which have been collected by the fire insurance companies in the United States, where such faulty installations are much more frequent than in this country, show that even with this extra risk the number of fires caused by electricity is a small proportion of those caused by other illuminants. We think that the chairman of the above company would do well to look into his statistics before making general statements which are as misleading as they are absurd.

High-Voltage Transmission.—What we believe to be the first case of power transmission in railway practice at more than 26,000 volts is that which will shortly be brought into operation at Indiana, U.S, where the Union Traction Company propose to have power supplied over 32,000-volt three-phase transmission lines. The railway system is at present being supplied over 14,000-volt lines. The interurban system of the company already has a total length of 97 miles, and this is shortly to be added to by 75 miles of new line, for which the 32,000-volt transmission will be used. The transmission line will run north from the power station at Anderson to Alexandria, and then west to Tipton, following the railway right of way. At the latter place there will be a high-tension switching station, at which the load can be thrown on to either one of the two high-tension transmission lines that will be provided. The longest distance of transmission will be 60 miles. This is said to be a considerable advance in voltage and distance over any power transmission yet carried out in the Eastern States, though in California this distance and voltage have been equalled in many and exceeded in at least three prominent cases.

Mechanical Engineers' Conversazione.—A very successful conversazione was given by the president and council of the Institution of Mechanical Engineers at the institution buildings, Storey's-gate, Westminster, on Friday night. Among the guests were Lord Strathcona and Mount Royal, Lieut.-General Kelly-Kenny, Rear-Admiral Durnford, the Bishop of Rochester, the Mayor of Westminster (Colonel Probyn), Lieut.-General J. F. Owen, Mr. Balfour-Browne, K.C., Sir W. de W. Abney, Lieut.-Colonel Yorke, Lieut.-Colonel von Donop, Sir E. Bradford, Mr. Fletcher Moulton, K.C., M.P., Mr. Charles Hawksley, Mr.

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R. W. Dana, Sir John F. L. Rolleston, M.P., Mr. D. J. Dunlop, Captain Tamari, Sir Walter Peace, Sir Horace Tozer, and many other representatives of learned and scientific societies The band of the Scots Guards, conducted by Mr. F. W. Wood, played in the large hall, while a programme of vocal music was performed in the library, the vocalists being Mrs. Montague Fordham, Miss Gertrude Calvert, Mr. Samuel Masters, and Mr. Robert Radford. In the large hall a number of interesting slides showing the process of ice-breaking in the Arctic regions were shown and described by Mr. Arthur Gulston, of Newcastle-on-Tyne.

German Electric Railways. — Some valuable statistics have recently been published which show the state of the public electric railway and tramway interests of Germany up to Oct. 1 last year On this date 113 German cities, against 99 in 1900, had electric traction, with a total length of roads of 1,940 miles, equal to 2,844 miles single track. The total capacity of the generating electric machinery in use for traction was 108,021 kw., as against 75,608 kw. in 1900, excluding storage batteries. The increase in the use of storage batteries was still greater ; their power was 25,531 kw. at the end of October, 1901, as against 16,890 in 1900. The total capacity of generating machines and batteries together for traction was, therefore, 133,552 kw. For light and traction together the total capacity of generating machines and storage batteries was 486,120 kw. The average number of kilowatts per motorcar was 15·7, against 15·1 and 14·3 in 1900 and 1899. These averages have, therefore, remained nearly constant, although the values of single roads differ greatly from these averages. Of the total 2,844 miles single track, only 445 miles are owned by municipalities, but even this is in part rented to private companies. The above figures do not include the statistics of private roads, with the exception of the Berlin-Zossen experimental railway.

New Type of Submarine.—Particulars are to hand of the new submarine boat invented by Mr. Claude Goubet, which has just been sold to the newly-formed British Submarine Boat Company. It is said to differ very widely from the newest "Holland" type, to which the present British submarines belong. While the latter have a reserve buoyancy when submerged, and are kept under by means of horizontal rudders, the Goubet boat possesses no reserve buoyancy when beneath the water, its weight equalling its displacement. The new type, in fact, weighs nothing when submerged, and it is said that the addition of a very small weight will set it sinking. In order to keep the boat on an even keel and prevent it either rising or sinking, the inventor has devised an arrangement which pumps water from a forward tank to one situated aft, and *vice versâ*. The method of working is described as follows : Should the vessel incline in any direction a pendulum swings forward, and in so doing forms a connection between a motor and the batteries ; the former at once commences working the rotary pump in a direction which causes the water to flow through the pipes from the lower tank to the higher, until the addition of water to the latter is sufficient to bring both the boat and tanks level again. The pendulum swinging straight then cuts off the electric current and the motor instantly stops.

Alternating-Current Meters.—The American Patent Office have recently issued four patents relating to alternating-current meters, all of which were granted to German inventors. Mr. G. Stern, of Charlottenburg, is responsible for two which are both concerned with a new arrangement of actuating the windings of an alternating-current meter. As applied to an induction meter, there are two measuring systems, each consisting of two series and one shunt winding, the windings being arranged in co-operative relation to the usual short-circuited armature operating a counter. The current windings are so connected and arranged that the resultant of the current fluxes in the two systems are displaced in phase from one another by 150deg.; and the shunt winding is connected and arranged to generate potential fluxes displaced in phase from one another by the same angle, the potential flux of the non-inductive load lagging in one system behind and the other leading the current flux. The second patent covers connections such that the displacement of the current is 30deg. from its impressed E.M.F. Two other patents, taken out by Mr. Schroltke, of Berlin, describe a meter of the induction type, consisting of a four-pole field surrounding a short-circuited armature, which latter actuates a counter. On two opposite poles is a winding in series, with one of the working conductors and also a short-circuited secondary winding. On the other two poles is a potential or shunt winding, in series with which is an inductance or a condenser.

Local Veto.—An unsuccessful attempt was made in the House of Commons on Thursday week to amend Standing Order No. 22, the effect of which would be to abolish the veto at present vested in the local and road authorities in regard to the construction of tramways in this country. The motion was brought forward by Mr. Chaplin, who denounced the present law, which makes the consent of the local authorities concerned an absolute condition before any Tramway Bill can even be introduced into Parliament, as having led to "considerable scandals." What he proposed was this: that proof should be given before the committee on the Bill that the promoters had either obtained the consent of the local authority or that it had been withheld, and that if, in the opinion of the committee, such consent had been unreasonably withheld and ought to be dispensed with, they should report accordingly. Naturally enough, the proposal did not gain a favourable hearing, and it was opposed by practically all the representatives of the metropolitan borough councils and the majority of the provincial local authorities. The chief argument adduced against the amendment was that if the local veto were abolished, great injustice would be done to the local communities, who would be put to needless expense in employing parliamentary counsel and opposing schemes which affected them. In fact, nearly all the speakers on the question declared their intention of voting against the amendment, and ultimately it was rejected without a division.

Birmingham Local Section.—The report of the committee of the above section of the Institution of Electrical Engineers for the past year was presented to the annual general meeting of the section, held at Birmingham on the 14th inst. It is noteworthy that at the six meetings held in the past session the papers read were in every case illustrated by demonstrations with apparatus or lantern. The Council of the parent institution has decided to include all the communications which have come before the section at these six meetings in the *Journal*, either in abstract or in full. We further gather from the committee's report that the membership has been increasing steadily, the total number of members of all classes now being 152, as against 123 at the end of the previous session. For the coming session the committee invite offers of papers, such offers to be in the hands of the hon. local secretary in time to enable the committee to draw up a complete programme for issue to the members before the first meeting in November. The committee wish again to remind the members of the absolute necessity of receiving papers from local members if the section is to continue its

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existence. The programme of the current session was very largely arranged for by officers of the section. The following is the list of officers for the session 1902-3: past-chairman, Prof. Oliver Lodge, D.Sc., F.R.S.; chairman, Mr. Henry Lea, M.I.C.E.; vice-chairman, Mr. J. C. Vaudrey, M.I.C.E.; committee, Messrs. Fredk. Brown, Alfd. Coleman, Alfd. Dickinson, R H. Housman, W. O. Rooper, W. E. Sumpner, D.Sc, A M. Taylor, and R. Threlfall, F.R.S.; hon. secretary, Mr. D. K Morris.

Electrolytic Extraction of Copper.—An apparatus for the extraction of copper from sulphuric ores by an electrolytic process is the invention of Mr. Lehonin, a Russian engineer, and one of the claims he makes for his method is that it does not necessitate the preparatory roasting of the ore. The apparatus is especially adapted to localities where fuel is scarce, but where water is easily obtained. After the ore has been picked and crushed, it yields almost pure pyrite, which is submitted to a treatment with sulphuric acid. By this means the green vitriol dissolves, and the solution flows into a row of stepwise-connected cells, making it possible to use currents of different power. The arrangement consists of a zinc box containing cells, in the first of which is placed one cathode of any desired metal; in the second, divided by a partition, are two cathodes; in the third, with two partitions, are three cathodes; and in the fourth, with three partitions, are four cathodes. The electrolyte flows consecutively through all the elements. In the first apparatus, which has the largest surface—*i.e.*, 25 square decimetres—the current is 50 amperes, or two amperes to one square decimetre; in the second apparatus the current density is one ampere per square decimetre; in the third, three fourths of an ampere, and in the last, half an ampere. The concentrated solution enters the first apparatus, leaving a sediment of copper, then flows into the second, and so forth. The solution contains copper as well as iron vitriol, but the iron vitriol does not separate unless the solution contains at least 5 per cent. of copper. The copper received on the cathode is ready for refining, while the sulphuric acid obtained from the apparatus can be used over again.

Comparative Cost of Coal and Gas.—Some valuable data of interest to all power users are obtainable from a series of tests which Prof. Henry G. Cox has recently made in the States in order to determine the comparative cost of gas and coal fuel. The tests were carried out in one of the large manufacturing plants of Indianapolis, where half of the boilers were fired by natural gas, the rest by coal. For the purposes of the experiments the price of natural gas was taken at about 4d. per 1,000 cubic feet, and the coal used was a West Virginia screenings variety, costing about 9s. a ton. The coal was good, high in heat value, low in ash, iron, and sulphur, and in this test it won over the natural gas by the amount of above 30 per cent. It is customary in boiler tests to find the cost of evaporating 1,000lb. of water to be used simply as a basis for comparison, and in the above test the cost of evaporating 1,000lb. of water by using natural gas was about 8½d., while coal evaporated the same amount at a cost of under 6d. Another test was made last November with Indiana coal, and in this case also, not only did the coal again make power about 30 per cent. cheaper than natural gas, but the efficiency of the boiler and stoker was so much greater that the coal evaporated 1,000lb. of water at a cost of only just over 3d. In giving the above results before a scientific society the other day, Prof. Cox stated that they came as an agreeable surprise to him, for, though many engineers claimed that with some good make of stoker carefully-fired coal could generate power as cheaply as natural gas, none were prepared to see the coal make it so much cheaper. His conclusion is that in dealing with the power problem, natural gas is not to be taken into calculation as a permanent commercial proposition.

Metallisation of Textiles.—A method of metallising textiles electrically, which is said to afford the possibility of impregnating the thickest piece of cloth, either thoroughly or only on its surface, with any kind of metal, has been invented by Dr. K. Donilowsky, of Russia. The object is attained by an electrical process of separation of the different salts from a given metal and by accumulation of the separated metal in a cathode. From an interesting account of the process we gather that for metallisation there can be used copper, iron, silver, nickel, and, in general, any metal which can be separated from its salts by electrolytical manipulation. Before the process of metallisation the textile has to go through a preparatory treatment, which consists in impregnating the cloth with a solution of the salt of a certain metal—for instance, with sulphuric acid of copper or oxide of silver, etc. After the cloth has been impregnated it is submitted to a certain treatment with oxidised sulphur, which causes the metal to be separated from the solution in a sedimentary mass, which, being very fine, intrudes the cloth, uniting closely with its fibres, and also settling down on the surface of the cloth. When the cloth is thus prepared it is ready for the process of metallisation, and for this purpose it is put into an electrolytic tub filled with a solution of the salt of the kind of metal in which the cloth shall be metallised, and brought in contact with the positive surface of an electrical device. The power of the current, as well as the contents of the tub, has to be regulated for each case respectively. The result which is claimed for this operation is a cloth perfectly impregnated throughout its thickness, as well as on its surface, with a certain metal in crystallised or in any desired form, which has so uniformly united with the substance of the cloth that the latter is perfectly metallised.

Low-Voltage Lamps.—At a recent meeting of the Société Française de Physique a paper was read on "The Electric Light by Incandescent Lamps by Carbon Filaments on the Economiser System of Weissmann-Wydts." The communication was by Mr. G. Weissmann himself. The idea of the inventors is to vary the voltage on incandescent lamps with candle power so that carbon filaments of uniform thickness can be used with all types. The reason for this is stated in the paper to be that the efficiency of the lamps depends on the diameter of the filament. The figures given by the author in support of this are as follows: With a 10-c.p. 110-volt lamp the average consumption is stated to be four watts per candle, whilst with a 5-c.p. lamp it works out at five watts per candle. If, on the other hand, a 110-volt 32-c.p. lamp is used, an average consumption of three watts per candle is said to be obtained, or 2·5 watts per candle with a 50-c.p. lamp, etc. The author's conclusions are that the efficiency is dependent on the candle-power with the ordinary types of lamps, and that if he could use a short length of thicker filament for the small candle-power lamps, he would get a much higher all-round efficiency. In order to do this he has designed, with the assistance of Mr. Blondel, a system of supplying all the lamps on an installation through small transformers. One transformer is provided for each group of lamps, and the voltage can in this way be decreased to that required. For instance, the 10-c.p. lamps would be worked at 22 volts, and the 50-c.p. lamps at 110 volts. The transformers are so connected that they are out of circuit when the lamps are not in use. It will be seen that the system would only be

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available on alternate-current circuits, and we personally are inclined to think that it is to the lampmaker, rather than to the transformer maker, that we must look for the desired improvements in the efficiency of high-voltage lamps.

Lightning Conductors.—In the course of a long article in the current number of the *Wisconsin Engineer*, Mr. G. W. Wilder remarks on the numerous attempts which have been made to find out the probable value of the current which traverses a lightning conductor during a discharge. Until recently it was thought to be some function of the difference in potential between the earth and the clouds only. Now it is known that with exceedingly high frequencies the cross-sectional form, and the kind of material which constitutes the conductor, are of much more importance. On account of the shortness of duration of a lightning discharge, the current in a copper conductor must be enormous, the writer thinks, in order to produce some of the heating effects which have been observed. No reliable measurements have yet been made, nor are any likely to be made, owing to inability to measure the small interval occupied by a lightning flash. The writer considers it probable that the current value is extremely variable, reaching into the thousands of amperes as an upper limit. Discussing the commercial development of lightning conductors, he remarks that the well-known exploits of lightning-rod agents in America have had the effect of making the public sceptical regarding the efficiency of any kind or form of conductor. This is probably the chief cause of the extensive use of thick copper rods, and it is found almost impossible to arouse interest in the barbed-wire scheme in the States. Even the insurance companies are loth to grant risks on buildings thus protected. Considering the great number of violent storms and the consequent losses, and the comparative cheapness of barbed wire, the writer finds it a matter for astonishment that America to-day is at a complete standstill regarding lightning protection. In England things are different. Much progress has been made in this direction, and the old style of copper rod is looked upon as a thing of the past. Considerable attention, too, has been devoted in this country to the architectural arrangement of wires, with the result that in many cases they are only visible at very slight distances.

Electrolytic Preparation of Metals of the Cerium Group.—The preparation of metals of the cerium group by electrolytic fusion is described by Messrs. W. Muthmann, H. Hofer, and L. Weiss in a recent paper which we find well abstracted in the current number of the Chemical Society's *Journal*. It appears that the authors employ a jacketed copper crucible which can be cooled with water throughout the electrolysis. The electrodes are carbon rods, the cathode passing through the bottom of the crucible; the temperature is regulated by means of smaller carbon rods, 3mm. in thickness and 23mm. in length, placed between the electric terminals. When a current of 40 amperes and 10 to 12 volts is employed with this apparatus, cryolite is readily melted, and on removing the connecting small carbon rods the electrolysis sets in, the current strength now being 8 to 10 amperes with 60 to 65 volts. Lead chloride is conveniently electrolysed with a current of 30 to 35 amperes and 8 to 10 volts. Anhydrous cerous chloride, mixed with 10 per cent. of a mixture of sodium and potassium chlorides, is electrolysed with a current of 30 to 40 amperes and 12 to 15 volts; the metal isolated contains 99·92 per cent. of cerium. Cerium is only slightly oxidised in dry air; it slowly decomposes water in the cold, but more rapidly on heating. Nitric acid, even when moderately dilute, attacks cerium, yielding a brown hydroxide, H_2CeO_3, a substance which yields the dioxide on heating. Neodymium is obtained when its chloride is electrolysed with a current of 56 amperes and 25 volts; barium chloride is added from time to time because this salt has the property of decreasing the conductivity of the fused mass, and in this way increasing the temperature. Neodymium is a silvery-white metal, whilst cerium has an iron-grey colour. The former metal has the higher melting point, and is the more oxidisable; it decomposes water especially on warming and is attacked by all acids. A mixture of cryolite and one of the oxides of cerium yields on electrolysis an alloy of cerium and aluminium. Cerium carbide, CeC_2, is obtained from the dioxide by electrolysis in the presence of carbon. This substance yields a mixture of acetylene and ethylene when treated with hydrochloric acid.

Australian Telephone Situation.—The Australian Government some time ago appointed a special committee to investigate the telegraph and telephone services of the Commonwealth and recommend improvements. Having concluded their labours this committee have now made a report, in which they recommend the complete reconstruction of the principal telephone systems on modern lines. In Sydney and Melbourne entirely new systems are recommended, including central offices, conduits, cables, wires, and subscribers' stations. The estimate of cost for the reconstruction of Melbourne system alone is £225,186, of which £156,000, or nearly two-thirds, is for conduits, cables, and other line plant. The switchboard is estimated at £30,000, and the subscribers' instruments at £24,000. In their report the committee acknowledge that the proposed expenditure amounts to a large sum, but they declare that it is impossible to carry on the service with the present plant. The only possible solution of the difficulty is to rebuild the entire system with modern plant, which would provide for at least 10,000 subscribers. The committee further recommend an expenditure of £100,000 for rebuilding the telephone system of New South Wales, £88,000 for South Australia, and £45,000 for West Australia. The establishment of a long-distance telephone line between Melbourne and Sydney, about 650 miles, is also advocated. Such a line, it is estimated, would cost £50,000, with an annual maintenance charge of £2,650. This would be more than met by the yearly revenue, which, at a rate of about 7s. a call with 35 messages a day, would come out at about £3,400. For local service the committee advise the adoption of a new scheme of message rates. The tariff at present in force in the Commonwealth is £9 a year for business service in cities, £7 a year in country places, and £5 a year for residence service. The proposed new rates comprise a flat rate and a message charge, the flat rate being based on the number of subscribers to the system, as follows: For 300 free messages the annual rate would be £4. 10s. with 5,000 subscribers, £5 with 20,000 subscribers, and £6 with over 20,000 subscribers. Any calls in excess of 300 up to 1,000 would be charged for at the rate of 1d. a message, from 1,000 up to 5,000 at ½d. a message, and from 5,000 to 20,000 at ·8d. a message.

Direct-Current Armatures with Alternating Current.—In a recent issue of the *Elektrotechnische Zeitschrift*, Messrs. Fleischmann and Orgler contributed a well-illustrated article on the properties of ring armatures which are supplied with single or polyphase currents through the commutator by means of stationary brushes. The authors give a simple explanation of the process in such armatures. They first consider a ring armature which receives single-phase alternating current from two

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diametrically opposite brushes, the armature being fixed and the brushes revolving synchronously—*i.e.*, with the same speed as the vector of the current. They show that the E.M.F. induced in the windings, and therefore also the reactance of the ring, is entirely independent of the speed of rotation of the brushes. The magnetic flux varies at all points of the ring with the double frequency of the applied alternating current, the flux waves being pulsating waves; the variation of the flux all over the armature during a complete period is given in a series of diagrams. The authors next consider the same ring armature when it is supplied with two-phase alternating currents through two pairs of brushes displaced in space by 90deg. When the brushes rotate synchronously, the flux has a constant value at each point of the ring, and the reactance of the ring is zero. If the brushes are fixed and the armature rotate synchronously, while being supplied with two-phase alternating currents, then we have a field fixed in the iron and revolving in the space with the speed of the armature. It is thus seen that to supply two-phase currents through a commutator here has the same effect as is obtained with the rotating field of a synchronous motor when direct current is applied by means of slip rings. If such an armature is brought to synchronism in a bipolar revolving field produced by two-phase alternating currents, the armature will run as a synchronous motor, after the alternating-current excitation has been started. By moving the brushes it is possible to vary the relative positions of the stator and rotor poles. If, according to Heyland's method, the commutator segments are connected together by larger non-inductive resistances, the armature will revolve in a revolving field by itself. But it is doubtful whether—especially when loaded—it will approximate synchronism sufficiently to reach synchronism and run as synchronous motor when the excitation has been started.

Ions from Hot Platinum Wires.—The current number of the *Physical Review* has a long article by Mr. C. D. Child describing some investigations he has been making on the velocity of ions from hot platinum wires. The fact that the discharge from a positive platinum wire is greater than from a negative one led the writer to suspect that the positive ions move more rapidly than the negative ones, and for this reason, if for no other, the subject is worthy of attention. His conclusions on this matter may be summarised as follows: The discharge from a hot platinum wire at first decreases and then slowly increases. He observed that the positive discharge commenced a little below the temperature of red heat, increased at first rapidly as the temperature was at first increased, remained nearly constant through quite a range of temperature, and finally decreased somewhat. The negative discharge began at nearly the same temperature as that at which the positive began to decrease. It never became as large as the positive. Both positive and negative discharge increased rapidly as the potential difference between the wire and cylinder was increased. Four methods were used for comparing the velocity of the positive and negative ions. One of these compares the average velocity of one with that of the other. This showed the velocity of the positive to be the greater. Two methods compare the velocities of the most rapidly moving of the positive ions with the most rapidly moving negative. Both of these show the positive ions to have the greater velocity. One compared the slowest of the positive with the slowest of the negative. This showed that at the lowest temperatures the slowest of the positive ions have a much greater velocity than the slowest of the negative, but at higher temperatures a slower class of ions is produced, and the comparison of these with the slowest negative ions gave no definite results. It was also found that at a certain temperature ionisation is produced in the gas about the wire to greater than molecular distances. This is nearly the same temperature as that at which the negative discharge commences, as that at which the positive discharge materially decreases, and as that at which the very slowly moving positive ions commence to appear. Experiments on a wire enclosed in a glass tube indicate the presence in the tube of particles which diminish very greatly the velocity of the ions. The "emanation" appears to load the ions, and thus to diminish their velocity both when they are within an enclosed tube and when they are in an enclosed space. Thus the particles driven off from a hot wire do not appear to aid in the discharge, but, to materially check it. The writer, however, reserves further discussion of this question for another article.

High-Speed Electric Railways.—A paper by Mr. G. W. Meyer on the electrical operation of long-distance, high speed railways is abstracted in the current number of the *Electrical World*. At the outset it is stated that only pure three-phase traction is to be considered, and after some general discussion the author goes on to compare the relative advantages of the two following three-phase systems, the first, with transformer sub-stations distributed along the line, the second, with transformers on the motor-cars, the three-phase currents being supplied to the motor-cars at full voltage. The second system requires heavier motorcars than the first. He assumes a motorcar, with seats for 90 persons, to run at a normal speed of 180 km., and at a maximum speed of 200 km. per hour. For the first system the weight of a car with 12 wheels is 110 tons, hence the pressure on a wheel is 9·2 tons. For the second system the weight of a car is 145 tons, the pressure on a wheel 12 tons. The power required for a motorcar in the first system is 1,420 km., in the second system 2,000 km. He refers to the experience gained in very high-tension transmission in California, and believes that for traction also the tendency will be to use very high voltage, which could not well be transformed down by transformers placed on the train. For all these reasons he prefers the first system, with transformer sub-stations along the line, to the second system, with transformers on the trains. The author next discusses a project for an electric high-speed railroad from New York to Chicago, the distance being about 1,600 km., the present trains taking 23 hours. For the electric road he assumes three stations—at Philadelphia, Pittsburg, and Fort Wayne; he assumes a normal speed of 180 km., and a maximum speed of 200 km.; trains running at intervals of half an hour from both terminals, the total distance being passed through in nine hours. With the first system 100,000 h.p. are required, with the second 130,000 h.p. The essential advantage of the first system is that only very few generating stations are required, two or even one being sufficient; the one power house he suggests placing at Niagara Falls with 10 alternators, each of 10,000 h.p., generating three-phase currents at 11,000 to 12,000 volts, which are transformed up to 75,000 volts; he suggests placing 40 transformer sub-stations along the line each of a normal capacity of 2,400 kw. and a maximum capacity of 4,000 kw.; there the voltage is lowered to 6,000 volts; each sub-station has to supply distances of 40 km. length. On the other hand, with the second system, in which the transmitted currents are directly supplied to the motor car and transformed in it by transformers, he thinks it would not be possible to run a higher transmission voltage than 20,000. This would require 10 generating stations distributed along the line, each supplying a portion of the line of 160 km. He thinks the first system is to be preferred.

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CAMPS BAY, CAPE TOWN, AND SEA POINT TRAMWAYS.

Among the important Colonial tramway systems, that of the Camps Bay and Cape Town ranks high. This system, as it exists to-day, is a natural extension of the previously existing Cape Town line, although the Camps Bay section is owned by a separate financial organisation. The construction of this tramway would have presented numerous difficulties under ordinary circumstances, but it will be admitted that these were considerably enhanced when it is remembered that the whole of the work was carried out during the progress of the Boer War. Not only did the course of the war prevent easy shipping facilities, but serious trouble arose from the difficulty of obtaining adequate labour. Yet in spite of these drawbacks the tramway system, comprising nine miles of difficult track work, has been completed without any serious delay. The whole of the materials for the system were supplied and erected by Messrs. Dick, Kerr, and Co., Limited, whose experience in the construction of foreign tramways has been unique as far as an English company is concerned. The same firm, it may be remembered, successfully completed the Barcelona and Madrid tramways, and the progress of this contract, curiously enough, was to some extent interfered with by the progress of the American-Spanish War. Another important Colonial tramway system which has been recently constructed by the same firm is that of the Calcutta tramways. To return, however, to the Camps Bay tramway, it may be stated that the construction has been carried out under special Act of Parliament.

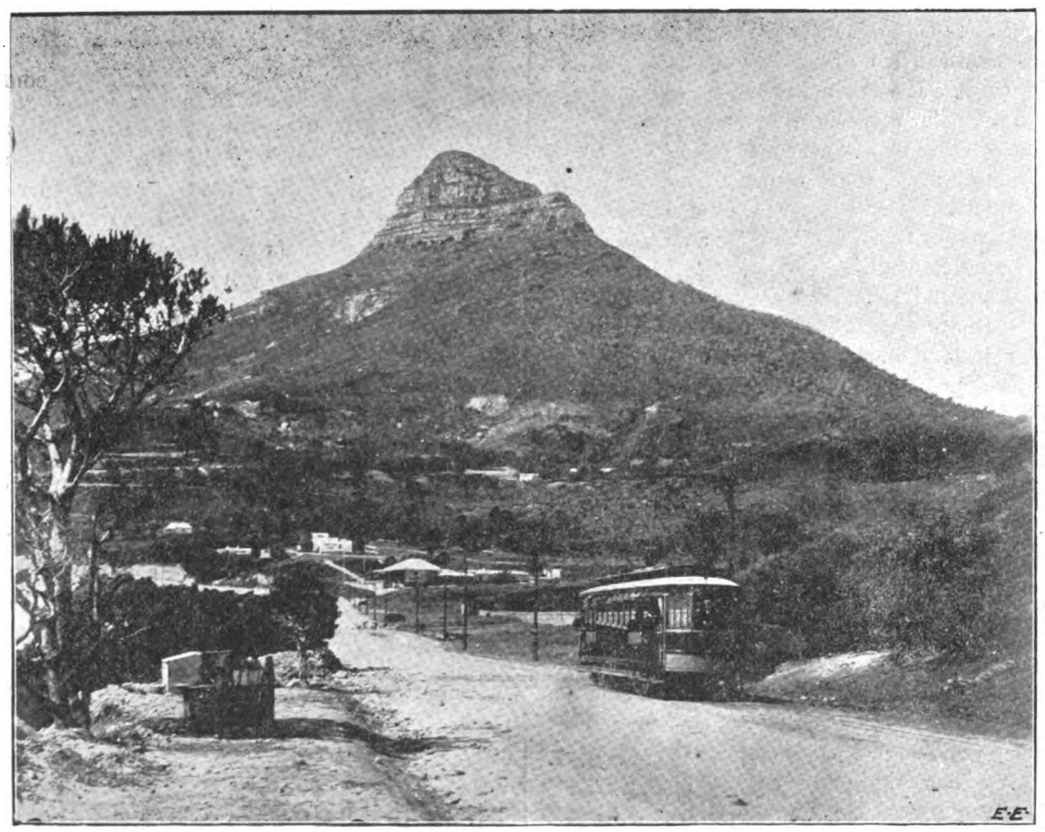

FIG. 1.—Typical View of the Camps Bay Tramways, Cape Town.

Commencing at the Round Church, Sea Point, on the south-west of Cape Town, where connection is made with the Cape tramway, the line commences on an easy ascent, but though gradual it has reached at the end of the first mile an altitude of nearly 300ft., and grades of 1 in 12, or 8·33 per cent, have been encountered. Continuing southward, Upper Clifton is reached, and at this point a magnificent view is obtained of Camps Bay, and the range of mountains—to wit, the Twelve Apostles—stand out clear and distinct. Continuing in a scarcely perceptible descent, the line passes the Old Toll House, and at Camps Bay the track leaves the roadway and continues its course over land purchased by the company. Some three-quarters of a mile distant stands the power-house. After passing the power-house the tramway leaves the existing roadway, and is laid over the private estate of a local land company; following a new roadway, which has recently been made for the purpose, the most southerly point of the tramway is reached at Oudekraal. Here the line diverges in a north-easterly direction, and after encountering the heaviest grades of the system the highest altitude is reached at Kloof Nek. At this point, some 800ft. above sea-level, there is obtained one of the finest views in the Colony. To the south the rugged scenery of Camps Bay and Oudekraal, to the north Cape Town and its world-famed Table Bay, while dimly in the distance lie the Blue Berg Mountains, the Lion's Head and Table Mountain being on either hand.

As affording some indication of the difficulties of construction, it may be observed that the average grade from Kloof Nek to the terminus at Burnside-road—a distance of little more than 1¼ miles—is slightly steeper than 1 in 12. Severe though this may be, it is exceeded in other places, where grades of 1 in 9 are encountered for short distances. The distance from the Round Church at Sea Point is, roughly, seven miles From the foregoing description it is clear that the laying of the permanent way involved more than the usual difficulties. It called for not only a considerable length of new roadway, but more than 75 per cent. of the existing roads had to be widened and graded. Though blasting operations on a large scale were necessary, they provided the compensating advantages of much excellent stone for concrete and road metalling; moreover, the decomposed granite proved a suitable material for surfacing the roadways. Besides making provision for carrying off the heavy rains by means of capacious drains and culverts, massive retaining walls had to be constructed, consisting of dry stonework laid in courses. In places these were of exceptional strength, measuring from 6ft. to 10ft. thick at the base, and from 20ft. to 25ft. in height, crossing the deep sluits of watercourses on the estate.

The gauge of the tramway is 4ft. 8½in., and is thus uniform with the Cape Town tramways, over which system running powers have been obtained. The rails are of girder section, weighing 90lb. to the yard; they are laid

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on a concrete foundation, a strip of concrete 6in. deep and 18in. wide, composed of 5 to 1 Portland cement, being laid under each rail. Karri wood paving has been laid for a width of 1ft. 10in. on each side of the track, and a 9in. toothing course along the inner side of each rail. The rail joints are each bonded with two $^6/_0$ S.W.G. "Neptune" rail bonds. Special cast-steel points 8ft. 8in. long have been used.

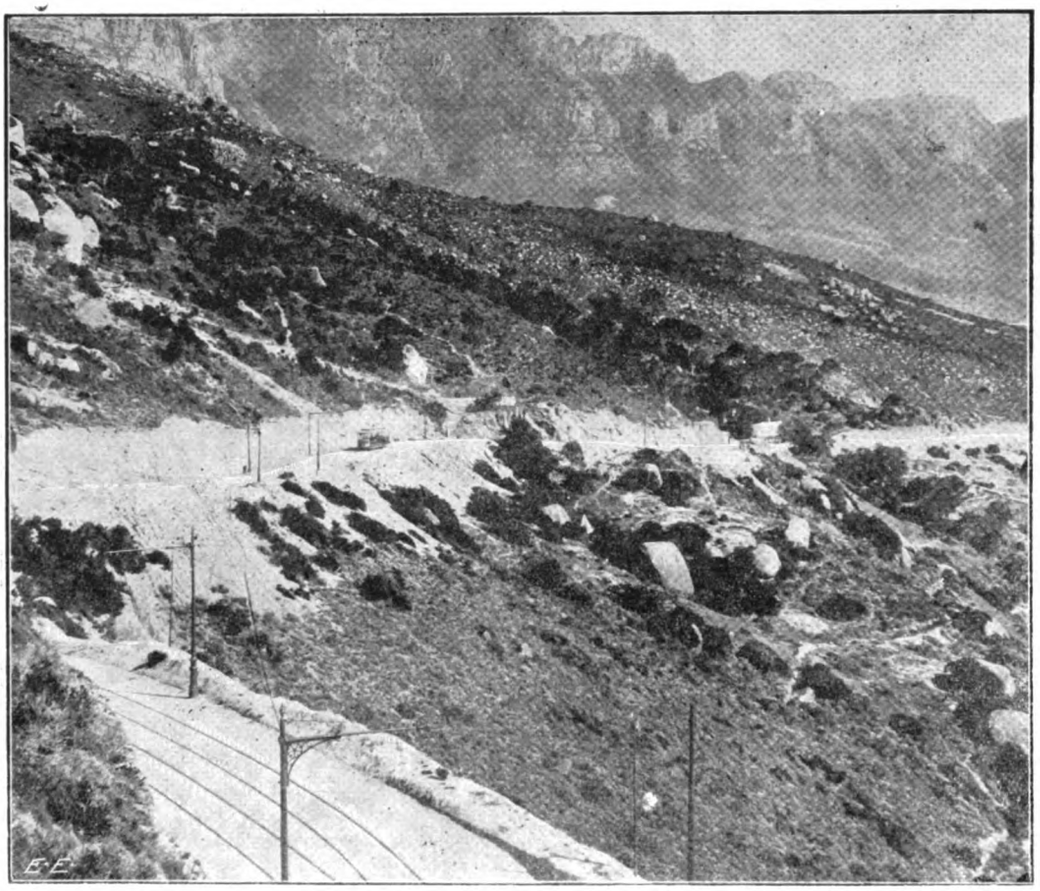

FIG. 2.—View of the Heavy Grades on the Line.

The side-wire system of overhead equipment has been adopted (Fig. 1), the trolley wire, No. 0 B.W.G., being carried at a height of 18ft. 6in. above the rail level. The poles are of mild steel, tapering from 7in. at the base to

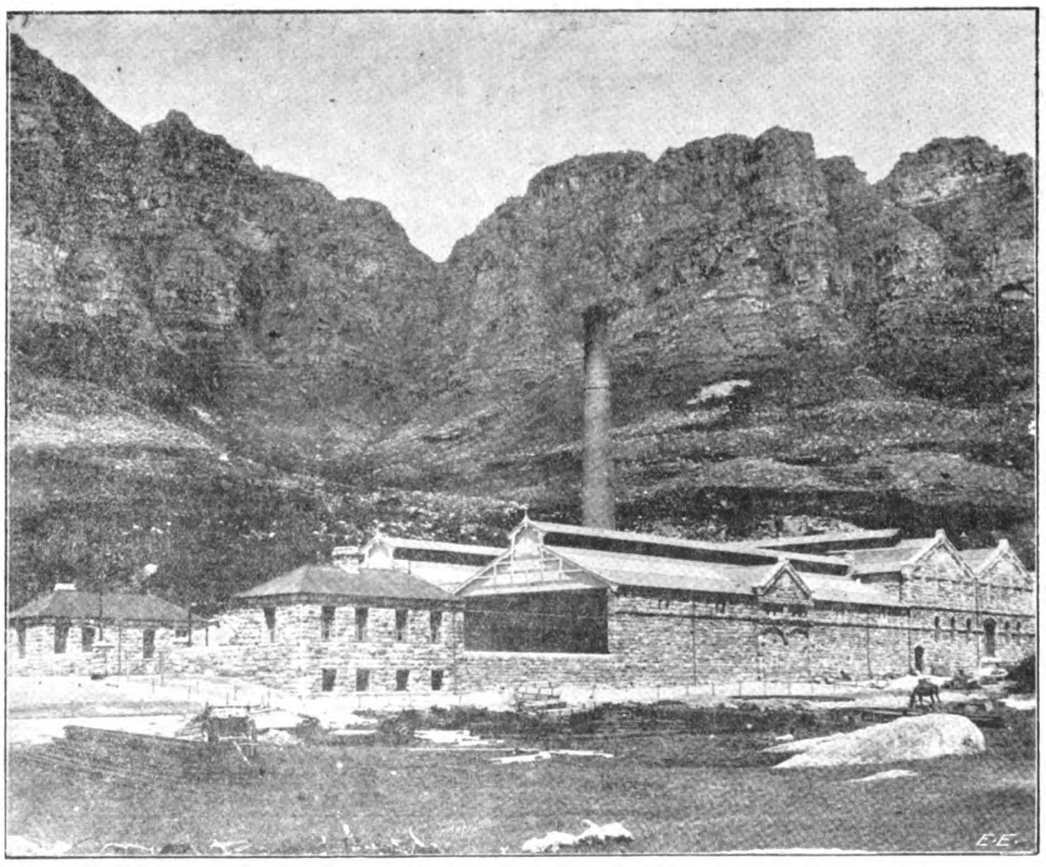

FIG. 3. The Power House of the Camps Bay Tramways, Cape Town.

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3½in. diameter at the top, and are furnished with ornamental base castings, finials, and brackets. The arms vary in length from 6ft. 6in. to 15ft., according to the width of the road, the average distance of the farthest trolley wire from the centre of the track being 10ft. Owing to the tortuous character of the route, it has been found necessary to run the trolley wire partly on one side of the road and partly on the other to allow of the poles being fixed in the most suitable positions. As many of the curves are of very sharp radii, it will be readily understood that the wiring of these required considerable care to avoid the use of a large number of poles and the angles of the trolley wire being too acute. As will be seen from the diagram map, it is probably one of the most tortuous and heavily-graded systems equipped on the overhead system.

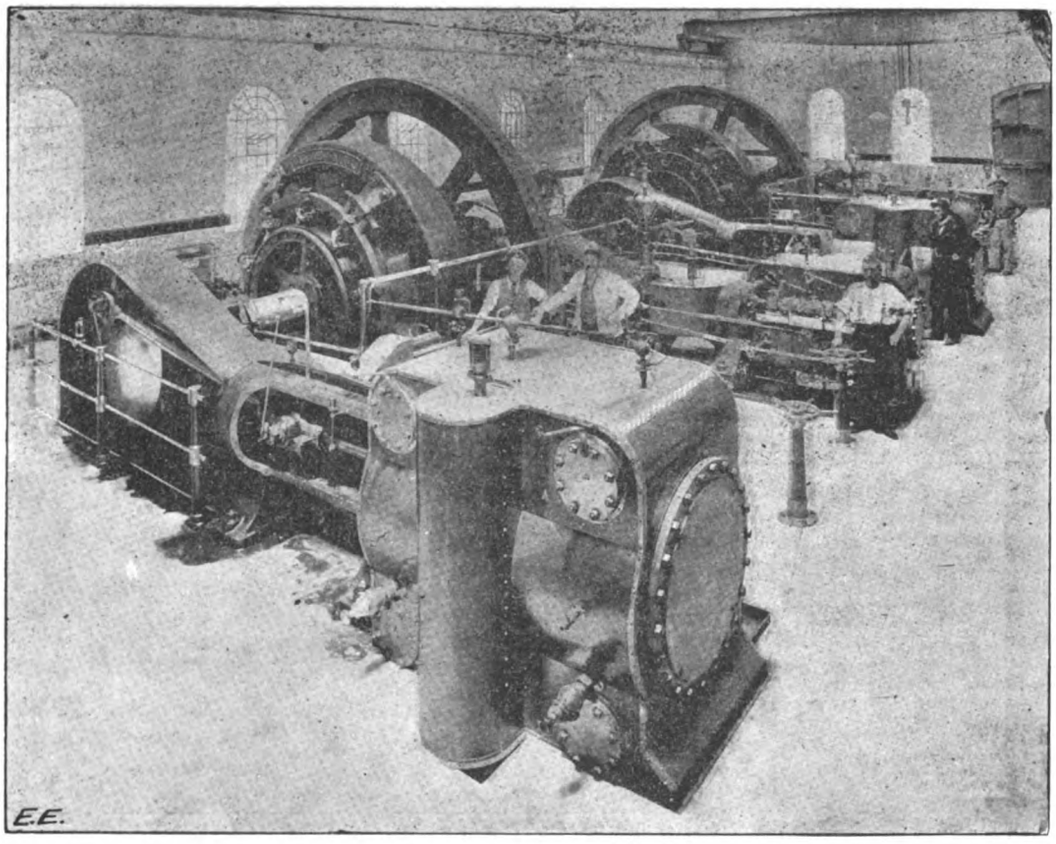

FIG. 4.—The Engine Room with Yates and Thom Engines coupled to English Electric Manufacturing Company's Dynamos.

The generating station and car-shed is situate at Camps Bay, almost at the southern extremity of the system. This site was the most suitable, owing to its proximity to the sea, from whence water is drawn for condensing purposes. Another reason lay in the fact that a continuous supply of fresh water for boiler feed purposes is obtainable from a spring, a small stream flowing therefrom

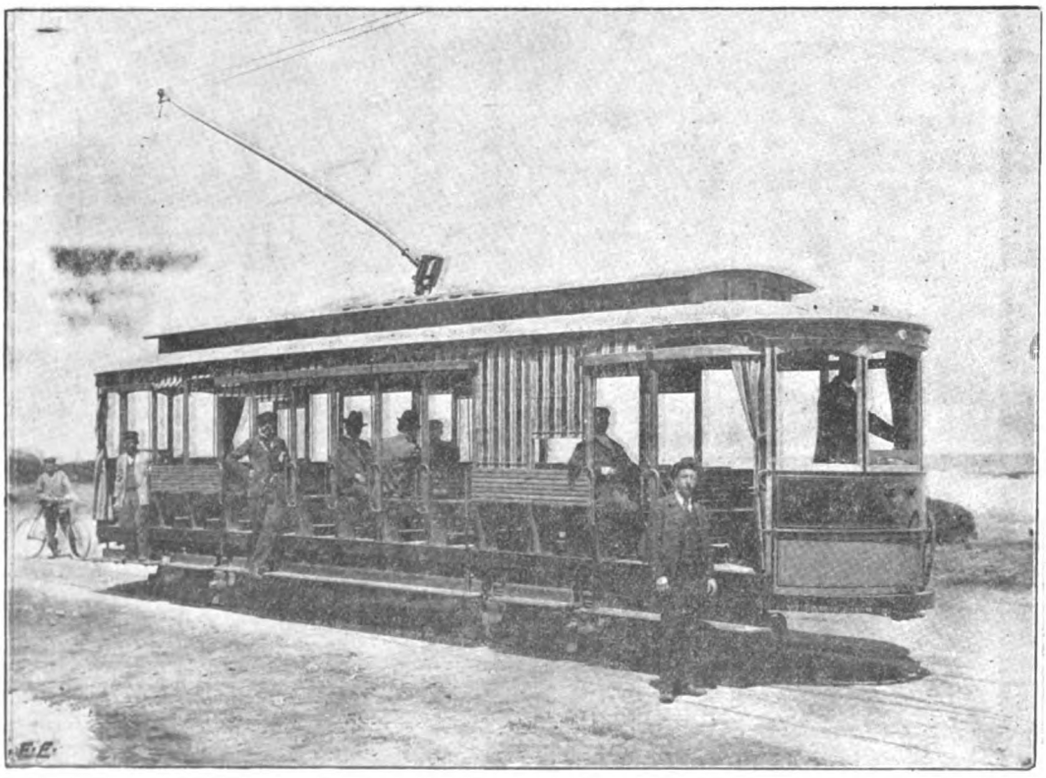

FIG. 5.—One of the Tramcars made by the Electric Tramway Carriage Works.

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down Table Mountain. The position is fairly central, being near the apex of a triangle formed by the two branches of the route. The engine-room is 94ft. by 42ft., and consists of two floors and a condenser pit. An overhead travelling crane arranged for hand power and capable of lifting 10 tons runs the whole length of the engine-room, and has a lift of 16ft. The boiler-house is 94ft. long by 43ft. 5in. wide. The car-shed, which is also part of the same buildings, is 136ft. long by 94ft. wide, with eight lines of track, four of which have pits running their entire length. At the entrance to the car-shed are offices, mess-room, and stores.

The generating plant (Fig. 4) consists of two direct-coupled 400-kw. sets. The engines, constructed by Yates and Thom, are of the cross compound type, developing 720 b.h.p. with a steam pressure of 150lb. at the cylinders when running at 90 revolutions per minnte. The main shafts are 19in. diameter, and on these the generators and flywheels are keyed. The latter are 18in. diameter, and weigh about 24 tons. The cylinders are fitted with Corliss automatic valve gear. The generators were built at the works of the English Electric Manufacturing Company, Limited, Preston, and were subjected to severe tests by the engineers of the company, Messrs. Alfred Dickinson and Co., Birmingham, who were highly satisfied with the way in which their specification had been met. The output of each of the machines is 400 kw. at 550 volts; they are compound wound, and are in accordance with the standard practice adopted at Preston, and similar to those which Messrs. Dick, Kerr, and Co. have supplied to many tramway and lighting authorities in the United Kingdom. The chief features of these generators comprise the use of a high-permeability cast-iron magnet frame, into which are cast laminated steel pole-pieces. The armature is built up on a special form of spider, in which the sections of the rim are unconnected, thus avoiding shrinkage strains. The core is built up of steel laminations, spacing laminations being inserted to form ventilating ducts for cooling the interior of the core and the windings. The armature coils are laid in open slots on the periphery, and are interchangeable. The commutator is carried on its own ring, which is mounted on an extended hub of the armature spider. The commutator bars are of hard-drawn copper, and are firmly clamped by means of steel end rings Equalising rings are attached to the commutator and equalise any slight variations in the magnetic reluctance of the various magnetic circuits, thus checking the slightest tendency to spark.

The switchboard consists of nine panels, of which three are generator panels, three feeder panels, one station panel, one lighting panel, and one leakage panel. Two of the generator panels only are in use, the other being a spare panel. Each is fitted with a positive and negative quick-breaking switch, capable of carrying 1,000 amperes, a magnetic circuit breaker, and an ammeter reading from zero to 1,200 amperes. Two of the feeder panels are in use, the other being a spare. Each is fitted with an automatic circuit of the same type as those used on the generator panels, an ammeter reading up to 500 amperes, and a quick-break switch for connecting feeder to 'bus bar. The main station panel is fitted with a main ammeter reading up to 3,000 amperes, on which the total output of the station is constantly shown, and a recording wattmeter. It is also fitted with a recording voltmeter, with a working pressure of 550 volts. The leakage panel contains all the instruments necessary for testing for leakage, etc. The lighting panel is arranged for six 50-ampere double-pole circuit switches, with fuses and throw-over switches.

In the condenser pit are two surface condensers, with combined air and circulating pumps. These are of the Admiralty type, and are specially devised for using sea-water. The sea-water is supplied to the condensers by means of large cast-iron pipes, which are carried well out beyond low-water mark. To avoid the danger of seaweed being drawn up into the condensers, the suction pipe has been intercepted on the shore by a sump built in concrete carried well down below low-water level, which is easily kept clear. In the boiler-house are two water-tube boilers, each with a heating surface of 3,654 square feet, and capable of evaporating 12,000lb. of water per hour under normal conditions. Each boiler is fitted with a dead-weight safety valve and a spring valve set to blow off at 160lb. pressure. The collars are fed by means of two compound non-condensing duplex feed pumps, working at a pressure of 160lb., and capable of delivering 24,000lb. of water per hour against a boiler pressure of 160lb. Before being pumped into the boilers the feed water is passed through a fuel economiser, containing 288 pipes, fixed in the main flue. The chimney stack is 125ft. in height, and 5ft. inside diameter at the top. The works are equipped with the necessary machine tools for the purpose of carrying out the repairs, and comprise a large screw-cutting gap lathe, wheel lathe, wheel press, drilling machines, grindstone, smiths' hearth and fan, the whole being driven by an electric motor.

The feeders are lead covered and insulated with paper and vulcanised rubber. They are laid in cast-iron troughs 18in. below the surface and surrounded with bitumen. The main cables are laid in half-mile sections, and at the junction of each section a feeder pillar is placed in which the cables are connected to a 'bus bar, and from thence to the trolley wires in the usual manner. It is natural that climatic conditions should to a great extent determine the type of cars, and it will be seen on reference to the illustrations that variation has been necessary in the case of Cape Town. The cars (Fig. 5) are single-deck bogie type, part are what are known as gridiron open cars, and part are of the combined type. The former have a seating capacity of 65 passengers, and the latter of 54. The length of car is 40ft.; width, 7ft. 6in.; and height inside, 8ft. They were built for Messrs. Dick, Kerr, and Co., Limited, by the Electric Tramway Carriage Works, Preston, and shipped to Cape Town completely finished, the only work to be done before they could commence to run being to mount them on the trucks, connect the wiring, and fix the trolley poles. In passing, it may be observed that so popular has Camps Bay already become that the company anticipate that the present equipment of cars will shortly be found too few to cope with the traffic. The car bodies are mounted on trucks of the bogie type, each truck carrying two motors, one on each axle. Departing somewhat from the usual lines, the equipment of the cars comprises four motors, each of 25 b.h.p., so that each car is capable of developing 100 b.h,p. There is hardly any question that four motor equipments with long cars are imperative where grades are heavy, and in the case of Camps Bay the gradients are unusually heavy. Not only, however, is a proper distribution of power necessary, but the question of braking and retardation is of prime importance. The brakes, therefore, on these cars have received very careful consideration, three brakes having been fitted—viz., a hand-brake, with a brake block on each of the eight bogie wheels; an air-brake, acting in conjunction with the hand-brake; and an auxiliary slipper brake. In addition to these it is also possible, by throwing over the reversing switch, to convert the motors into generators, thus enabling them to act as a powerful emergency brake. The cars are operated from either end by means of special controller designed for four-motor equipments.

It may be stated that Messrs. Dick, Kerr, and Co., Limited, carried out the work to the specification of Messrs. Alfred Dickinson and Co.

ALDERSHOT ELECTRICITY WORKS.

These works, which were inaugurated last week by Lady Hildyard, have been carried out under the supervision of Mr. Nelson F. Dennis, the surveyor of the Urban District Council. When electric lighting was first spoken of in Aldershot, it was hoped that the town would get the contract for supplying electricity either in bulk or in detail to the various Army buildings situated in and around the town. At that time we believe a consulting engineer was called in, and gave a report as to the establishment of a station which would be capable of supplying all the camps as well as the town. The decision of the military authorities to erect their own electric supply station, however, put a new complexion on the matter, and the scheme was

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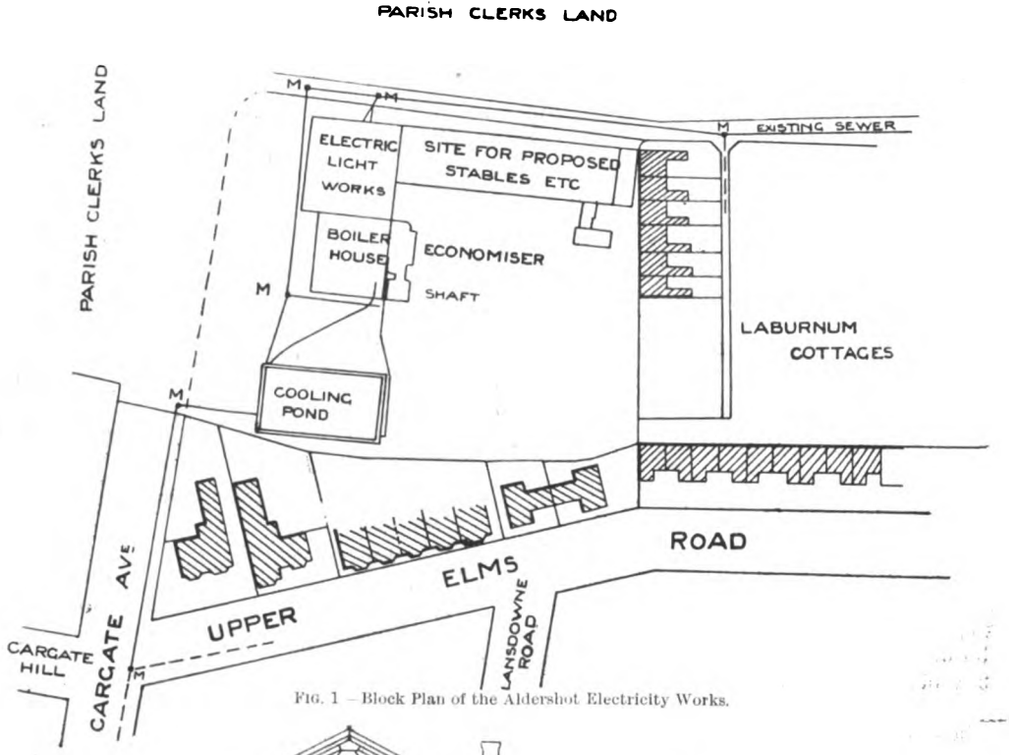
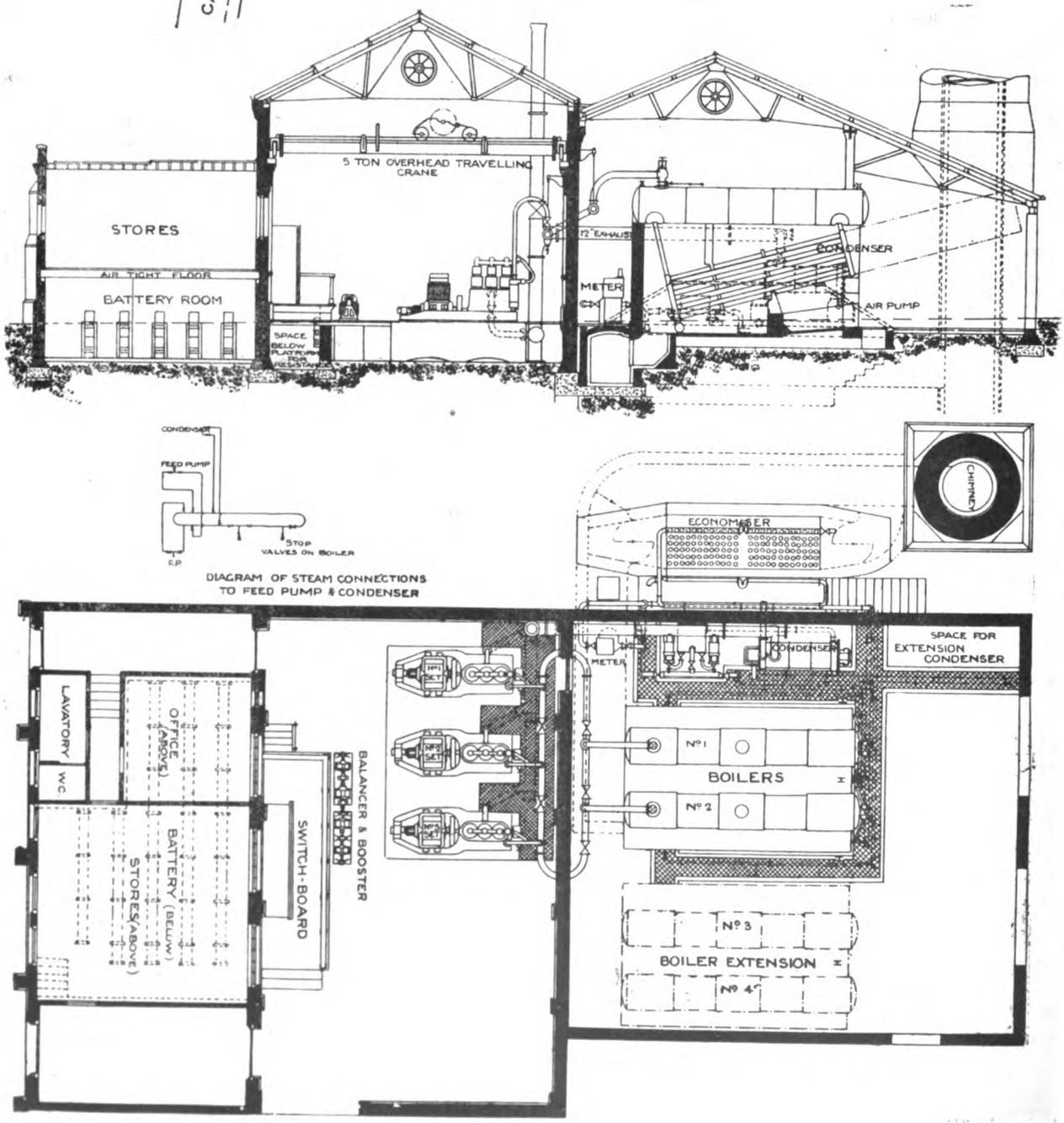


FIG. 1 – Block Plan of the Aldershot Electricity Works.



FIGS. 2 AND 3. – Plan and Sectional Elevation of the Aldershot Electricity Works.

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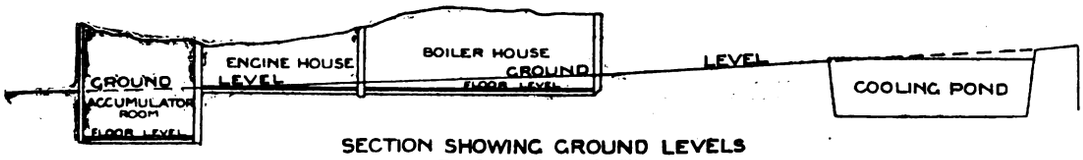
not carried out. A committee of the Town Council was afterwards appointed to go round and inspect electricity works in some nine or ten towns in England. Mr. Nelson F. Dennis, the surveyor, accompanied this deputation, and had a considerable hand in the drawing up of the report. The decision arrived at was that tenders should be invited from contractors who were able and willing to supply everything required for the scheme with the exception of the buildings. The details were as a rule left to the parties tendering, but the output required from the plant and the size of the mains was, of course, the same in each case. The result of the invitation to tender showed a remarkable closeness with regard to the amount of the lower tenders, and the work was placed in the hands of Messrs. Thomas Parker, Limited, of Wolverhampton. We may say here that this reversion to the older method of employing only one main contractor, and making him responsible for the whole of the work, has in Aldershot produced excellent results. Messrs. Parker, Limited, selected for their sub-contractors firms of the highest order, and the result is that good harmony exists between the various items making up the complete system.

The works are situated in one corner of a large piece of land which has been acquired by the Urban District Council. In Fig. 1 we give a block plan of that portion of the site which has been allotted to the electricity department. On the larger piece of ground, not shown in this illustration, it is proposed to erect large municipal buildings, and the vacant space behind will be laid out as pleasure grounds. The buildings were designed throughout by Mr. Dennis, and are exceedingly well arranged for the purpose they serve. They consist, as can be seen from the general plan and elevation (Figs. 2 and 3), of an engine and boiler room, with offices adjoining. Under these offices is arranged the accumulator-room, which is most conveniently situated as regards the switchboard, so that the length of the connecting cables is small. The buildings now erected will contain a considerable amount of extension in plant without any alteration, as will be gathered by an inspection of the plan (Fig. 2). When this spare space has been occupied the building can be enlarged. In connection with the engines, which are working condensing from the very first, a cooling pond has been arranged. The position of this can be seen on the block plan (Fig. 1), while Fig. 4 shows a cross-section through the cooling pond and the building, and Fig. 5 gives the details of the pond itself. The water for condensing purposes is collected from the rain-water sewers of the high land lying behind the works. From the records of rainfall in the district, Mr. Dennis expects to keep this pond always full, and any rain which comes in will, of course, tend to change the water in the pond itself. When full this pond contains some 5ft. of water. Its other dimensions are 71ft. long by 39ft 6in. broad. The circulating water for the condensers is taken from the bottom of one corner of the pond and returned into it at the opposite corner. The chimney shaft (Fig. 6) is 110ft. high, and the flue in passing to it goes through a Green's economiser of 144 tubes. The scraper of this economiser is driven by a small Parker motor.



SECTION SHOWING GROUND LEVELS

FIG. 4.—Section of the Site.

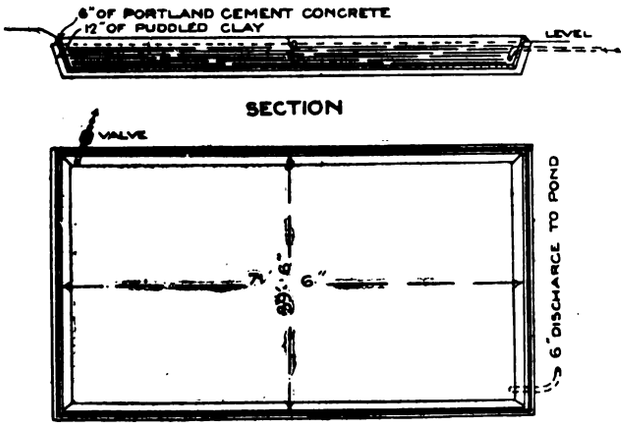


FIG. 5.—Details of Cooling Pond.

The equipment of these works consists of two Babcock-Wilcox boilers, each of which is capable of supplying two of the main generating sets at full load. These three steam dynamos, seen in Figs. 2 and 3, are Willans-Parker combinations. They consist of Willans engines of the 3 G type directly coupled to a Parker two-pole dynamo, capable of giving 80 kw. as a normal load, or 90 kw. on emergency. These dynamos, which can easily be used for traction purposes, if so required in the future, can give any voltage from 420 up to well over 500 volts

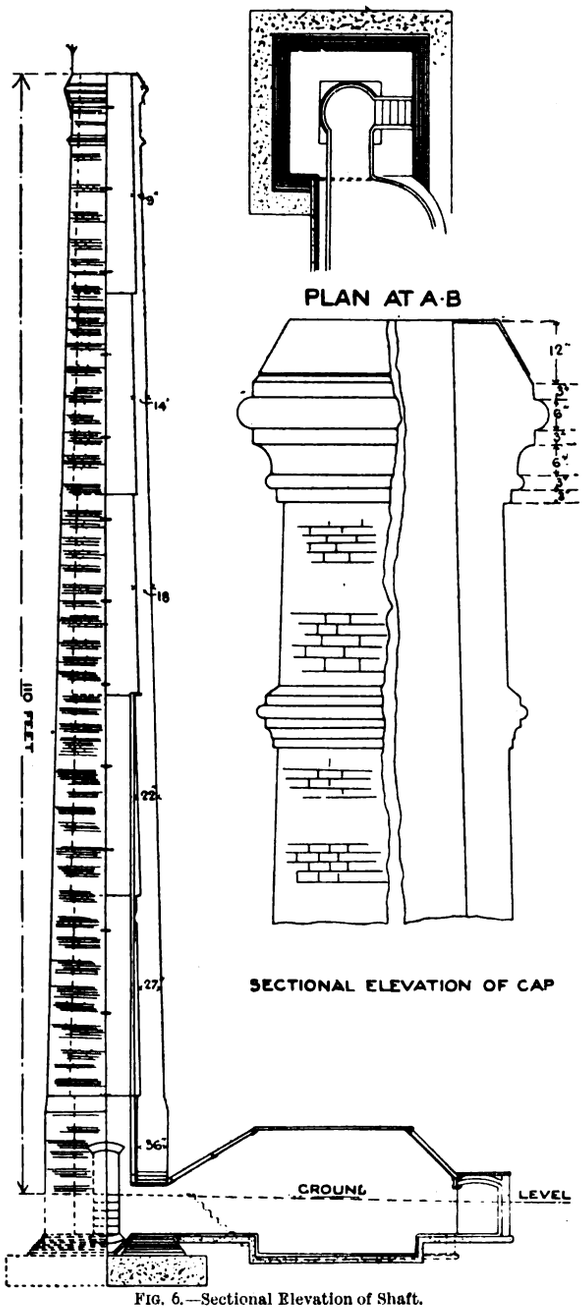


FIG. 6.—Sectional Elevation of Shaft.

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as shunt machines. The armatures are wound on the Eickemeyer system, and the commutators have copper bars, and not gunmetal. The steam-pipes are arranged on the ring system, as will be gathered from the illustrations. The other electrical plant consists of a balancer and booster combination, which is placed by the switchboard platform. The boosters are, of course, used to charge the accumulators, while the balancers are capable of dealing with about 75 amperes of out-of-balance current on either side of the three-wire system. The switchboard is of the usual type as regards connections, but the details of the board itself show considerable improvements over the average switchboard for three-wire working. In the first place, the whole of the regulating apparatus for these two batteries of accumulators and for the field circuits of the dynamos are arranged on the middle wire, so that they are practically at earth potential. Of course, when regulating, there may be a few volts above or below this potential, but the difference is small. Kelvin measuring instruments are used throughout. The automatic switches in the dynamo circuits are of Messrs. Parkers, Limited, own make, and the release is effected by the interaction between a shunt and series coil, so that the switch operates at either no load or overload as the case may be. Another detail, for which we believe Mr. O. F. Francis is personally responsible, is the use of some winged thumb nuts for clamping all the fuses. These can be easily turned by hand, and can be more readily operated than an hexagonal nut requiring a spanner. There is also with the spanner a considerable risk of making connections with adjacent metal work, which risk is avoided with the present construction. We may mention here that Mr. Francis has superintended the whole of the works for Messrs. Parker, Limited, and that he will be responsible for the running of the station for the first six months. He was selected for the work with an idea that he would afterwards take charge of the plant as the borough electrical engineer, and from the care he has taken in the carrying out of the detail arrangements the choice could not be improved upon. The switchboard as at present arranged provides for three feeder circuits, three main dynamos, two batteries of accumulators, and the balancers and boosters. On another board at one end of the engine-room Mr. Francis has grouped together all the switch and fuse gear, which is so often scattered throughout an electric lighting station. On this board the instrument for recording the earth return current is placed, and also the switches and fuses for the lighting and power circuits in the building. A throw-over switch is provided, by which this load can be transferred from the one side of the system to the other, in order to compensate for any out-of-balance current on the mains.

The accumulators are of the D.P. type, of which 240 cells, each of 300 ampere-hour capacity, are provided and grouped in two main batteries. Twelve more cells of the same size have also been erected for use in connection with meter testing and as hospital cells. These batteries, which are of the D.P. Company's central-station type, can give a discharge of 100 amperes for one hour if so required. The current going into and out of each of the main batteries is registered on Chamberlain and Hookham meters. Two meters, one of which will run in each direction, are connected in each battery circuit. The reversal of the direction of rotation of the motors in these meters is prevented by means of small pawls acting on one-toothed ratchet wheels. By making the meter, which runs when the batteries are being charged, read 10 per cent. slow, the batteries should be kept in order if the two meters give identical reading.

The whole of the mains in the town were supplied and laid by the Callender Cable and Construction Company. The general arrangement of these mains can be seen in Fig. 7, in which the feeding points are indicated by a star

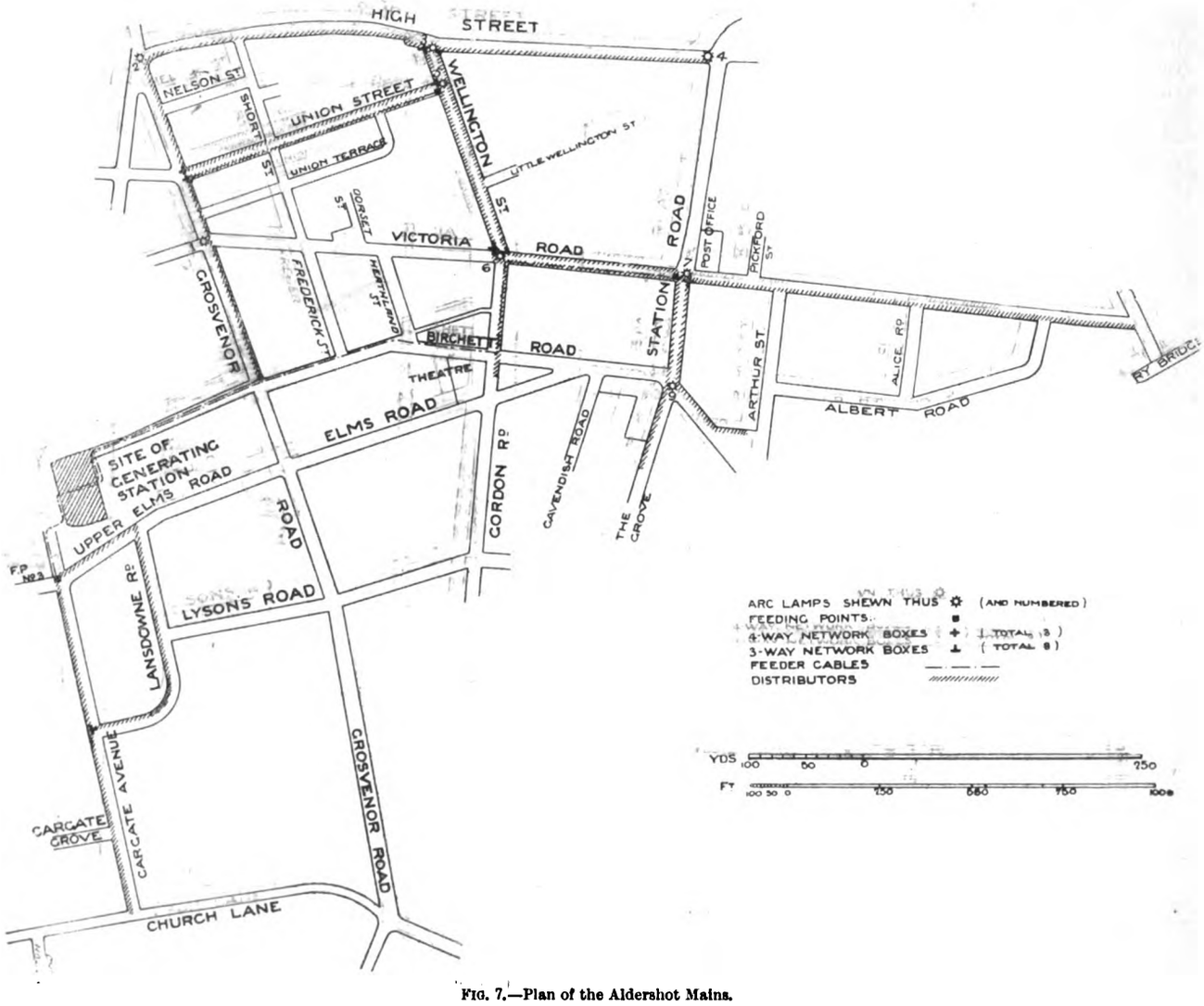

FIG. 7.—Plan of the Aldershot Mains.

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with a white centre. The shading along the sides of the streets indicate where distributing cables are laid. The section of these distributing cables is, as a rule, ·1, ·06, and ·1 for the more important streets, and three conductors of ·06 in other cases. The No. 1 feeder, which supplies at the junction of Union-street and Wellington-street, has a section of ·4 of a square inch, as has also No. 2 feeder, which supplies at the corner of Station-road and Victoria-road. Besides these distributors and feeders, two arc lighting circuits have been laid from the station. At present only four arc lamps are supplied on each circuit, but they can easily be extended into eight or nine arc lamps per circuit. The whole of the cables are insulated on the Callender's system with vulcanised bitumen, and are laid on the solid system in wooden troughs with tile covers. Owing to the excellent footpaths of cement concrete used at Aldershot, it was decided to lay these cables in the roadway, just beyond the channelling, as this has kept down both the damage to the footpaths and the cost of making good. The arc lamps for the street-lighting, which were also supplied by Messrs. Callenders, are of the Oliver type. The excavations for the mains and the making good of the trenches were carried out by the surveyor.

The works are to run for six months by Messrs. Parker for a sum equal to 3¾d. per unit generated, but the Council guarantee a consumption of 50,000 units. Already nearly 50 consumers have been obtained, with over 2,000 8-c.p. lamps, exclusive of the public lighting. The charges are to be made on the Wright system, with 6d. per unit for the first hour's daily use of the maximum demand and 4d. per unit for all electrical energy in excess of this. For power the charges will be 3d. per unit for the first hour and 2d. per unit afterwards. We have to thank Mr. Nelson F. Dennis and Mr. O. F. Francis, the resident engineer, for their assistance in collecting the above information, and for the loan of the drawings from which the illustrations were prepared.

FORMERS AND FORMER-WINDING.

BY F. W. DAVIES.

(Continued from page 695.)

III. Formers for Ring Armature Coils.

Ring armatures are not used to so great an extent as they were formerly, except for machines for the higher voltages; such, for instance, as those for pressures of over 500 volts. For the ring type of armature former-wound coils are not often used, although for drum armatures hand-winding is the exception and former-winding the rule. Former-winding is only practicable for *wire-wound* ring armatures when the plain type of armature core is used. *Bar winding*, however, can be used whether the armature core be of the plain, toothed, or iron-clad type. In fact, as will easily be understood, the ring armature does not lend itself very readily to former-winding, especially when the coils are wire-wound. Nevertheless, for the sake of completeness, a brief mention of what has been done in this line will be made. The advantages which have been enumerated as accruing from the use of former-winding refer more particularly to drum-wound armatures, and are only partially realised in the case of ring-wound armatures. Not only is this so, but former-winding for wire-wound ring armatures is more expensive in most cases than hand-winding. Its use, therefore, is to be recommended only for very small machines designed for ordinary voltages, such, for instance, as those small motors developing a fraction of a horse-power, which are usually run off 100 and 200 volt mains. In such machines each armature coil consists of a large number of turns of very fine wire. If the armature is hand-wound, a length of wire sufficient to wind one coil has to be wound upon a winding shuttle, from which it is wound on to the armature core. It is in such a case as this that former-wound coils may be used with some advantage, as then the use of the winding shuttle is dispensed with. The armature core must, of course, be made in two or more sections, otherwise it will not be possible for the coils to be threaded on it. A ring armature core designed for use with former-winding is shown in Fig. 5, in which is also shown one of the segmental stampings of which the core is built. The armature core is made in two halves, which are hinged together by means of a pin passing through the hole marked A. It is shown open, ready to receive the coils. After the coils have been slipped over the ring core the two halves of it are closed up until the two holes, B and B_1, coincide. The two halves of the ring are then locked together by means of a pin, which passes through the holes, B and B_1, when the armature may be mounted on the spider in some suitable manner. The coils for such an armature may conveniently be wound upon a divided block former of similar design to that used

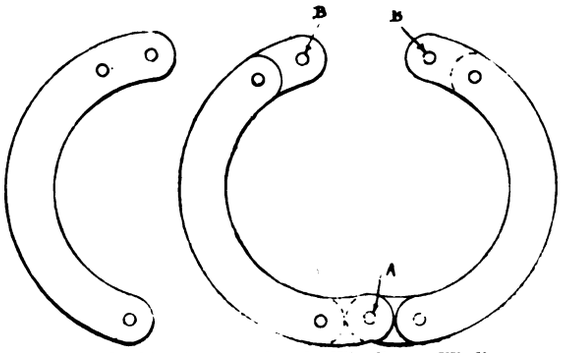

Fig. 5.—Ring Armature Core for Wire Former Winding. (Showing Detail of Segmental Stamping.)

for magnet coils (Fig. 2), but with the flanges inclined to one another at a slight angle, instead of parallel to one another as in the figure. By this means one side of each coil will be made narrower than the other. The coils must be placed on the core so that the wide part comes on the outside of the ring and the narrow part on the inside, on account of the peripheral space being less on the inside of the ring.

Bar winding for ring armatures is simpler than wire winding, as there is usually but one turn per section in a bar-wound armature. As has already been pointed out, every symmetrical bar winding is, strictly speaking, a species of former-winding. On account of the difficulty of bending conductors of large section, it is advisable to use a bar winding, whether the armature be a ring or a drum, when the conductors require to be much larger than ·03 of a square inch. Conductors larger than this, no matter whether solid or stranded, are found to be too unwieldy for wire winding. Bar-wound coils for ring armatures are very simple in construction. They are of practically the same shape as their hand-wound prototypes. In Fig. 6 is

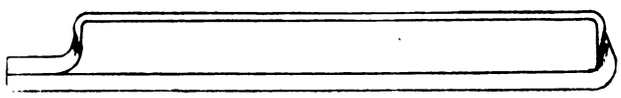

Fig. 6.—Formed Coil for Bar-Wound Ring Armature.

shown a coil for former-wound ring armatures of a type used by Messrs. Crompton and Co. It will be noticed that the conductor is arranged so as to be placed edgewise to the core on the inside of the ring. This is done for the same reason that one limb of a wire-wound coil is made narrower than the other—namely, that the conductors may be packed more closely on the inside of the ring. The coils are sprung over the core, and are then ready for coupling up. As these coils can be obtained from the manufacturers ready formed for assembling on the core, and as they are of exceedingly simple construction withal, it is not necessary to describe a former for them.

An alternative way of making the coils to that shown in Fig. 6 is to have the outside and inside limbs of each coil in separate lengths, which are riveted and soldered together when they have been assembled in their places on the core. This latter method is preferable to the other for very massive and stiff conductors, as it obviates the necessity for springing them open in order to get them on the core.

(To be continued.)

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NOTE ON AMERICAN PRACTICE IN DYNAMO DESIGN.

BY T. SQUARE.

The fact that up to the present date almost every generating station of any size in the British Isles has been equipped with American machinery is one which the electrical firms of this country are, at last, beginning to wake up to; and we may hope that before long this unsatisfactory state of affairs will be, to some extent at any rate, remedied. The chief things which have been in favour of the Americans all along are their go-ahead business management, and the fact that, although some of the first examples of electric light and traction were in England, it was in the States that the subject was enthusiastically taken up, and where all the various details have been worked out. In fact, the whole modern system of "multiple unit control" may be said to have been perfected by them alone. At the present day, however, there are several firms in the British Isles, apart from the American firms with English branches, who can turn out most lines of electrical machinery quite as well and as cheaply as the Americans. This is especially true of continuous-current dynamos and motors. But now that the Americans have caught the popular fancy, it is very difficult to get the trade into our own hands again.

One great reason why the Americans have been so successful in the past is due to the fact that all the machines they put in ran fairly well. This can be attributed to the low speeds which they always adopted whenever possible. Almost anyone can design a machine which will run well at low speeds, but it is a matter of extreme difficulty to design machines over 300 kw. or 500 kw. which will run well, especially with regard to commutation, when coupled to a high-speed engine of the Belliss or Willans type. England may be said to be the home of the high-speed engine, and many English dynamo builders have tendered for machines direct coupled to these engines, often with very little previous experience. The usual result is an indifferent running and "sparky" machine, and the next time the customer has an order to place it goes to a foreign firm. The designing of large direct-current generators for high speeds is a difficult task, and where the Americans have attempted it they have in many cases turned out far worse machines than those of the English builders. The fact that C. A. Parsons and Co. have turned out several 300-kw. dynamos direct coupled to their steam-turbines at 3,000 revolutions per minute, is a good proof that English makers are as good as any for high-speed generators.

The output of any continuous-current machine may be said to be limited by one of two things—either heating or commutation. Small machines—say below 26in. diameter of armature—are usually limited by heating, larger machines by commutation. In other words, in a big machine we can increase the load until the sparking at the commutator begins to get troublesome, and still the temperature rise on the core of the armature will only be about 40deg. or 50deg. F., the temperature which is usually stipulated as a maximum being 70deg. F. Some people have the idea that a low temperature rise is an excellent thing under all circumstances, being willing to buy a machine much too large for its work if it will only give a low temperature rise, the idea being, as far as I can make out, that its efficiency must be very good, as there are very few watts being wasted in heating the machine up. This is, of course, quite wrong, as it is well known that a machine only partly loaded may have a lower efficiency than a smaller machine fully loaded. It is, however, a good thing to have a fairly low temperature rise on a machine which is to be used in some confined space where the normal temperature may be often about 90deg. F., as is the case with ship-lighting sets. It is also better to have a little lower maximum permissible temperature rise on a large generator than on a small machine, as the consequences of any damage to insulation resulting from over heating is much more serious. It is not a great matter to have a small 10-h.p. motor shut down for a day or two as a rule, but it may be a very expensive affair to do the same with a large 1,000-kw. generator in a heavily loaded station. Again, temperatures are usually measured on the outside of the armature, but the temperature inside the core is still higher. However, for the same outside temperature of armatures the temperature inside the core of a big machine will be much higher than that of a small machine, owing to the greater distance that the centre of the mass generating heat is from the radiating surface. It is, however, quite safe to work to 65deg. F. rise by thermometer on outside surface up to the largest sizes of machine without damage to the insulation. On small machines we can work to 75deg. to 80deg. F. rise, while in traction motors the rise may go up to 130deg. F. or so.

The time taken by a machine to reach a steady temperature—*i.e.*, to reach its maximum temperature rise—for any given load varies with the size of machine over very wide limits. Thus a small 1-b.h.p. fan motor will probably reach a steady temperature after one hour, whereas a large 1,000-kw. generator may require anything up to 12 hours. Machines up to 500 kw. will, however, have reached their maximum temperature in about six or eight hours, or at least the rise will be very slow, as this figure is usually taken as the duration of a test. The American standard temperature rises were fixed by a committee formed for the purpose, and are as follows:

For armatures: open machines, 65deg. to 75deg. F.; enclosed, 90deg, to 120deg. F.

For fields: 80deg. F., measured by increase of resistance.

For commutators: 75deg. to 90deg. F.

The Americans have been very much ahead of us in combining a good mechanical design with the cheapest possible construction. For instance, the magnet yoke, bed-plate, and bearing pedestals are in small machines usually cast in one. The poles are also cast into the yoke, so that all the machining to be done is to bore out the poles and bearings. Again, most English builders use a spider over the spindle to thread the armature core plates on to, so that if the spindle gets bent or damaged by rough treatment it can be replaced by a new one without pulling the armature to pieces. This is done down to the small 4-b.h.p. or 5-b.h.p. motors. The Americans, on the other hand, prefer to use a rather stiffer spindle, thus allowing for a certain amount of rough usage, and thread their core plates directly on the spindle, thus making a cheaper machine.

Another point where the Americans gain, especially in the manufacture of small motors, is that he turns out such a large number of similar machines at a time. Thus the Crocker-Wheeler Company make:

55-kw. machines	at about	25	at a time.	
20-kw.	„	„	40	„
Smaller	„	„	60	„

Each machine tool is set for doing one particular job, and the workman is kept at that one job alone, so that the cost of production is enormously reduced. The small sizes of motors and dynamos, too, are made only with six or eight standard windings, which are chosen to suit the speeds and voltages usually asked for, and the customer has to take these standard machines unless he is prepared to pay a substantially higher price to have a machine made to his own special requirements, and even then a great many American firms will not take the order, as they have quite enough work to keep them going on the standard types In England in too many cases each little motor is treated on its own merits, so to speak; special armature and field windings are got out and the little fads of the customer or consulting engineer studied as far as ever possible, the result being a machine no better than the American one, but far more costly.

In England nearly all business is done through a consulting engineer, and it is really rather ridiculous when a manufacturer gets an order for, say, a 10-h.p. motor to find a specification enclosed, covering about 20 pages, imposing all sorts of conditions, such as the current density in the armature and field conductors and in the brushes, the number of oil-rings in the bearings, etc.—in fact, practically designing the machine. If the manufacturer has to take

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the responsibility for the good performance of a machine, he ought to have a free hand in designing it. If, on the other hand, it is to be built to a consulting engineer's design, he should take the responsibility for its performance. In America, the manufacturer is not worried like this; in fact, most small motors are simply sold "over the counter," the makers, of course, guaranteeing their satisfactory performance. In very many cases where an order has been obtained by a foreign firm, they have simply put in their standard machine, and no objections have been raised to the points where it differed from the specification. If this had been done by an English firm the machine would probably never have been accepted.

The magnet yokes of American machines are now made of cast iron in most cases, the only exception being for traction motors or in cases where weight is of importance. The difference in cost between a cast-iron or cast-steel yoke is slightly in favour of the former, as although the steel has a much higher permeability, the cast iron is much cheaper. The section required, and hence the weight, for cast iron is 2 to 2½ times that of steel. Cast iron, however, exercises a great steadying effect on the running of the machine if it is inclined to be unstable at all. This is because any slight change of flux through the yoke produces large eddy currents, which tend to stop any further change. This effect is also produced in many machines by fitting a ring or strip of copper round the poles. A cast-iron yoke of "hog-back" section is also, I think, a much nicer-looking job than the steel yoke with its stiffening flanges. The poles are usually cast solid with the yoke in machines up to about 6 h.p.; above this they are made of laminated steel plates about $\frac{1}{16}$in. thick, and cast into the yoke. The field coils are former-wound, and in many cases simply taped and whipped with string and put in place without any bobbin. They look very well, and work quite satisfactorily. In large compound-wound generators the series coils are only fitted to alternate poles, thus saving a certain amount of complication.

The General Electric Company, however, use round solid poles, and fit separate laminated pole shoes, which are fixed to the pole by countersunk cheeseheaded screws. This reduces the mean length of turn of the field winding, and so effects a saving in copper. Also there is no appreciable loss cause by the non-lamination of the pole, since the eddy loss set up by the teeth in passing is only a "skin" effect, and does not penetrate more than about 1in. Most firms make the flange, where the two halves of the yoke ring are bolted together, on the inside, which greatly improves the look of the machines, also a beading is cast around the top half of the yoke at the joint to prevent the necessity of chipping should the two outside surfaces not butt together nicely when erected. The brush gear is supported from the tail bearing for small machines up to about 26in. diameter of armature, but above this from the yoke ring, which affords a wider and firmer base.

As regards the armature, specially stiff spindles are used on all machines, and armature spiders are used above about 18in. to 25in. diameter of armature, this being about the usual point of transfer from four to six poles, and where owing to the smaller relative flux per pole a smaller core cross-section may be used. The flux densities adopted in American machines are about as follows:

Core	= 13,000 to 18,000	lines	per sq. cm.	
Teeth	= 18,000 to 21,000	,,	,,	
Poles	= 13,000 to 16,000	,,	,,	
Yoke	= 13,000 to 16,000	,,	,,	for cast steel.
	= 6,000 to 8,000	,,	,,	for cast iron.

The armature core plates are punched in one operation complete, to do which very complicated punches and discs have to be used. For large machines, of course, the old slot-by-slot method is still used, except in those cases where the core plate is made up of several segments, when each segment can be made at one operation. The slots are in all cases rectangular, and the windings are held in place by wooden strips or covers, which are slid in two small grooves at the top of the slot, as in Fig. 1. Great attention is paid to the quality of the iron, and the plates are carefully annealed after stamping so as to keep the iron loss as low as possible. This is a most important matter, not so much from the point of view of efficiency as from that of heating. In those machines whose outputs are limited by heating, it is as well to remember that of the total watts got rid of by the armature for a given standard temperature rise at least one-half is iron loss, hence the more we can keep these losses down the more we can increase the output of the machine. The armature should be most efficiently ventilated, so as to increase the permissible watts which can be got rid of. At least 15 per cent. of the total length of core plates is taken up by ventilating spaces, the core plates being held apart by brass distance pieces. These distance pieces are either made separately, and

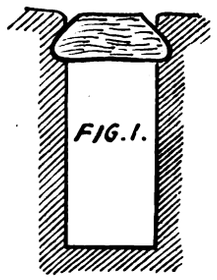
FIG. 1.

fastened in place one by one, or they may be all cast in one and fastened at one or two points only. The latter method is probably the cheapest. The end castings which are used to hold the core plates together, and to support the "end connections" of the armature windings, should be made of cast iron of high specific resistance, so as to prevent any stray field from causing much loss by setting up eddy currents. They should be well ventilated, so as allow of a good flow of air past the end connections of the armature winding. In four or two pole machines, however, it is found that practically the whole of the cross-section of the core is required for the flux, so that in very small machines ventilation has to be given up.

In large generators the spider has a number of radial arms, ranging from 4 to 20 or so, and the segments of the core plates (if the machine is large enough to require its core plates to be in segments) will each be dovetailed into at least two of these arms, as shown in Fig. 2. This exposes the inside of the core freely to ventilation, and the spider arms, together with the brass distance pieces in the ventilating spaces, act as the vanes of a fan in forcing air through the core of the machine. The armature coils, which are all former-wound on machines above about 12in. diameter of armature, are squeezed to shape in steam-heated presses after being wound. In some firms the formers are power-driven, but this has not been found to reduce

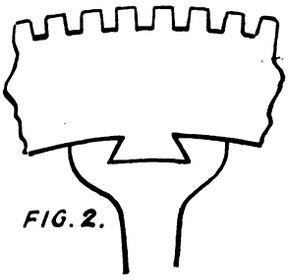
FIG. 2.

expenses. In small machines the armature coils are simply wound in loops and pulled into shape by hand. This is, of course, much cheaper, but it does not make such a nice-looking job, and also tends to bruise the insulation on the wires if they are of at all large section.

The insulation on the armature and in the slots varies very much with different makers. The slot is usually lined with micanite, and the coil limbs in both the top and bottom halves of the slot are held together with india-rubber, or impregnated linen tape, after being insulated with mica cloth or presspahn—*i.e.*, pressed cardboard. Each wire in the half slot is insulated from its neighbour by double cotton covering, braiding, or tape, according to its section. The Stanley Electric Company have got out a method of covering copper wire with boiled linseed oil, which they say is quite as good as double cotton covering,

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and does not take up nearly so much space. The core plate are insulated from each other by varnish, but a piece of thin paper is placed about every ½in. to supplement it. The plates used vary from about 25 to 30 mils in thickness, and their permeability is specified to be about:

$\mu = 430$ at a density of 15,000 C.G.S. lines per square cm.
$\mu = 50$ „ „ 20,000 „ „ „

these being about the average top densities in the core and teeth.

Cross-connecting rings are nearly always used on machines with over four poles to prevent "bucking." There may be any number of them, but usually three or four are fitted. They are used to connect up all the points in the armature winding, which should be of the same potential, so that if one point is out of balance and tends to have a slightly higher voltage than its correct value, current immediately flows through the low-resistance cross-connecting ring from the other similar potential points on the armature, returning through the armature winding. This extra current causes a greater copper drop in the section which is out of balance, and so reduces its voltage until it is practically the same as the others. The number of points of equal potential in an armature winding is obviously equal to half the number of poles of the machine, hence each cross-connecting ring is connected to this number of points. These rings, of course, tend to even up any slight difference of potential between the brushes of the same sign, thus improving commutation, since the current set up by this small potential difference, which would have flown through the brushes, now flows

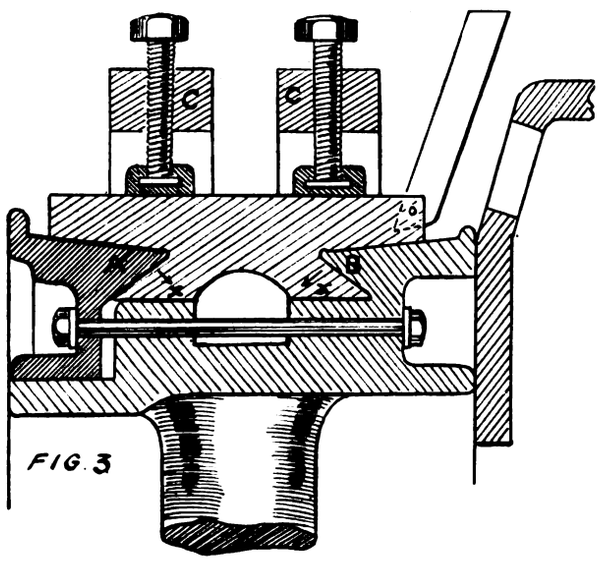

FIG. 3

through the cross-connecting ring, and so prevents the brushes from being overloaded. This current may be very considerable, as the resistance of the circuit is so low.

The commutator is nearly always mounted on a separate casting, which is keyed on to the spindle and butts up against the armature end casting, as in Fig. 3. The bars are of the dovetail or undercut type. The Americans do not like to have an "arch-bound" commutator, which is the usual English practice. By this is meant one which is kept rigid by the pressure between the sides of the bars alone, being supported solely by the two wedge-like projections, A and B, on the commutator body. Hence most of the best firms have the bottom of the commutator bars bearing down on to the commutator body, as at x in figure, and the pressure is put on only by the bottom faces of the two wedges, A and B. Of course, all parts of the commutator body which are touched or near the commutator bars are well insulated with asbestos and mica. The commutator parts are stamped out of copper strip, which is usually bought rolled to the correct level. About ⅛in. is left all round the bar for machinery. The bars are then built up on a dummy commutator body, which is slightly smaller in diameter than the actual one. The bars are insulated from each other with the best soft mica. While the commutator is being built it is held together from the outside by one or more clamping rings, C C_1, as in figure. When all the bars are in place the dummy commutator body is removed, and the commutator squeezed inwards as far as possible by means of the clamping rings. The commutator bars are then entirely held together by the clamping rings. It is then fixed up on the face plate of a lathe, and the inside and ends truly machined to gauge. The angle δ is usually about 10deg. or less, and the angle β is about 20deg. to 25deg. (see Fig 4). The outside is now the only part which is not machined, as the clamping ring is in the way. At this stage, then, the commutator bars are mounted in their position on the commutator body, and the wedge-plates, A, bolted up in place. The commutator is then as shown in Fig. 3. Lastly, the clamping rings are removed, and the whole armature is put in a lathe, and the outside surface of the commutator bars turned up perfectly true with the spindle. Carbon brushes are invariably used, and the current density is about 40 amperes per square inch of contact surface. The brush-holders are usually of the "parallel motion" type. The current density in the armature conductors is usually from 2,500 to 3,000 amperes per square inch, and in the field it varies from 800 to 900.

The speeds of American machines, as noted above, are, however, much less than those of English makers. The table given below shows the speeds and outputs of the General Electric Company's machines taken from their catalogue, compared with a mean English maker's speeds:

Output in kilowatts.	G.E. speed. R.P.M.	English maker's speed.	Approx. eff. Per cent.
25	305	800	85
35	300	650	87
50	280	550	89
75	270	500	90
100	270	450	91
160	230	400	92
200	200	350	92
300	150	350	93
400	150	300	93
550	100	300	93
800	100	250	94

As regards the size of machine required for a given output, each maker has his own rules on this, which have

FIG. 4.

been derived in most cases from tests on his own machines. Mr. Kapp has proved that the output of a dynamo in kilowatts is given by the formulæ:

$$KW. = D^2 L \times \text{revolutions} \times \text{constant};$$

or, in other words, the kilowatts per revolution $= D^2 L \times$ constant,

where D = diameter of machine in inches;
L = length of armature core in inches.

The value of the constant varies very much, indeed, according to the make and size of machine, and the conditions imposed. As a very rough guide we may take it as

8 to 14×10^{-6} for open machines up to 26in. diam. of arm.
20 to 25×10^{-6} „ „ above „ „

TUBE BILLS IN PARLIAMENT.

LORD WINDSOR'S COMMITTEE.

THURSDAY, MAY 15

The House of Lords Committee presided over by Lord Windsor continued the consideration of various "tube" railway schemes proposed for London, proceeding first with the opposition to the Central London Railway extensions.

Mr. Ellis, general manager of the Metropolitan Railway, recalled, said the Metropolitan Company was now about to spend a large sum on electrifying the line, and he thought they were entitled to consideration before further new railways were authorized. He was of opinion that the scheme proposed by the Central London Railway could not possibly prove remunerative. It was expected that the Metropolitan Railway would be run by electricity in 18 months.

Mr. Thomas Parker, M.I.C.E., electrical engineer of the Metropolitan Railway, stated that he was carrying out as rapidly as he could the electric equipment of the Inner Circle. When this was completed the carrying capacity of the Metropolitan and the District

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would be increased by 40 per cent., and, of course, the ventilation would be immensely improved. He considered the public would prefer to travel in this way than in the ordinary "tubes," on account of the distance to which they had to descend underground, and the long underground passages they had to traverse.

Mr. G. H. Redford, chairman of the Parliamentary Committee of the London County Council, gave evidence as to the views of the Council on the subject. The County Council were of opinion, he said, that some body like the Light Railway Commissioners should be established to which all these schemes should be submitted before they came before Parliament. Meantime they had considered the schemes at present proposed. They were of opinion that power to purchase after a term of years should be given to the local authority. Power was given to purchase tramways overground, but if at any point the tramway got power to burrow underground it got a valuable concession for nothing, and there was no power to purchase. The Council also were of opinion that an enquiry should be held into the question of shallow tramways such as had recently been sanctioned by a committee of the House of Commons. They knew that such an enquiry would involve delay, but the County Council considered the matter of so much importance that they thought the delay would be justified. After considering the present schemes they were in favour of the Central London—first of all, because it would form a good service in itself, and also because it was capable of working into a larger system by exchange stations, because there was not so much danger of inflation of capital with regard to it as in the case of the other schemes, and because a more rapid service of trains could be had on a closed circuit than on the shuttle system.

Replying to Lord Zouche, Mr. Redford said he knew the line from Brompton to Piccadilly had been already sanctioned, and if the Central London scheme was sanctioned there would be two lines under Piccadilly, but he did not think that presented any serious difficulty. The County Council was in favour of the North-East London line.

Mr. Wheeler, K.C., for the Corporation of London, stated that they had come to a similar conclusion as the County Council. They considered the Central London scheme was the most advantageous not only for the City, but for the whole of London. The Corporation was in favour of the North-East London provided it did not come further west than Cannon-street.

Mr. Fitzgerald, K.C., then addressed the committee on behalf of the Central London scheme, and **Mr. Littler, K.C.,** on behalf of the Yerkes group.

FRIDAY, MAY 16.

On the committee resuming, **Mr. Balfour Browne, K.C.,** spoke in the interests of the combined scheme of the Piccadilly and City and the London United Electric Railways Companies for a line from Hammersmith to the City. The first recommendation of the proposal, he said, was that, in conjunction with the North-East London line, it afforded a great through route from the densely-populated parts of the Metropolis to the less densely-populated parts, and, therefore, helped to solve the very important question of the housing of the working classes. Secondly, it provided two important services for London. It conveyed passengers from the north-east to the centre and from the south-west to the centre. The third advantage was that of cheap fares. A fourth point greatly in their favour was that they proposed to make a railway from Clapham Junction to the Marble Arch, giving an important north and south communication, which was offered by none of their rivals. The fifth advantage of their line was that they made a new centre in London, for instead of going to the Bank they had their station at the Monument. As to speed, their service would be quicker than that of the Central London, as they averaged 19 miles an hour, with stops. Both the Central London and the Brompton and Piccadilly-circus companies had become aware of the fact that there must be a railway from Hammersmith along Piccadilly to the City, and they had both attempted to block that route in their own interests and to protect themselves against competition. He ventured to express the opinion that if either of those lines was sanctioned by the committee, it would not be constructed. There was no *bona fides* in either of them. He asked the committee to allow this Bill to proceed for a line which was not only proposed, but which would be constructed.

The room was then cleared, and after an interval of half an hour counsel and parties were readmitted.

The **Chairman** said the committee had decided not to proceed with the Central London Bill as far as related to the proposed railway from Shepherd's Bush *via* Hammersmith to the Bank, but they were prepared to consider the extension of their line beyond the Bank and the small branch lines at the West-end. With regard to the Brompton and Piccadilly Bill, the committee would not proceed with that portion of their proposed line between Piccadilly-circus and Charing Cross, leaving the other portions for future consideration. With regard to the London United Electric Railways, Piccadilly and City, and North-East London, the committee would not proceed with that portion of the United Electric Railway which ran from Addison-road *via* Shepherd's Bush to Hammersmith. The committee would meet on Monday week, and they proposed then to proceed with what further opposition there was to the United Electric combined scheme.

The committee adjourned.

LORD RIBBLESDALE'S COMMITTEE.

The result of the deliberations of this committee, which closed their sittings on Wednesday week, may be summarised as follows: Charing Cross, Euston, and Hampstead (Nos. 1, 2, and 3), passed; Edgware and Hampstead, passed; Islington and Euston, rejected; City and Crystal Palace, rejected; Great Northern and City, passed; Great Northern and Strand, passed; North-West London, passed; Baker-street and Waterloo, passed.

DISCUSSION IN THE LORDS.

An interesting discussion on the subject of what provision should be made to protect property owners from damage due to vibration, took place in the House of Lords on Thursday last week on a motion by the **Earl of Camperdown** that the special clauses to be proposed with reference to the damage done by underground railways be submitted for consideration by the House before being inserted in any Railway Bill. He said that special clauses had been drafted, and were now under consideration by private Bill committees. But he thought that, as these or similar clauses would probably in future be applied to all Bills relating to underground railways, this procedure involved a question of general policy, and, practically, an alteration in the general law. The clauses, therefore, in the first place, should be laid on the table of the House so that their lordships and the public might become acquainted with them, and that any questions might be raised in regard to them. They should come before the House in the same way as general Bills, for they affected the original jurisdiction of their lordships with which they should be slow to part to committees.

The **Earl of Morley** said that tube railways were novel, and there was practically no experience to guide them in deciding what damage might be done to adjoining property by their construction. He entirely agreed with the noble earl that something ought to be done. He also sympathised with his wish that the House of Lords should be thoroughly informed of all the clauses introduced into private Bills to further the object which he, and the House also, he believed, had in view. But the committees, whose members were considering with great care the clauses embodying suggestions as to what should be done to give further protection to owners of property than they had under the present law, had the great advantage of having the cases for the promoters of the railways and for the owners of property before them. The suggestions were being thoroughly discussed by counsel. It would be better to leave the elaboration of the clauses to the committee in the first instance. It would be perfectly open to the House afterwards to consider these clauses and make any alteration they thought fit. He would be happy to inform the noble earl when the Bills were coming on for third reading so that he could call attention to the clauses and take the opinion of the House upon them, which would be a guide to future committees and to himself. He suggested this as the more convenient course.

Eventually the motion was withdrawn on the undertaking of the Earl of Morley that the House should have copies of the new clauses before the third reading of the Bills.

FORTHCOMING EVENTS.

FRIDAY, MAY 23.

Physical Society. — At 5 p.m., ordinary meeting. Papers: "On the Ebullition of Rotating Water: a Lecture Experiment," by Mr. T. C. Porter; "The Conservation of Entropy," by Mr. J. A. Erskine; "Rational Units of Electromagnetism," by Mr. G. Giorgi.

THURSDAY, MAY 29.

Institution of Electrical Engineers (Dublin Section).—At 8 p.m., annual general meeting. A paper will also be read entitled "The Lighting and Driving of Textile Mills by Electricity," by Mr. M. Osborne.

Society of Arts (Colonial Section).—At 4.30 p.m., ordinary meeting. Paper: "Western Australia: Its Progress and Resources," by the Hon. H. W. Venn.

FRIDAY, MAY 30.

Royal Institution.—At 9 p.m., Mr. G. Marconi on "The Progress of Electric Space Telegraphy."

The Incorporated Municipal Electrical Association will hold its seventh annual convention in London from July 2 to 5.

APPOINTMENTS VACANT.

Switchboard Attendant, Eccles Corporation electricity works, £62 per annum, May 24.

Borough Electrical Engineer and Tramways Manager, Newport (Mon.) Corporation, May 31. Full particulars may be obtained from the town clerk.

Draughtsman, Leicester Corporation borough engineer's office, £135 per annum, May 27.

Demand-Note Clerk and Collector, Stepney Borough Council electricity department, £100 per annum, rising by annual increments of £10 to £150, May 30. See advertisement.

Assistant Engineer, Wimbledon Urban District Council Electricity Department, £78 per annum, May 28. See advertisement.

Mechanical Draughtsmen, with electrical experience. See advertisement.

Shift Engineers, Coventry Electricity Works and Cork Electric Tramway and Lighting Company, Cork, 45s., May 29. See advertisements.

Junior Switchboard Attendant, Hoylake and West Kirby Urban District Council, £52 per annum, May 28. See advertisement.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed*

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PRINCIPLE OR NO PRINCIPLE.

The moderate man has to take the kicks of both extremes, and never looms largely in the eyes of the world because he does not tub-thump loud enough. Likewise, he generally pays the piper, but does not call the tune—that is because the right way, which lies between the two extremes, is scarcely or never followed, the way tending toward the stronger or more blatant extreme. No doubt the first tramway was somewhat of the nature of an accident, likewise of an expedient. It got put down in a public street because that street was almost impassable to ordinary vehicles, and no one troubled about principle or what the future would bring forth. Upon what principle did the original tramway companies obtain their powers? We presume, like most new introductions, parliamentary sanction was obtained, but as there would be no opposition, and Parliament acts through expediency and not by principle, always taking the line of least resistance, sanction was easy. Once sanction obtained, precedent would hold good, and promoters only had to show a bolder front and a longer purse than opposers to make their case good and obtain what they asked for. The poor, long-suffering public was ultimately recognised, and tramway work harried and rendered almost impossible by limitation of time of ownership, with subsequent loss of control and property without due reward. He would be a bold man who to-day would argue that tramway traction did not interfere more or less with the general use of the street; and the question is being asked with greater emphasis every day, in what way are the rights of the general public to the street surface being considered? The frontagers have a say for or against a given tramway, but these are not the only people who use the street surface and whose business meets with interference. Colonel Crompton and others have been suggesting the formation of new main roads, contending that the nation has not in this respect kept up with the requirements of the times. They hold that automobilism is the coming tractive power, and that its free development is restrained because of the restrictions laid upon automobilists. Quite so, but if there were fewer impediments in existing streets, there would be greater room for the newer traction. However, we contend that the street surface is for the benefit of the whole community, and that the danger is arising when freedom of use of the streets will be impossible. If a tramway is considered to be an improvement upon the existing state of things and does not seriously interfere with the other traffic, then no serious harm can arise, but undoubtedly the Legislature is far too lax in allowing schemes which do seriously interfere with other traffic. In such cases, if a tramway is constructed, it should be constructed upon its own ground, and not upon street surfaces, which in the nature of the case are public property. Take as a last example of legislative action—the so far probable permission to construct a tramway along the Thames Embankment—the only road from East to West not at present seriously overcrowded. The construction of this tramway is promoted, we firmly believe, not because its promoters are convinced of its utility, but as a means to employ a stronger lever in the future for southern lines to cross the bridges. Parliament can make and unmake laws, but in its unrestricted permission to build tramways by those who possess the longest purse and most impudence it is going periously near to becoming the weakest link in the constitution. We conclude by again asking, what principle is followed in allowing the hundred and one interferences with streets, the aim of each one of which is to benefit a limited number, and not the whole of the community? If there is no underlying principle, and each

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case is considered upon its merits, the sooner some principles are evolved the better, for "merit" in some cases simply means length of purse and persistency. Colonel Crompton's statement that tramway traction is nearly, if not quite, the worst method of moving a mass of humanity from a given point and distributing the items to other points, put forward in his inaugural address to the Mechanical Section of the British Association, has never been seriously disputed, much less disproved, and till it has been proved incorrect more weight should be given to the opponents of schemes when the schemes involve the partial blocking of old and narrow streets.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE INSTITUTION OF ELECTRICAL ENGINEERS AND THE PROPOSED "MODEL GENERAL CONDITIONS" FOR ELECTRICITY WORKS.

SIR,—I was much surprised to read in your issue of May 16 that during the adjourned discussion on the above subject, "Mr. Shoolbred having spoken in favour of the document," etc. I beg to say that I did nothing of the kind. Any remarks that I made were quite to the contrary, more especially as to the tendency which pervaded the whole of the document to make the contractor, and not the consulting engineer, the exponent of the views of the intending purchaser. This is evidenced especially by the clauses as to the drawings, the whole of which, including even the preliminary drawings, are to be supplied by the contractor.

I have always been given to understand, during the experience of a fair number of years, that it is by means of the architect or the consulting engineer that the intending purchaser seeks to explain to intending contractors the nature and extent of the works which he is desirous of having constructed.

If, instead of the purchaser's views being explained by his own adviser to the contractor, it is the contractor who is good enough to explain what he is prepared to supply in order to comply with the purchaser's requirements (as is proposed in the model general conditions), it is quite conceivable that the intending purchaser may somewhat differ as to what are his own requirements, and he might prefer that his own adviser should be the exponent on his behalf of his own views and requirements.—Yours, etc.,

JAMES N. SHOOLBRED.

32, Victoria-street, S.W., May 21, 1902.

REVIEWS.

The 1902 Edition of the General Electric Company's Complete Catalogue.

For the third time the General Electric Company have gathered together under one binding the whole of the range of catalogues and price-lists which they issue for their various departments. The binding of this third volume is coloured red and green to distinguish it from the others, and the book so made can be used for a great variety of purposes. As a whole it is a useful adjunct to the library of an electrical engineer, and in an office its weight alone renders it of service. Thus with practice it can be used with effect to speed the departure of an unwelcome visitor. The internal value, however, far surpasses its service as a projectile. Thus in it one can select any article used by electrical engineers, from the 1,500-kw. central-station dynamo down to the curling tongs for ladies, to which new stations are invariably counselled to look for their load. Another range of subjects varies from the telephone equipment for a large town to the electric alarm warranted to wake the dead at sunrise, or the apparatus for enabling a man to estimate the anatomical value of his own skeleton. From this catalogue one can purchase electric fittings of almost innumerable shapes and types of finish, and the price one can pay is also varied, from the cheap plain pendant up to works of art listed in guineas. In fact, the present volume is more complete than any other catalogue we know of, and it speaks well for its editors that its index and arrangement allow of any desired article being quickly turned up. The first few pages give illustrations of the various works of the company over which their 5,000 employés are distributed. These include the new carbon works at Witton, which form a comparatively small part of the huge electric manufacturing shops now nearly completed. At the carbon works arc lamp carbons are now being turned out in large quantities, these reviving what has been practically a lost industry in this country. In connection with the Witton works, near Birmingham, the company are erecting a large number of cottages for their employés on adjacent land. This will prevent the scandals over the housing question which have attended the moving of other large firms to new works.

We next find a host of useful information printed on a pink supplement—for those who wish to buy, sell, or manufacture—written specially in popular style, so that the retailer, who has not the implements of a drawing office or library always at hand, may be able to benefit equally with the trained engineer. Here we find, besides the indices mentioned above, tables of weights and measures with metrical equivalents, foreign money tables, data for house wiring, and comparison with gas for private plants, hints to purchasers, and a glossary of electrical terms. For those Colonial customers who have not always time to write home for quotations, a series of estimates for complete plants are included, and, finally, there is the General Electric Company's special telegraphic code, by means of which any of the 100,000 listed articles in the catalogues can be cabled for in conjunction with the ordinary commercial codes; and many electrical and mechanical expressions are coded as well, so that orders can be sent for all requirements.

We now come to the catalogue proper, which comprises the following sections: (S) switchboard and electric light supplies (80 pp.); (W) wires and cables (56 pp.); (M) instruments, meters, etc. (40 pp.); (E) arc lamps and engineering specialities (112 pp.); (T) traction supplies (16 pp.); (P) electrical plant (56 pp.); (H) electrical heating and cooking (24 pp.); (L) electric bells, etc. (95 pp.); (K) telephones, etc. (96 pp.); (O) electro-medical apparatus (32 pp.); (F and G) fixtures and glassware (272 pp.). At the end of the catalogue there is an art paper supplement with some excellently reproduced photos, showing the great variety of and enormous field covered by the installation work of the General Electric Company—from dynamos and switchboards to lighting and street telephones.

All these sections aggregate close on 1,000 pages, and (with few exceptions as in lamps, where the varieties are too great) every article has a catalogue number, and every class of article is accompanied by a short and concise description and specification, which can be embodied by contractors in their own estimates. These specifications and the blocks are so clear that no doubt can arise in the minds of buyers as to the quality or appearance of the article desired. All the articles illustrated are manufactured by the General Electric Company, and there is, therefore, no wonder that, in spite of their London, Birmingham, and Manchester works, they have had to go into the country to build additional works. As we have from time to time reviewed the various sectional catalogues a detailed description here is not needed, but a few remarks on the section which deals almost exclusively with dynamos and motors will not be out of place. Here we find the well-standardised "Byng-Hawkins" multipolar dynamos and motors, open and enclosed types, single and polyphase generators and motors, and various appliances connected with these. It is expected that the opening of the Witton works will make this section in future one of the most important catalogues issued by the firm. A yellow supplement completes this part, in which steam, gas, and oil engines, boilers, and other prime motors, not made by the General Electric Company, are listed for the special benefit of buyers abroad.

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In conclusion, we can only repeat our remarks made in previous editions, that the General Electric Company's catalogue is an absolute necessity to electrical engineers.

"THE ENCYCLOPÆDIA BRITANNICA."

We have received a copy of the first of the new volumes of "The Encyclopædia Britannica," now being published by the *Times*, of Printing House-square, London, and by Messrs. Adam and Chas. Black, of Edinburgh and London. The new volumes now being issued will form in combination with the existing volumes of the ninth edition a complete encyclopædia. The first volume of the new series deals with additions required under letter "A," and contains two important articles of interest to electrical engineers The first of these is contributed by Mr. W. Hibbert, F.I.C., F.C.S., on "Accumulators." Mr. Hibbert's work in this direction is well known to electrical engineers, and the article, taking up some 10 pages of the encyclopædia, is worthy of careful perusal even by those who have a good general knowledge of the subject. He begins by explaining that the names given to Planté's first cell have been frequently misunderstood. The terms "secondary battery," "storage battery," and "accumulator" have been taken to indicate that there was an accumulation or storage of electricity or of electric current, but the error is not Planté's, as is clear from his declaration that his couple is able to give discharges of long duration, or to retain its charge for a long time, *et d'emmagasiner ainsi le travail chimique de la pile Voltaique*. The value of the cell arises from a happy combination of properties. The three active materials are peroxide of lead, spongy metallic lead, and dilute sulphuric acid. Of these the peroxide is an excellent depolariser; the lead is a sufficiently good electro-positive metal; and the dilute sulphuric acid has a very high conductivity for an electrolyte. Moreover, the two solid substances are not only themselves insoluble in the dilute acid, but the sulphate of lead formed from them in the course of discharge is also insoluble. Consequently it remains fixed in the place where it is formed; and on the passage of the charging current the original PbO_2 and Pb are reproduced in the places they originally occupied. Thus there is no material change in the distribution of masses of active material. Lastly, the active materials are in a porous, spongy condition, so that the acid is within reach of all parts of them. The resistance of the cell is low, while the energy of the chemical action to which it gives rise imparts a high E.M.F.

After reviewing the early work done by the above-mentioned experimenter, illustrations are given of the best forms of accumulators as manufactured at the present day, in order to show the forms of construction which have given the greatest success in regular work. The author, before going fully into the theory of accumulators, explains the need of the three active substances used in them, which consist of spongy lead on the negative plate, spongy peroxide of lead on the positive plate, and dilute sulphuric acid between them. The fourth substance—sulphate of lead—is also formed during the discharge, and also to a small extent during repose. The author gives the following figures for the density and specific resistance of the above substances. Spongy lead has a density of 11·3 and a resistance of ·00000195 ohm between the opposite faces of a cubic centimetre. The spongy peroxide of lead has a density of 9·28, and a specific resistance varying from 5·59 to 6·78 ohms. Sulphate of lead is a white powder with a density of 6·3. Its electric conductivity is so low that it may be classed as a non-conductor. The densities of these three solids being known, it is easy to follow the changes in volume which accompanying the formation of sulphate of lead on either plate. One hundred volumes of lead (on the negative plate) form 290 volumes of sulphate, and will, therefore, require three times as much space as before the action, while 100 volumes of peroxide (on the positive plate) form 186 volumes of sulphate, and will, therefore, fill nearly twice as much space as before. These expansion figures are not only important in themselves, but also throw light on the well-known tendency of the negative plate to run down before the positive. In a given discharge the quantities of sulphate of lead formed on the two lead plates are the same, but the expansion in the lead plugs (and consequent reduction of porosity) is 60 per cent. greater than in the positive plugs.

The author goes on to deal with the local actions which occur in accumulators and with the theory of accumulators generally. In so doing he gives a large number of curves obtained from experimental working under various conditions, which are of great interest. No less than 34 illustrations are used in the article, which concludes with a description of the accumulator cars used at Birmingham, and the advantages which may be derived from the employment of accumulators in a traction generating station.

The other article referred to above as appearing in the first of the new volumes deals with atmospheric electricity. This has been contributed by Dr. C. Chree, D.Sc., F.R.S., of the National Physical Laboratory. He commences by showing that investigations into the early history of atmospheric electricity would be the province rather of the antiquary than of the scientific man. In pre-scientific days lightning was usually regarded as the special vehicle of divine vengeance. Lucretius was perhaps the first who attempted to apply to its elucidation the scientific method. He pointed out that even the temples of Jupiter had not escaped the thunderbolt, which seemed to imply an incredible degree of inefficiency in the department over which that divinity was supposed to preside. Like most modern scientific men who have considered the subject, Lucretius had a theory of his own, and he might almost be looked upon as the parent of the "electric fluid" phraseology still so prominent in popular writings. Even in 1749, when Franklin proposed the famous kite experiment to test the identity of natural and artificial electricity, the electric fluid theory was probably held by most scientific men in a fairly literal sense. The electric fluid was supposed to reside in the clouds, whence it was attracted by any sharp point held upwards. Shortly after 1750, the observations by Lemonnier and others of electric phenomena in the atmosphere in the absence of cloud, led to some modification of ideas. It was only, however, with the introduction of improved methods and apparatus after the middle of the nineteenth century, mainly by Lord Kelvin, that there was any approach to exact measurements of atmospheric electricity. To understand the different methods employed or recommended, a brief survey of the phenomena is necessary.

At most places, in dry weather the electric potential near the ground is normally positive relative to the earth, and increases with the height. The existence of earth currents shows that the earth, strictly speaking, may not be all at one potential, but the potential differences between points on the earth's surface, say 1 km. apart, are insignificant compared to the normal potential difference between the earth and a point 1m. above it, and when considering this latter difference we may regard the earth as at a uniform zero potential. What is aimed at in ordinary observations of atmospheric electricity is the measurement of the potential difference between the earth and a point at a given height above it, or else the difference in potential between two points in the same vertical at a given distance apart.

The addition of sharp points was a step in advance. But the method can hardly be said to have been a quantitative one until the sharp points were replaced by either a flame (fuse, gas, lamp) or a liquid jet breaking into drops. In either case the theory is the same. The matter leaving the conductor, whether it be the products of combustion of a fuse, or the drops of a liquid, supplies the means of maintaining equality of potential between the conductor and the air at the spot where the matter quits electrical connection with the conductor.

He then discusses the older methods of dealing with the electrification of air, and describes in detail the advances made in such work under the guidance of Lord Kelvin, who substituted either the flame or liquid dropping apparatus for the water-dropper electrometer for the older methods. Interesting tables of the mean diurnal inequalities in atmospheric electricity as measured in observatories

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in various parts of the world in different years are given and commented on by the author, who proceeds to draw conclusions from the same. For instance, he shows that a certain high thunderstorm frequency and low potential gradient vary in parallel lines. Thus, thunderstorm frequency and intensity are greatest about midsummer, when potential gradient is least, and there is at most stations a minimum of potential gradient in the afternoon at about the same hour as the thunderstorm maximum. The connection is, however, far from close. Thus we have the thunderstorm minimum occurring alongside of the early morning potential gradient minimum; and the diurnal and annual variations in thunderstorms appear much more accentuated than the corresponding variations in potential gradient.

The last part of this article deals with the phenomenon of aurora, of which much work has yet to be done. Dr. Chree comments on the fact that at the Danish polar station, Godthaab, Paulsen saw on several occasions auroral sheets, which seemed to be suspended vertically like curtains, and to sweep past with great velocity, travelling from magnetic south. At Paulsen's suggestion, Lieutenant Vedel, of the Ryder Arctic expedition, 1891-1892, kept a look-out for this phenomenon, and was able on a variety of occasions to observe the declination magnet during its occurrence. According to these observations—made on an island in Scoresby Sound, 70° 27′ N. lat.—the needle moved to the west as the auroral curtain approached from the south, oscillated as the curtain passed overhead, and then moved to the east as the curtain receded towards the north. Paulsen believes the phenomenon to imply the existence of an electric current directed downwards in the space occupied, or seemingly occupied, by the auroral curtain.

Numerous attempts have been made to determine the height of auroral displays. Simultaneous theodolite observations have frequently been made from two stations at a considerable distance apart. The calculated heights in mean latitudes have often exceeded 100 km. At Godthaab the calculations of the Danish observers often put auroral arcs at heights under 10 km., and occasionally under 2 km. From the observations at Sodawkyla, Lemstrong thought it doubtful whether the objects seen from the two ends of the base were really the same. The question has been treated with great fulness of detail by Cleveland Abbe ("Terrestrial Magnetism," vol. iii., 1898, pp. 5, 53, and 149). He seems disposed to doubt whether what the observer sees as aurora has an independent objective existence.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

483. Six 400-kw. machines connected across the outers in a three-wire station are on load; five of them are excited from the station 'bus bars, the sixth being a self-exciting machine. The armature bands of this self-exciting machine give way, and, jamming between the pole-pieces, earth the armature and blow the fuses on the main switchboard without affecting the + or − volts in the slightest. On examining the recording voltmeter cards afterwards a very slight drop is noticed a while before the main fuses went; at the point where the fuses did blow a slight rise is noticed. How can this be satisfactorily explained?—R. M.

484. In an Allis three-line engine of 4,000 h.p., driving a traction generator, the diameter of the shaft is increased in each successive line approaching the armature. Is this practice to be recommended as sound engineering? State reasons for or against.—C. I. S.

ANSWERS.

Question No. 477.—Explain the use and object of the fourth wire when used in connection with the distribution of three-phase current.

Best Answer to No. 477 (*awarded* 10*s.*).—One of the chief reasons for using a "fourth wire" in connection with the distribution of three-phase current is economy. To demonstrate this saving in copper due to the presence of the neutral or fourth wire in polyphase working, is quite easy. When a simple three-core cable is employed, the consumer's service wires are for lighting purposes attached to adjacent conductors, but when a fourth or balancing wire is added, the consumer's service wires are connected between any one of the three principal conductors and the fourth wire. From this it follows that if in each case the difference of potential in the consumer's premises is the same, the pressure between the three principal conductors can, when a neutral conductor is added, be increased over the pressure between them when there is no such conductor in the ratio of $\sqrt{3}$ to 1—in other words, while retaining the same pressure at the consumer's terminals, we can, when there is a fourth wire, raise the pressure on the three wires in this ratio, and seeing that the weight of copper is inversely as the square of the pressure for the same percentage loss, so far as the three principal conductors are concerned, the weight of copper is at once reduced to one-third. Let the neutral conductor which has to be added bear the same proportion to the combined area of the three principal conductors as in the three-wire continuous system, and we have the total weight of copper with neutral as only five-twelfths of the weight of the three-core cable—that is, considerably less than half. The advantage of using a fourth conductor for three-phase distribution will then be apparent. There are several methods of arranging the low-tension network with a neutral conductor. Fig. 1 shows one method which is used

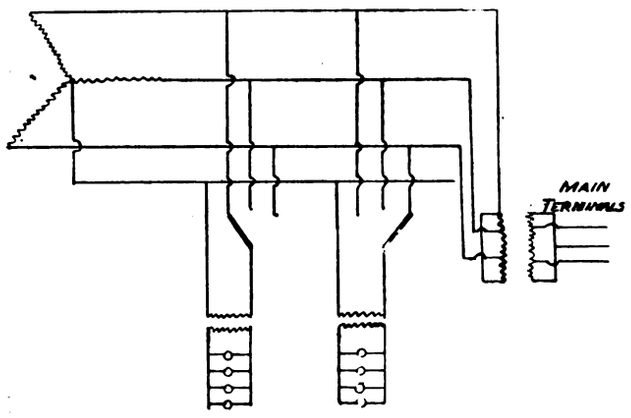

Fig. 1.

chiefly in America. From the station three-phase feeders are run each capable of supplying 500 kw. or more, these long feeders delivering power to areas, say, of a couple of miles in radius such wise that all consumers may be connected by short single-phase branches tapped off from one outside wire and the neutral. The necessary transformation is done by means of an ordinary transformer wound for whatever the system may be and the declared voltage on the secondary. This transformer either supplies an individual customer or a small local three-wire secondary network, the various branches being arranged to give a balance as near as possible. When motors are required to be operated they may be run from the three-phase mains, "delta" connected transformers preferably being used, or, perhaps, better still, a three-phase transformer, as this would be a very good balancer. It would be advisable (in fact, the Board of Trade require it) to earth the neutral wire in order that no potential difference other than that for which it is designed should be thrown on the transformer. This system is so connected together that motors can be operated with practically no effect on the lighting. No instance of this as yet exists in this country so far as I am aware; but the important scheme which is being arranged for Dublin on a different plan to the above may

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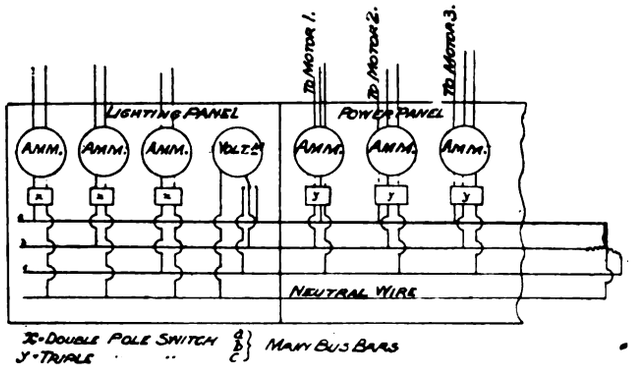
no doubt be followed by others, especially as the manufacture of induction motors will shortly be freed from the restrictions imposed by the Tesla patents.—A. G. S.

Answer to No. 477 (*awarded* 5*s.*).—If a three-phase installation is put down for motor power work only, there will be no necessity for having a fourth or neutral wire; but if it be intended to light the premises off the three-phase generating plant, it may be advisable to adopt a fourth-wire system.

Let us assume the current is generated at an E.M.F. of 400 volts; if the machine is star-connected the E.M.F. between any of the main leads will be 400 volts, but between any main lead and the neutral wire the E.M.F. will be $400 \div \sqrt{3} = 230$ volts. There are three methods, then, by which a lighting distribution can be carried out in connection with a three-phase current motor-power installation: (1) by connecting up the lamps in series across a pair of mains; (2) by reducing the E.M.F. by means of static transformers connected across pairs of mains; (3) by adopting the fourth-wire system.

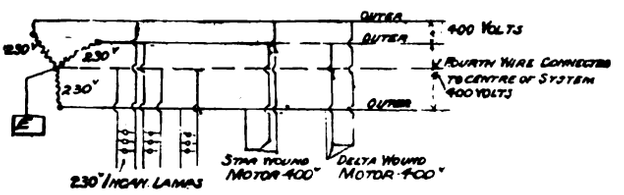
It must be borne in mind that the load on each pair of mains should be as nearly equal as possible, whatever be the system adopted. Thus, call the three main leads *a*, *b*, and *c*. If the lamps are connected in series, the same number should be connected across *a* and *b* as across *a* and *c* and *b* and *c*. Also, with static transformers the current taken from *a b* must equal that from *b c* and *a c* respectively.



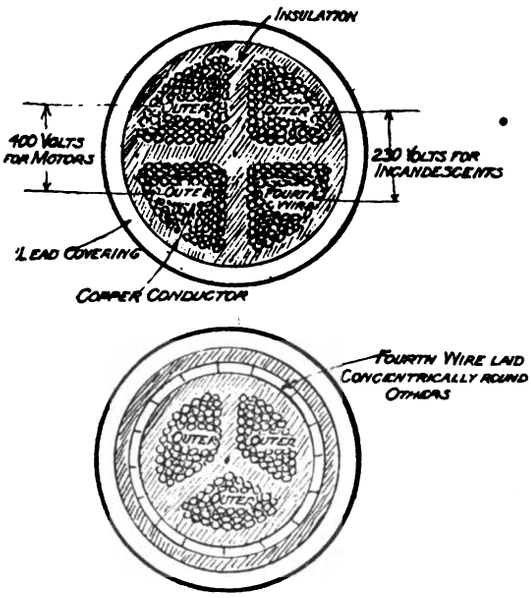
This is not an absolute necessity, but in order to obtain a good balance the loads should be kept as nearly equal as possible. When the fourth wire is used, the load between it and *a*, *b*, and *c* should also in each case be kept equal.

Each of the above methods of lighting distribution has been adopted in different contracts, and good results have been obtained from each. A typical case of the fourth-wire system is shown in the installation at the Bristol Carriage and Wagon Works. The figure is a diagrammatic sketch of a distribution board for a four-wire system. It will be noted that each lighting circuit is protected by a double-pole switch, the supply being taken from one of the main 'bus bars, and the 'bus bar connected to the neutral line, while each motor is protected by means of a triple-pole switch, the supply being taken from the three main 'bus bars. If this distribution board is fixed some distance away from the generating plant, the size of the neutral wire will depend upon the degree of balance between the three lighting circuits, as the only current which flows along this between the generating plant and the distribution board is that due to imperfect balance. The wire between these points may be considered as equivalent to the middle wire in the case of a three-wire direct-current distribution.—M.

Answer to No. 477 (*awarded* 5*s.*).—The fourth wire on a three-phase system is generally used when the mains distribute current to consumers for both lighting and power. It is used where the connections are on the star system of three-phase distribution, and acts in a similar way to the middle wire of a three-wire direct-current system—*i.e.*, as a balancing wire to provide for the return of any out-of-balance current which may be produced by the lighting load being unequally divided on the different sides of the system. It also enables us to make use of *two* voltages, as explained below, and a considerable economy is effected in the amount of drop for a given lighting load, or, in other words, less copper can be used for a given drop. The accompanying diagram shows connections and explains itself. The three outer conductors are connected up to the outer ends of the three legs of the star-wound



machine (or transformer) in the ordinary way for three-phase working, and the fourth wire is connected to the centre of the windings and also earthed at this point. The fourth conductor may be small in comparison with the other three, but is generally made the same sectional area, as it is just as well to have some spare copper and it makes a better cable. These cables are generally built up as per accompanying sketches.



Referring to the diagram of connections, suppose there are 400 volts between any two outers, then there will be $\frac{1}{\sqrt{3}} \times 400 = 230$ volts (approximate) between any outer and the middle wire. Motors either star or delta wound could be connected between the three outers, thus keeping the system always balanced as far as the power load is concerned. The incandescent lamps for lighting can be connected up at 230 volts between either of the three outers and the fourth wire, and these can be well balanced between the three sides of the system. The balancing is obviously about 30 per cent. easier than in the case of the ordinary three-wire direct-current system. Without the fourth wire the voltage between any two mains would be too high for incandescent lighting, or if the voltage *was* made suitable for incandescents, then the voltage between outers would be somewhat too low for efficiency in motor driving, to say nothing of the ease of balancing by means of the fourth wire and the economy of drop.—J. A. Morton.

Answer to No. 477 (*awarded* 5*s.*).—Three currents of equal average value, alternating according to three sine functions 120deg. different in phase, will have their algebraic sum at any moment equal to nothing; hence if in a three-phase system (1) equal E.M.F.'s are generated in three phases, (2) these are loaded equally, the phases can all be connected to a common point, the ends of the generator winding being also connected to another common point, and since these points are at the same potential, there will be no need for a return wire between them.

The use and object of the fourth wire, when used in connection with the distribution of three-phase currents, is to regulate the voltages on the three phases when this is rendered necessary (generally by the non-fulfilment of condition 2 above). Where a fourth wire is used, the star grouping must be adopted, and the wire is brought back to the common junction of the three circuits

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of the generator, and serves to equalise the pressures whenever the loads in the three branches are unequal. This inequality will evidently not exist where the system only supplies three-phase apparatus, such as motors, which will take an equal amount of current from each branch. The difficulty arises chiefly in cases where lamps have to be supplied, but experience has shown that the fourth wire is even then not always indispensable. A three-phase equaliser can be added at some convenient point in the distribution. This consists of a three-phase choking coil, the three windings of which are united star fashion, the fourth wire of the circuits being brought to their common junction. When a three-phase transformer has its three cores connected together, so that the magnetic circuits are combined, it will exert an equalising effect, and induction motors are also found to have a similar influence.—A. L. R.

Question No. 478.—With a condenser to be capable of dealing with 12,000lb. of steam per hour, with cooling water at 60deg. F. to 75deg. F., and to sustain a vacuum of 26in., what is the best method of arriving at the diameter, stroke, and bucket speed of both single-acting and double-acting vertical air-pumps, also speed of water through the foot and head valves for single-acting bucket pump (Fig. 1)? Also speed of water through suction and delivery valves for double-acting piston pump (Fig. 2)? Also capacity of jet condenser and cooling surface required for surface condenser?

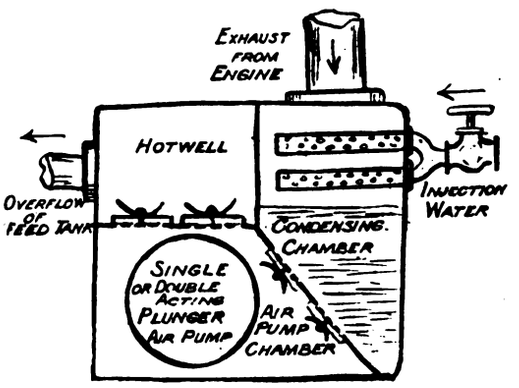

FIG. 1.

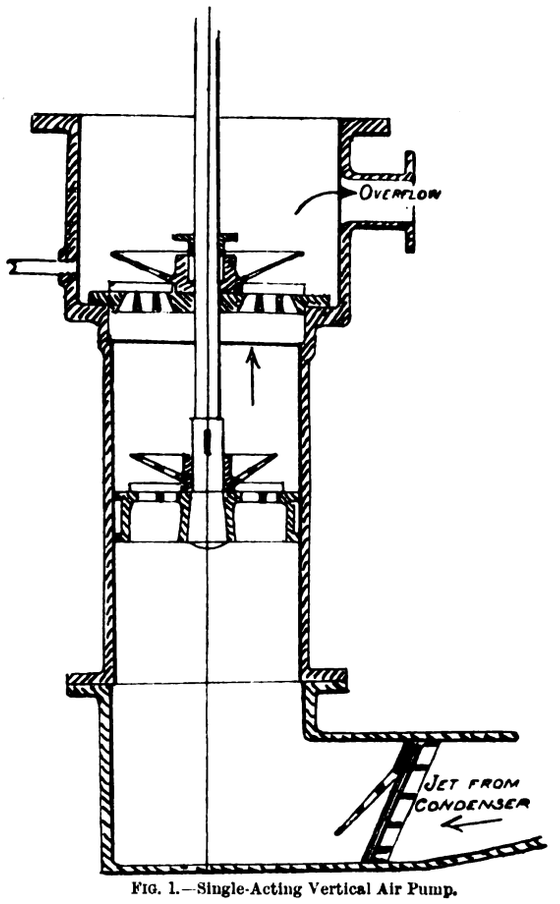

FIG. 1.—Single-Acting Vertical Air Pump.

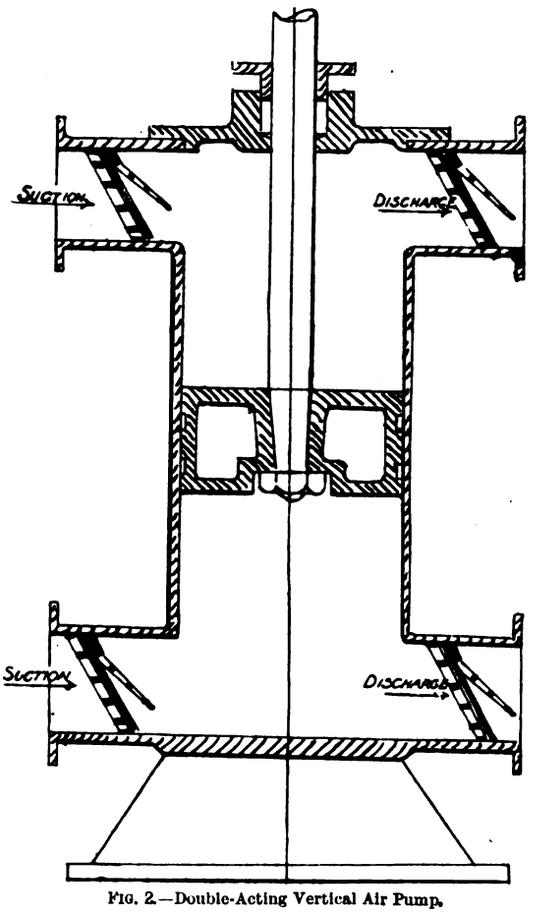

FIG. 2.—Double-Acting Vertical Air Pump.

Best Answer to No. 478 (*awarded* 10*s.*).—This question may be divided into two parts: (1) required the capacity of jet condenser, and particulars of single-acting and double-acting air-pump for same; (2) required the same for a surface condenser. Let us take the points in this order.

1. *Jet Condenser.*—This usually consists of a square box-like casting divided into three parts, as in Fig. 1: a condensing chamber, air-pump chamber, and hot-well. Owing to the fact that there is such a large clearance in the air-pump chamber—*i.e.*, space *not* swept through by the piston—due to the special design adopted, the vacuum obtained is not so good as that of a surface condenser. It is very difficult to get more than 24in. of vacuum, and certainly 26in. could not be obtained. Assuming this to be good enough, however, we can get out a rough design for one as follows: The cubical capacity of the condensing chamber should be from one-quarter to three-quarters that of the cylinder discharging into it according to the speed. For medium-speed engines one-half is about correct. The exact proportion varies very much according to the maker and the conditions of service. A rule which holds well in practice is to make the capacity of the condensing chamber about seven to eight cubic feet for each 1,000lb. of steam condensed per hour. According to this rule, it ought to be in this case = 8 × 12 = 96 cubic feet.

The Size of the Air-Pump.—This pump has to withdraw both the condensed steam and the injection water from the condenser. The condensing water required can be found as follows: The latent heat in 1lb. of steam at 24in. vacuum (= 3lb. absolute pressure) is about 1,016 B.T.U.'s per pound. The temperature of the hot-well should be about 110deg. F. say, hence the loss of sensible heat by the steam will be (140deg. – 110deg.) = 30 B.T.U.'s per pound, since 140 is the temperature corresponding to 24in. vacuum.

∴ The total heat given up per pound of steam = 1,016 + 30 = 1,046 B.T.U.'s.

The heat gained per pound of condensing water = 110 – 70, say = 40 B.T.U.'s.

∴ Number of pounds of condensing water per pound of steam $= \frac{1,046}{40} = 26.$

The air-pump in a jet condenser is nearly always worked from the engine; let us suppose that it makes 180 revolutions per minute. Now, the limit of speed at which it can

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be run depends on that at which the water will follow it. This is theoretically 15ft.-16ft. per second; allowing for friction we might get 12. To avoid shocks and whirls, however, it is well to take it much lower, say 8ft. per second. The exhaust steam is 12,000lb. per hour

$$= \frac{12,000}{180 \times 60} = 1{\cdot}11\text{lb. per revolution.}$$

Condensed steam and injection water per revolution
$= 1{\cdot}11 + (26 \times 1{\cdot}11)$
$= 30{\cdot}1\text{lb.}$

Now, the air-pump has not only to exhaust this, but has also to pump out any air which leaks in, in order to maintain the vacuum. Also, there is always a certain back-rush of water just as the valves are closing at the end of the suction stroke. For these reasons we make an allowance of about 50 per cent.—*i.e.*, when working, the air-pump will only be about half full of water.

Suppose, first, the pump is *single-acting*; then each revolution of the engine corresponds to one effective stroke of the pump, during which it has to pass 30lb. of water.

Now, 1lb. of water = 27·6 cubic inches.

$\therefore$ 30lb. of water = 27·6 × 30 = 828 cubic inches.

Doubling this as explained above = 1,656 cubic inches.

Now, each revolution takes $\frac{60}{180} = \frac{1}{3}$ second.

A stroke takes half this = $\frac{1}{6}$ second.

$\therefore$ at 8ft. per second stroke $= \frac{8}{6} = 1{\cdot}335\text{ft.} = 16\text{in., say.}$

$\therefore$ area of pump plunger $= \frac{1,656}{16} = 103{\cdot}5$ square inches,

and diameter of pump = 11½in. (approximate).

If the air-pump is double-acting, we need only make it half the size. We may, therefore, halve the stroke if we wish, so getting a speed of only 4ft. per second, which is really too good; or we may reduce the speed to 6ft. per second, which is a very good figure, indeed, making the stroke 12in. and the diameter 10in. The latter is probably the best thing to do.

2. *Surface Condensers.* — Here the condensing is done by passing the steam through a nest of tubes which have the cold condensing water circulating in them. The tubes are usually of gunmetal §in. or ¾in. outside diameter, and about $\frac{1}{20}$in. thick. The amount of tube-cooling surface required is about 1 1 to 1·4 square feet per indicated horse-power for engines about 500 h.p. A fairly good rule which agrees well with practice is to take one square foot for every 10lb. of steam condensed per hour. Thus in this case cooling surface $= \frac{12,000}{16} = 1,200$ square feet. Assuming tubes to be 6ft. long and §in. in diameter, each tube has

$$\frac{{\cdot}625 \times \pi}{12} \times 6 = {\cdot}98 \text{ square feet.}$$

$\therefore$ number of tubes required $= \frac{1,200}{{\cdot}98} = 1,225.$

Assuming pitch of tubes to be 1in. approximate, external diameter of condenser if round = 3¼ft. to 4ft. roughly.

The Air-Pumps are here separate, and owing to their clearance being so much less, no difficulty will be found in getting the 26in. vacuum required. In this case, however, the air-pump has not to remove the condensing water, hence it may be made much smaller. As, however, the air has still to be extracted as with the jet condenser, we assume that only 20 per cent. of the pump is filled with water. Thus, for a single-acting pump we have, assuming 180 revolutions:

Pounds of water per stroke = 1·11lb.
$= 1{\cdot}11 \times 27{\cdot}6 = 31$ cubic inches (approximate).

$\therefore$ volume swept through by pump bucket = 31 × 5 = 155 cubic inches.

Assuming stroke of 8in., area of barrel = 20 square inches, say.

Hence diameter = about 5in.

A double-acting air-pump is not generally used, but if it were, it need only be half the size as before. The velocity of water through the foot, bucket, and head valves should not be greater than 10ft. per second, and the area of the valves should be proportioned to allow of this being done. The weight of the valves should be as small as possible, for it is evident that the air-pump cannot reduce the pressure in the condenser below that necessary to lift the valves.—T. SQUARE.

Answer to No. 478 (*awarded* 7*s.* 6*d.*).—The formulæ used in designing air-pumps are more empirical than theoretical. The majority of them express the volume of the air-pump in terms of the volume of the low-pressure cylinder or cylinders of the plant in connection with which they are to work, and although many of these formulæ give good working results when applied to the air-pumps of marine and slow-speed Corliss engines, they require modification when used in the design of air-pumps for dealing with the exhaust of quick-revolution engines. Other formulæ, again, connect the volume of the air-pump with the indicated horse-power of the plant under consideration, but two different types of engines may deliver into the condenser steam varying widely in temperature and weight, although the indicated horse-power of both may be the same. The details of air-pump design require very careful attention after the volume and water velocities have been decided, otherwise very moderate results will be achieved.

Referring to the case of the vertical single-acting air-pump in Fig. 1 to be used in connection with a jet condenser, this air-pump is required to pump into the hot-well 12,000lb. of condensed steam per hour, together with the amount of water required to condense it, and the accompanying volume of air. Suppose that the steam is exhausted at a pressure of 6lb. absolute, the corresponding temperature being 170deg. F. = t_1, the initial temperature of the injection water is, taking the higher of the two figures given, 75deg. F. = t_2. A vacuum of 26in. has to be maintained in the condenser, corresponding to a temperature of, say, 124deg. F. = t_3. Now, the amount of heat absorbed by the injection water in condensing 1lb. of this steam

$$= t_1 + \text{latent heat} - t_3.$$

By Regnault $= 1,114{\cdot}4 + {\cdot}3\,t_1 - t_3.$

But heat absorbed may also be written

$$W\,(t_3 - t_2),$$

where W = weight in pounds of injection required for every pound of steam condensed.

$$\therefore W\,(t_3 - t_2) = 1,114{\cdot}4 + {\cdot}3\,t_1 - t_3.$$

$$\therefore W = \frac{1,114{\cdot}4 + {\cdot}3\,t_1 - t_3}{t_3 - t_2} \text{ lb.}$$

Substituting actual values,

$$W = \frac{1,114{\cdot}4\ ({\cdot}03 \times 170) - 124}{124 - 75} \text{ lb.}$$

$$= \frac{1,041{\cdot}4}{49} = \text{(approximate) } 21\text{lb.}$$

$\therefore$ Weight of water to be discharged by air-pump
$= (21 + 1)$ 12,000lb. per hour,
$= 4,400$lb. per minute,
$= \frac{4,400}{62{\cdot}4} = \text{(say) } 70$ cubic feet per minute.

Now, ordinary sea-water contains $\frac{1}{20}$ of its volume of air at atmospheric pressure, which on entering the condenser will be expanded to $\frac{1}{2}^5$ its original volume; and the volume of the mixture to be pumped out every minute after the air has been raised to the temperature of the condenser

$$= 70\left(\frac{19}{20} + \frac{15}{40} \times \frac{t_3 + 461}{t_2 + 461}\right) \text{ cubic feet}$$

$= 94{\cdot}5$ cubic feet.

If the air-pump were a perfect pump, this volume would have to be displaced every minute by the bucket, but the efficiency of a single-acting vertical pump of this type is only about ·5, so that the volume to be displaced by the bucket per minute = (94·5 × 2) = 189 cubic feet. Now, the mean velocity of the mixture of air and water through the bucket valves should be about 480ft. per minute, and as it will be difficult to obtain more than 30 per cent. of the bucket area for the passage of water, the diameter of the bucket will be

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$$\sqrt{\frac{189 \times 100 \times 144}{480 \times 30 \times 7854}} \text{ inches}$$

$$= 15\tfrac{1}{2} \text{in.}$$

The ratio $\frac{\text{diameter}}{\text{stroke}}$ is decided in the figure; in any case, it only remains to decide upon either the length of stroke or the number of strokes per minute, and the remaining term will be fixed by volume, to be displaced per minute.

With regard to the double-acting air-pump, if the efficiency given by it were the same as that obtained by the single-acting type, it would only be necessary to make the double-acting pump half of the capacity given above, but the efficiency of the double-acting air-pump seldom exceeds ¼, so that its capacity will be determined accordingly. In either pump, if D = diameter of pump and S = speed in feet per minute,

$$\text{Area through foot valve} = \frac{D^2 \times S}{1{,}000} \text{ square inches;}$$

$$\text{,, ,, head valve} = \frac{D^2 \times S}{800} \text{ square inches.}$$

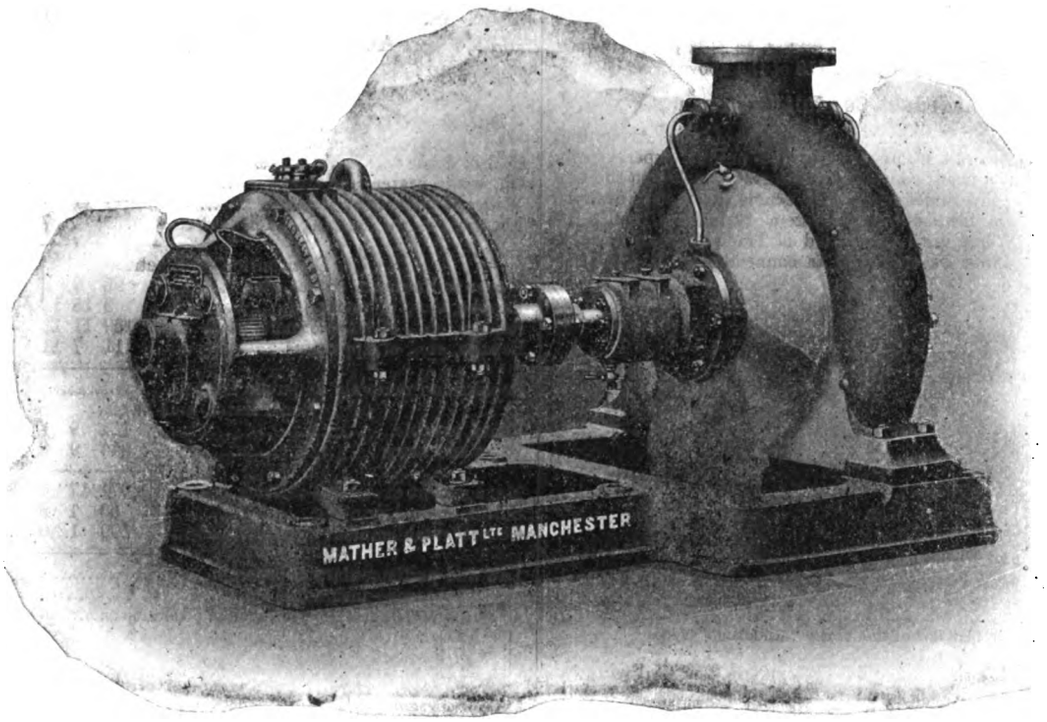
If the area through the foot valve be excessive, its action is liable to be sluggish, and the efficiency of the pump correspondingly decreased. The capacity of a jet condenser should be from ¼ to ⅓ the volume of the cylinder or cylinders exhausting into it, the latter figure being for use with quick-revolution engines.

With regard to the cooling surface required in surface condensers, with the terminal pressure assumed at the commencement—viz., 6lb. absolute—1·8 square feet per indicated horse-power will suffice with the cooling water at 75deg. F. It is generally regarded as a very satisfactory performance if one square foot of cooling surface will condense 13lb. of steam per hour. In conclusion, the design shown in Fig. 1 is hardly in accordance with the best modern practice.—C. L. B.

TRADE NOTICES AND NOVELTIES.

Electric High-Lift Pump.

Messrs. Mather and Platt, of Manchester, while standing in the front rank as pioneers in electrical engineering, have an equally good reputation in a considerable number of other branches of engineering manufacturing. Amongst the more recent of their productions is a high-lift pump driven by electric motors. Up to the present most of the mine pumps made for working against a considerable head have been of the slow-moving plunger type. Even then the shocks due to the reversal of the slow-moving plungers causes considerable wear and tear of the plant. Messrs. Mather and Platt have taken up the design of a multiple-chamber centrifugal pump, which is specially adapted for high lifts. The pumps are manufactured under the Mather-Reynolds patent. The feature of this pump is that it consists of one or more sets of vanes, or impellers, each set running in its own chamber, but upon a common shaft, the delivery pressure of the liquid varying directly as the number of chambers used. Thus, if an ordinary single pump can deliver water against a head of 30ft., the addition of another chamber will give a final delivery head of 60ft., while four chambers will enable the pump to discharge the same amount of water against a head of 120ft. With this multiple pump the firm have been able to deliver large quantities of water to a height of as much as 150ft., a result never attained before by a centrifugal pump. Recently they have introduced still greater improvements, and are now able to deliver water against as great a head as 200ft. with a single chamber, and at a high efficiency, some of the larger sizes giving out the equivalent of as much as 76 per cent. of the power put into them. In our illustration we give a view of one of these pumps, which have given great satisfaction in several installations. In one case in a Spanish silver mine they have been at work since July, 1888, delivering 1,000 gallons of water per minute against a head of practically 1,500ft. In this instance there are three sets of pumps in series, each capable of working against a head of 500ft. The pumps are placed up the shaft at 500ft. intervals. In this way the lowest pump draws directly out of the sump and discharges straight into the suction pipe of the pump 500ft. above, no lodgment for water being necessary; the middle pump in like manner, drawing direct from the first, delivers straight into the third or top pump, so that the column of water is entirely unbroken, and constantly flowing steadily onward. The result is manifest in the now continuous working of the pumping plant, the cessation of breakdowns, and practically the disappearance of the former vast bill for repairs and maintenance. Two or three times a year the pumps are stopped, the internal parts pulled out, examined, cleaned, and replaced, and the plant set to work again after the incredibly short stoppage of about four hours. The pumps are driven by direct-coupled motors, which are supplied with current from the surface, the old hydraulic engines having been altered so as to drive electric generators by belt from the flywheel. It is interesting to learn that the present electrical and pumping plant is run with 15 per cent. less coal than was used by the best of the former pumps; and not only that, but the coal now used includes what is required to generate steam for other purposes, such as for electric lighting and for keeping the spare steam dynamos warmed up ready for starting in case of a breakdown in the generating plant.



Mather and Platt High-Lift Centrifugal Electric Pump.

Field Rheostats.

The design of resistance coils has for years been an intricate problem with which electrical engineers have had a considerable amount of trouble. A good rheostat should be able to dissipate heat without danger to itself or to the surrounding apparatus. The British Thomson-Houston Company have standardised a type of field rheostat resistance which overcomes the many objections which exist in older forms. We refer to their packed card resistances, of which we give an illustration herewith. This form consists of a series of resistances built up in the following way: A tube of asbestos on a steel mandrel is wound with a definite amount of German-silver wire or ribbon, taken from the mandrel, and pressed into the card form shown. These cards are the unit resistances used in making the rheostats. They are assembled side by side with asbestos between successive cards, the number of cards depending upon the resistance required in the rheostat. To increase the radiating surface, iron plates somewhat wider than the cards are inserted at intervals between the resistances, and project beyond the

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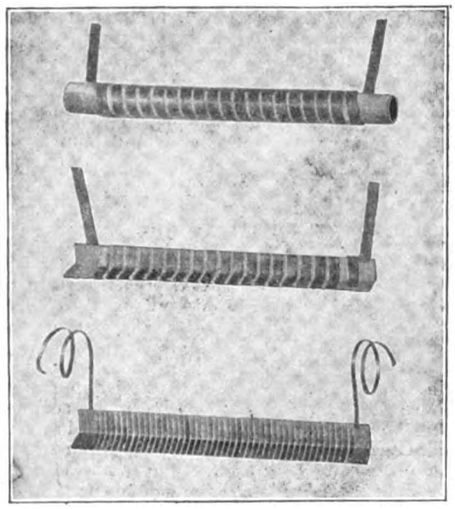
surface of the resistance section. The resistance cards and iron plates are then clamped by end plates and bolts. For heavier work, such as for the rheostats used in connection with railway motors, the British



Wound Tube and Pressed Cards for the British Thomson-Houston Rheostats.

Thomson-Houston Company still use spiral resistances supported between slabs of slate. Engineers interested in this class of work would do well to get the pamphlet No. 118 of the above firm.

The Armorduct Conduit System.

Mr. Fred Bathurst, the general manager of the Armorduct Improved Electric Conduit Company, has had unique experience in conduit work, and as a result considerable interest attaches to the new system which he is now introducing. Of course, he is still desirous of getting the single insulated wire system introduced, using the conduits as a return, but until the Board of Trade allow an earth in every house this cannot be employed in connection with a central-

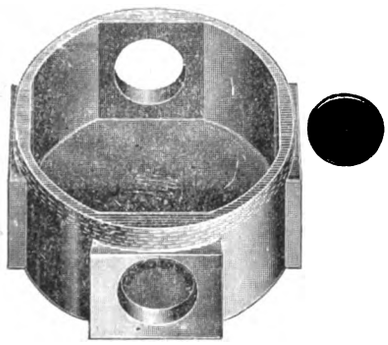


FIG. 1.—Circular Box of the Armor "Knockout" Type.

station supply. With the Armorduct system two insulated wires can be drawn into the same tube, and in certain cases the screw joint between the tubes and the boxes is dispensed with, as could not be done with the single insulated wire. The Armorduct itself is a high-grade mild-steel welded tube, with a specially smooth interior. The tubes are carefully coated both inside and out with a flexible moisture-proof enamel, which preserves the metal. We are also informed that the tubes can be easily bent cold without damaging it. As a rule the tubes will be supplied with a conduit thread, but they can be worked also with the ordinary gas thread if desired. So much for the tubing itself, and we now come to the boxes, which are of the "knock-out" type. This term

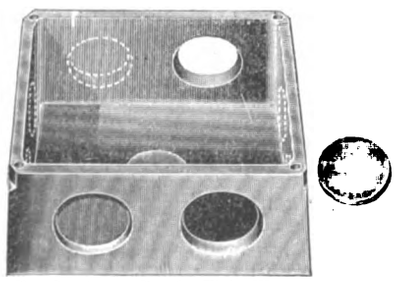


FIG. 2.—Square Box for Eight Ways.

has other significance than a high quality in this case. The boxes are supplied without any holes for the tubes, but there are in the sides of the box recesses cast in with a thin piece left as a seal, which can be knocked out with a smart blow from a hammer. Two of these boxes are shown in Figs. 1 and 2, in which this feature can be clearly seen. In connection with these boxes, which permits of these holes being knocked out as required on the job, the company have standardised a series of nuts (Fig. 3) which enable the tubes to be secured into the boxes without tapping the same. In especially damp places, however, the holes in the boxes can be screwed to give an absolutely water-tight joint, or an extra lock-nut can be added to the tube and a watertight joint secured by means of a packing between this and the square face on the box. In the illustration (Fig. 2) a

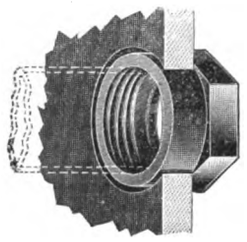


FIG. 3.—Conduit End applied to Side of Box.

square box is used in which no less than eight holes can be made if required. These square boxes will be found extremely useful where switching facilities are required for two or more separate circuits. The other details of the Armorduct system are also well designed, and the company should find a good demand for their wares.

HASTINGS ELECTRICITY ACCOUNTS.

From the accounts of the Hastings Corporation electricity works department it appears that the total expenditure on capital account to Dec. 31, 1901, amounted to £123,405. Abstracts of the revenue account, etc., are appended:

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.	£	s.	d.
Generation of Electricity.						
Coal or other fuel	4,529	13	7			
Oil, waste, water, and stores	393	6	2			
Wages at generating stations	917	11	9			
Repairs, etc., of buildings and plant	727	11	7			
				6,568	3	1
Distribution of Electricity.						
Wages to linesmen, fitters, etc.	25	0	2			
Repairs, etc., of mains	9	15	11			
Repairs, etc., of transformers, etc.	159	11	11			
Repairs, etc., of apparatus	11	7	11			
				205	15	11
Repairs and renewals of public lamps				670	1	7
Rent, Rates, and Taxes.						
Rents payable	151	9	0			
Rates and taxes	244	9	9			
				395	18	9
Management expenses—salaries, etc.	1,071	17	6			
Stationery and printing	68	1	9			
General establishment charges	190	1	6			
				1,330	0	9
Law and parliamentary expenses				34	9	8
Special charges—insurance, etc.				156	4	10
Gross profit, carried to net revenue account				5,601	2	3
				£14,961	16	10

Cr. Income.	£	s.	d.
Sale of current per meter	10,472	10	7
Sales under contract	120	17	1
Public lighting	3,696	11	10
	14,289	19	6
Rental of meters and other apparatus	545	2	4
Rents receivable	126	15	0
	£14,961	16	10

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	108,439	0	0
Amount due to borough treasurer	22,067	14	1
Sundry creditors	3,156	2	1
Consumers' deposits, including accrued interest	9	3	5
	£133,671	19	7

Cr. Assets.	£	s.	d.
Capital expenditure—amount expended on works	114,195	18	8
Loans fund for redemption of stock	9,209	15	4
Stores on hand	517	6	10
Sundry debtors for current, etc.	6,221	16	5
Insurance premiums—proportion unexpired	89	4	0
Balance at debit of net revenue account	3,437	18	4
	£133,671	19	7

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units		867,622
Quantity sold: Public lamps	195,192	703,814
Quantity sold: Private consumers by meter	508,622	
Total quantity accounted for		703,814
Quantity not accounted for		163,808
Number of public lamps		104
Total maximum supply demanded		584

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CANTERBURY ELECTRICITY ACCOUNTS.

From the accounts of the Canterbury electricity department for the year ended March 31, 1902, it appears that the total expenditure on capital account to that date amounted to £50,435. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended:

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£858	4	7			
Value of steam from dust destructor	100	0	0			
Oil, waste, water, and stores	33	14	10			
Wages at generating stations	367	13	1			
Repairs, etc., of buildings and plant	200	8	6			
				1,560	1	0
Distribution of Electricity.						
Wages to linesmen, etc.	18	1	0			
Repairs, etc., of mains	11	13	7			
Repairs, etc., of transformers, etc.	1	16	4			
				31	10	11
Public Lamps.						
Attending and repairs	89	9	10			
Renewal of lamps	62	17	3			
				152	7	1
Rents, Rates, and Taxes.						
Rents payable	6	10	0			
Rates and taxes	244	13	7			
				251	3	7
Management Expenses.						
Salaries—Engineers' department	367	19	5			
Accountant and clerical staff	74	2	0			
Stationery and printing	18	19	0			
General establishment charges	125	16	1			
				586	16	6
Insurances, etc.				34	1	0
Total expenditure				2,616	0	1
Amount carried to net revenue account				2,602	6	3
				£5,218	6	4

Cr.	£	s.	d.
Sale of current less discount	3,518	19	3
Public lighting	1,435	14	2
Rental of meters	113	3	5
Sale and repairs of lamps	89	13	2
Interest received on loan money on deposit	60	16	4
	£5,218	6	4

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	50,435	0	0
Less amount repaid	3,133	9	2
	47,301	10	10
Sundry creditors	513	9	7
Balance at credit of net revenue account	1,150	4	8
Loan repayment account	3,133	9	2
	£52,098	14	3

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	46,594	0	5
Stores on hand	88	13	5
Sundry debtors for current supplied	1,726	16	6
Cash with treasurer	3,684	18	9
Cash in hand	4	5	2
	£52,098	14	3

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units		399,930
Quantity sold { Public lamps	120,014	288,455
Quantity sold { Private consumers by meter	168,441	
Quantity used on works		44,396
Total quantity accounted for		332,851
Quantity not accounted for		34,636
Total maximum supply demanded (kilowatts)		270

Number of public lamps: 12 arc, 359 incandescent.

SOUTH SHIELDS ELECTRICITY WORKS.

The borough electrical engineer (Mr. J. H. Cawthra) in his first annual report to the Electric Lighting Committee points out that the first three months of the year under review were under the management of his predecessor. The capital expenditure has increased £10,312, bringing up the total amount spent to £138,801. Of this increase the sum of £6,450 has been laid out on new mains and some slight additions to the sub-stations, £536 on meters and other apparatus for consumers' premises, £2,811 being retention money held over on various contracts for new engines, alternators, boilers, pipework, etc. The kilowatt capacity of the plant installed at the depôt is the same as 12 months ago, and quite sufficient to meet all our requirements for some two or three years, probably more. The lamps connected have risen from 35,025 to 41,680, being an increase of 6,655, equivalent to 19 per cent.; whilst the consumers connected have increased from 680 to 778, this being an increase of 14 per cent. The maximum load on the station at any one time during the past winter was on Jan. 25, when the load was 767 kw., being an increase of 62 kw. over the previous year at the rate of 8 per cent., and the total maximum load is equal to the use of 25,566 8-c.p. lamps for the time being, this maximum load taking only some 48 per cent. of the normal capacity of the station. The number of units sold was 985,646, being an increase over the previous year of 229,820, equivalent to some 30 per cent. The public lighting has developed somewhat, the total number of arc lamps being practically the same, whilst the number of ordinary gas standards which have been converted to electric brings the total up to 283, being an increase of 175 since March, 1901. Coming to the revenue-earning side of the department, this appears at first sight somewhat disappointing, but on closely investigating the varied circumstances under which the department has worked during the two years forming the subject under review, the financial result is very satisfactory. The total costs chargeable against revenue amount to £5,914, being a decrease of £21 on the previous year, whilst, as before pointed out, the number of units sold equal an increase of 30 per cent. The total revenue amounts to £13,664, against £12,196 of the previous year, being an increase of £1,468, which leaves a gross profit of £7,750 against £6,261, which equals an increase of some 24 per cent., whilst the percentage of gross profit to the total capital expenditure is 5½ per cent., compared with 4·8 per cent. of the previous year. The amount required for interest and sinking fund is £7,155, against £4,793, an increase of 49 per cent. This is accounted for by reason of the readjustment of the sinking funds debited to the year ending March 31, 1901. After meeting all charges, including interest and sinking fund, there is a net profit of £594 against £1,468, being a decrease of £874, which drop will be readily understood in view of the foregoing explanation. From the amount of £594 shown as the net profit on the electric light undertaking must be deducted the sum of £163, being the loss on the working of the Holborn Quay during the past year. It must not be forgotten that during this past year the charge for electrical energy has been at the rate of 7d. and 2d. per unit during the two winter quarters, whereas during the previous year the charge was 7d. and 3d. for the last quarter of the financial year, this usually being the quarter from which the greatest amount of revenue is obtained, and therefore is in itself no small item; and, also, the fact must be taken into consideration that the quarter was made to extend over a period of some 16 weeks by not reading the meters until the financial year had actually expired, thereby reducing the first quarter of the succeeding year by some three weeks, accompanied by a corresponding decrease in the revenue. Mr. Cawthra calls attention to the exceedingly cheap rate at which current has been sold during the past 12 months. The average price obtained per unit for current supplied to private consumers works out at 3·9d. per unit against 4d. of the previous year, being a decrease of some 2·5 per cent.; whilst the price obtained for street-lighting is 1·3d. per unit against 1·8d. of the previous year, which is a decrease of some 28 per cent. The past year has been one comparatively free from breakdowns so far as the generating plant is concerned, not one single interruption in the supply having occurred. Regarding the mains department, he cannot report so favourably; from the commencement of the winter until the end of March there was considerable trouble on the distributors, the same constantly breaking down to earth. The King-street arc main also gave considerable trouble; this main was, however, found to be unfit for further use, and has been renewed. So far as possible, having regard to the limited time at his disposal, the whole of the plant has been maintained in a highly efficient manner, and will, he hopes, by the coming winter have been thoroughly and completely overhauled. Coming to the "cost of production," he calls attention to the greatly reduced cost of generation, etc., the actual cost of producing the energy sold being 1·29d. per unit, against 1·71d. of the previous 12 months, which is equal to a decrease in the working expenses of 24 per cent., this figure being absolutely the lowest cost of production now recorded by any electricity supply works, either municipalities or companies, who generate electricity for lighting purposes only—that is, works which do not enjoy the benefit of a tramway load. Two comparative tables follow, and, in conclusion, Mr. Cawthra states that the total costs per unit sold, including interest and redemption charges, amounted to 3·03d., against 3·23d. of the previous year.

Dr. ABSTRACT OF REVENUE ACCOUNT.	£	s.	d.
Generation charges	3,094	16	10
Maintenance	323	19	3
Distribution	367	8	1
Rents, rates, and taxes	193	12	2
Management	1,132	16	8
Law expenses	95	10	5
Insurances	82	8	3
Bad debts	12	13	6
Interest and redemption	7,155	15	2
Attendance and repairs of lamps	611	9	8
	13,070	10	0
Balance, being net revenue	594	14	1
	£13,665	4	1

Cr.	£	s.	d.
Sale of current—Street-lighting	2,448	8	4
Private lighting	10,880	7	0
Meter rents	336	8	9
	£13,665	4	1

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WIGAN ELECTRICITY WORKS.

In his first annual report to the Electric Lighting, Power, and Tramways Committee of the Wigan Corporation, the borough electrical and tramways engineer (Mr. H. Collings Bishop) says: "Generally, I think you may feel that you have had a very successful year. The first few years are always a trying time in electrical works, the difficulties met with being very great. There are always a number of prejudices to overcome, and many other points to prevent the progress being as rapid as desired. Taking everything into consideration, the progress made has been exceedingly satisfactory, and I am also glad to be able to say that all my estimates have come out very close with the result obtained. I have now more data to go upon, so that I hope the estimates I now make for the current year will be even closer than those made for the past. The whole of the works in my charge have been efficiently kept in repair out of revenue, and the plant has been running throughout without any stoppage of supply. The applications in hand for new connections are very much greater than at the corresponding time of last year, and there is every prospect of a very busy time before the staff. I am very much indebted to Mr. Dewse for the large amount of data I am able to include in this report; he has now got the books in excellent condition, and we shall from now on be able to give you every month a statement of all costs and revenue for the preceding month. With regard to the capital expenditure on the electrical plant, the estimates that I placed before you in 1899 have not been exceeded, and in some cases a large amount of work has been executed beyond that mentioned in my estimates. I feel that I should impress upon you the necessity of always keeping a sufficient amount of spare plant in hand to allow for increased demand, and I would draw your attention to the difficulties of Manchester through not doing so."

A number of tables are appended to the report, from which we take the following details: total passengers carried, 1,907,244; total revenue from fares, £8,771. 10s. 1d.; total car miles, 195,969·5; average price paid per passenger, 1·1d.; number of cars in service, 18; passengers carried per car, 105,958; revenue per car, £487. 6s. 1d.; average car miles per car, 1,887; total revenue per car mile, 10·74d.; total length of track in operation, five miles one chain; revenue obtained per mile of track, £1,764; total passengers carried per mile track, 381,448. The total number of lamps connected at the end of the year amounted to 33,889, while the brake horse-power of motors connected to mains was 622½, and the maximum load demanded 453 kw. In a table giving a comparative results of total costs between Wigan and 19 other stations (above and below), Wigan is thirteenth on the list with a total cost of 1·679d. per unit sold, the average price obtained being 2·57d. for private lighting and 2·00d. for traction.

Dr.	Revenue Account.	£	s.	d.
Coal, etc.		1,102	13	9
Oil, etc.		220	11	1
Wages		1,061	12	9
Repairs and maintenance of machinery		284	0	7
Repairs and maintenance of meters		38	7	11
Repairs and maintenance of mains		28	18	8
Repairs and maintenance of apparatus		3	18	6
Rents, rates, and taxes		379	8	8
Attendance and renewals of lamps		56	16	8
Salaries account		582	18	5
Printing and stationery		124	5	6
General establishment charges		173	6	0
Law charges		1	1	0
Insurance, etc., charges		57	0	3
Temporary plant		70	0	0
Repairing and inspecting motors		53	10	8
Discounts and allowances		94	18	8
Balance to profit and loss account		2,202	10	10
		£6,535	19	11

Cr.	£	s.	d.
Sale of electric current	5,713	11	1
Sale of electric apparatus	387	5	0
Hire of motors	220	12	11
Sale of old materials	214	10	11
	£6,535	19	11

Dr.	Balance-Sheet.	£	s.	d.
Loans outstanding		77,242	5	6
Owing bank, capital account		4,909	12	9
Owing bank, revenue account		11,122	13	10
Owing sundry persons, revenue account		1,126	4	7
Owing sundry persons, capital account		1,402	9	7
Estimated amount of discount for March quarter, 1901		37	10	0
Balance to credit of depositors' account		24	0	0
		95,864	15	10
Excess of assets		2,757	14	6
		£98,622	10	4

Cr.	£	s.	d.
Capital expenditure	86,312	2	4
Cash in hand	10	0	0
Stocks on hand	6,951	15	8
Debts due, electric current	2,061	3	4
Debts due, electric apparatus	987	3	6
Balance brought from profit and loss account	2,300	5	6
	£98,622	10	4

LEGAL INTELLIGENCE.

DUBLIN TRAMWAYS.

In the King's Bench Division of the Four Courts, Dublin, last week, Mr. Justice Johnson and Mr. Justice Kenny had before them the case of the Dublin United Tramways Company *v.* the British Thomson-Houston Company.

Mr. D. B. Sullivan, K.C., who, with Mr. Mahony, appeared for the defendants, said the action was brought to recover £10,500 for breach of agreement. Before an appearance was entered the defendants served a notice of motion to set aside the service of the writ as irregular. That notice of motion was duly served, and appeared in the list that morning. The previous night notice of discontinuance of the action was served by the plaintiffs, and counsel now wanted an order that their costs might be taxed.

The Court granted the order.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Shanghai.—The last day for receiving tenders for the proposed municipal tramway and motor 'bus service is June 30.

Beckenham.—The Electric Lighting Committee invite tenders for the supply of incandescent lamps. Tenders by June 6.

Dudley.—The Electric Lighting Committee invite tenders for the supply of incandescent lamps and oil. Tenders by June 6.

Poplar.—The Electricity Committee invite tenders for the supply of about 130 cast-iron arc lamp columns. Tenders by May 28.

Sophia (Bulgaria).—The General Post Office require tenders for £2,000 worth of telephone and telegraph material. Tenders by June 9.

Poplar.—The Electricity Committee invite tenders for the supply of special armoured cable, suitable for laying under water. Tenders by May 28.

Glamorgan.—Tenders are invited for wiring and fittings at Parc Gwyllt and Angelton Asylums, near Bridgend, Glamorgan. Tenders by May 31.

Calarashi-Stirbein (Roumania).—The Municipality invite tenders for the installation and working of electric lighting for 35 years. Tenders by June 13.

Fulham.—The Board of Guardians invite tenders for the supply, delivery, and erection on their premises of pipework. Tenders by June 5. See advertisement.

Greenock.—The Corporation invite tenders for the supply and erection of one 300-kw. steam dynamo, with steam and exhaust piping. Tenders by June 2. See advertisement.

Valparaiso.—The Municipality are inviting tenders for electric lighting and tramways. We understand that particulars may be obtained from the Chilian Consul. Tenders by Sept. 1.

Bury.—The Tramways Committee invite tenders for the supply and delivery of rails and fishplates, fishbolts and nuts, tiebars, points and crossings, and sole or anchor plates. Tenders by June 24.

Hull.—The Corporation invite tenders for the supply of 20,000 cast-iron holding-down plates (weight, about 42 tons). Full particulars may be obtained at the City Engineer's Office. Tenders by May 30.

Barking.—The Urban District Council invite tenders for motors, pipework, chequer plating, etc. Full particulars may be obtained from the Engineer, Electricity Works, East Barking. Tenders by June 6.

Brighton.—The Town Council invite tenders for the supply of 300 tons of steel girder tramrails. Specifications, etc., may be obtained from Mr. Thos. B. Holliday, tramways engineer, Lewes-road, Brighton. Tenders by June 9.

Lisbon.—The Portuguese Government Railway require 34,300 kilos of 1, 2, 3, and 4 mm. galvanised wire. Tenders by June 9 noon. Further particulars may be obtained from the Company's office, 28, Rue de Châteaudun, Paris.

Glasgow.—The Corporation invite tenders for one economiser, with induced-draught fan, and condensing plant. Particulars may be obtained from Mr. W. A. Chamen, the engineer, 75, Waterloo-street, Glasgow. Tenders by June 7.

Coventry.—The Electric Light Committee invite tenders for the supply and erection of steam and water pipes and accessories. Particulars may be obtained from the Electrical Engineer's Office, Electricity Works, Coventry. Tenders by May 26.

Burton-upon-Trent.—The Corporation invite tenders for the supply and erection of three 100-kw. high-speed tramway generators and switchboard, and three Lancashire boilers, steam-pipes, jet condensing plant, economiser, and accessories. Tenders by May 30.

West Ham.—The Corporation invite tenders for the construction of about eight miles of route length of tramways. Specifications, etc., may be obtained from the offices of Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster. Tenders by June 10.

Brighton.—The Town Council invite tenders for the supply of points, crossings, tiebars, bolts, and other fittings. Specifications, etc., may be obtained on application at the office of Mr. Thos. B.

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Holliday, tramways engineer, Lewes-road, Brighton. Tenders by June 9.

Launceston (Tasmania).—The Corporation invite tenders for polyphase generating, transmitting, and distributing plant and apparatus, transforming apparatus, reconstruction of existing plant, and enclosed arc lamps and accessories. Tenders by Sept. 15. See advertisement.

Manchester.—The Tramways Committee invite tenders for the supply of cast-iron bases, collars, and finials for tramway poles; and tramway rail bonds. Specification, etc., may be obtained from Mr. J. M. M'Elroy, general manager, Tramways Department, 55, Piccadilly, Manchester. Tenders by May 24.

Govan.—The Council invite tenders for fuse boxes for house services, meters (not electrolytic), demand indicators, manhole boxes and connections, and joint-boxes for armoured cables. Particulars may be obtained from Mr. J. Brown, resident electrical engineer, Electricity Works, Govan. Tenders by May 27.

Stretford.—The District Council invite tenders for the following in connection with its scheme for supply of electrical energy: Steam-raising plant, comprising boilers, superheaters, economisers, etc.; generators, comprising engines, dynamos, condensers, pumps, etc.; and mains. Tenders by June 18. See advertisement.

Astrachan.—Erection of electric generating station and installation of public and private lighting, commencing with 150 arc and 6,000 incandescent lamps. Manufacturers who will undertake to finish the work within two years can obtain particulars from the Municipality. Agents will not be able to tender. Tenders by June 7-20.

Bury.—The Tramways Committee invite tenders for the work required in the construction of the permanent way in several parts of the borough—viz.: Fairfield section, Bolton-road section, Heywood-street and Knowsley-street sections. Specifications, etc., can be obtained on application at the office of Mr. Arthur W. Bradley, borough engineer and surveyor. Tenders by June 24.

Worthing.—The Corporation invite tenders for the supply and erection of one 250-kw. steam dynamo (continuous-current dynamo direct-coupled to a vertical enclosed high-speed engine), and one dry-back marine type boiler, with fittings. The specifications, etc., can be inspected and all information obtained at the offices of Messrs. Burstall and Monkhouse, 14, Old Queen-street, Westminster, S.W. Tenders by May 26.

Belfast.—The Harbour Commissioners invite tenders and designs for the decoration and illumination by electricity or otherwise of the harbour office and the south end of the Glasgow shed, Donegall Quay, in connection with the celebration of the coronation of King Edward VII. A detailed specification of the work proposed to be carried out must accompany each tender. Any further information required may be obtained from the harbour engineer, Mr. G. F. L. Giles. Tender by June 2.

RESULTS OF TENDERS.

Mansfield.—The Electricity Committee have accepted the tender of Crompton and Co. for pipework, at £2,486.

Insulating Compound.—The National Telephone Company have accepted the tender of Rowland Carr and Co. for the supply of insulating compound for the six months ending Dec. 31, 1902.

Limerick.—The Allgemeine Elektricitäts-Gesellschaft, contractors for the electric lighting of Limerick, have accepted the tender of Messrs. Rowland Carr and Co. for the arc lamp columns required.

Brighton.—The Tramways Committee have accepted the tender of J. Longley and Co., Crawley, for extension of the car-sheds, boundary walls, and certain other buildings at the tramway depôt, Lewes-road, at £4,849.

Willesden.—The District Council have accepted the tender of the British Insulated Wire Company for the supply and erection of arc lamp columns of the design and manufacture of R. Carr and Co., London, E.C.

Lowestoft.—The Town Council have accepted the tender of J. Abbott and Co. for extra pipework in connection with the condenser, at £249. 10s., and that of Geipel and Lange for two feeder switch-boards for the harbour crossing, at £110.

Swindon.—The Corporation have accepted the tender of W. T. Glover and Co., Trafford Park, Manchester, for the supply, delivery, and laying in the borough of Swindon (Wilts) of feeder and distributing cables, conduits, and accessories, at £5,411.

East Sussex.—The County Council have accepted the tender of J. E. Spagnoletti and Co., of London, amounting to £11,773. 11s. 2d., for electric light and power plant, and £1,940 for the tramways, in connection with the provision of electric light and power plant, and for electric energy for the tramway.

Edinburgh.—The Electric Lighting Committee have accepted the tender of Crompton and Co. for the supply of carbons for continuous-current arc lamps for the year from May 15, at the following prices: 18mm. by 12mm. 12in. long, £4. 11s. 2d. per 1,000 pairs; 22mm. by 15mm 12in. long, £6. 13s. 7d. per 1,000 pairs.

Rotherham.—The Electric Light and Tramways Committee have accepted the following tenders in respect of Contracts 9, 10, and 11 for tramways: (Contract No. 9) rolling stock, Dick, Kerr, and Co., London, £8,711; (10) overhead construction, Macartney, McElroy, and Co., London, £7,102; (11) permanent way, Macartney, McElroy, and Co., £55,419.

Southampton.—The Tramways Committee have received the following tenders for the laying of the proposed tramways in St. Denys-road: Douglas and Richards, £4,666 (accepted); F. Grace, £4,733; G. Wimpey and Co., London, £4,841; W. Griffith and Co., London, £4,905. 16s. 7d.; F. Osman, £5,160. 7s. 1d.; Coston and Co., £5,208; Saunders and Saunders, Birmingham, £7,178. 4s. Borough engineer's protecting tender, £5,000.

Southend.—The Town Council have accepted the following tenders: Norman Engineering Company, East Dulwich, for electric wiring; H. Morris and Bastert, Loughborough, crane, £135; R. Blackwell and Co., London, car-lifting appliance, £35; Rawlinson and Sons, Blackburn, tower wagon, £60; British Thomson-Houston Company, five feeder motors £8. 18s. each; D. King and Sons, Glasgow, 50 arc lamp columns at £8. 10s. each; Crompton and Co., testing machines, £92. 10s.

Wolverhampton.—The Corporation have accepted the following tenders for the supply and delivery of the machine tools, etc., necessary for the complete equipment of the repair shops at their tramcar depot: Dempster, Moore, and Co., Robertson-street, Glasgow, one 12½in. centre sliding, surfacing, and screw-cutting lathe with continuous box gap, complete with 12in. chuck boring tools, motor, gearing, fixed and delivered complete, £228; one hydraulic wheel press, complete with 6in. pressure gauge, £69. 10s.; one radial drilling machine, complete with drills, drill chuck, and motor complete, £140; one set plate-bending rolls, £34.

Alternators.—The British Schuckert Electric Company, Limited, have recently received several contracts for alternating-current work—including two 600-kw. two-phase generators for the Corporation of Coventry; one three-phase generator and two three-phase motors for the Oakbank Oil Company; two three-phase generators and three three-phase motors for the Lancashire and Yorkshire Railway Company. Messrs. Browett, Lindley, and Co., Limited, have received the order from the Bournemouth and Poole Electricity Company for two 1,000-kw. steam alternators, complete with condensers and accessories. The engines are to be of the three-crank triple-expansion type, running at a speed of 250 revolutions per minute, and the alternators are to be made by Messrs. Ferranti Limited, of Hollinwood.

London.—The London School Board have received the following tenders for electric lighting at Northwold-road New School:

Vaughan and Brown	£489	0	0
Comyn Ching and Co.	412	10	0
Drake and Gorham	392	0	0
D. Watson and Co.	372	15	0
Lund Bros. and Co.	368	0	0
Rashleigh Phipps and Co.	368	0	0
Marshall and Woods	322	0	0
Wells and Co.	314	0	0
J. C. Christie*	310	0	0

* Recommended for acceptance.

Glasgow.—The Parish Council have received the following tenders for the electric wiring at the new general hospital, Stobhill:

C. Hamilton, Limited, 247, St. Vincent-street, Glasgow (accepted)	£4,197
Middleton and Townsend, 21, Rutland-square, Edinburgh	4,511
J. M'Kenzie and Co., 64, South Woodside-road, Glasgow	4,685
McCulloch, Potter, and Co., 127, West Regent-street, Glasgow	4,948
J. Findley and Co., 12, Renfrew-street, Glasgow	5,356
Cook and Gilchrist, 4, Norfolk-street, Newcastle	5,419
Casselle and Co., 168A, St. Vincent-street, Glasgow	5,580
Anderson and Munro, 136, Bothwell-street, Glasgow	5,989
Reid and Co., 57, Hope-street, Glasgow	5,670
Lowden Bros., 332, Argyle-street, Glasgow	6,138
McAuley, Clark, and McLellan, 34, Ann-street, Glasgow	6,273
Osborne and Hunter, 93, Waterloo-street, Glasgow	6,850
McAlpine's Electrical Company, 60, Bath-street, Glasgow	6,691
Malcolm and Allan, 29, Lilybank-road, Glasgow	6,750

Paisley.—The Corporation have received the following tenders in connection with the Paisley and District Tramways Company's proposals: For converting the 600-kw. alternator in terms of Mr. Parkinson's scheme—Bruce Peebles, £2,100; with delivery in seven months; Siemens Bros. and Co., £2,350, with delivery in seven months; Crompton and Co., £2,455, with delivery not given; British Schuckert Co., £1,984, with delivery in four months (accepted); British Thomson-Houston Co., £2,670, with delivery in six months. Messrs. Siemens, Crompton, and British Thomson-Houston Co. did not include the flywheel. The following tenders for supply of alternating plant, were also received: Hick-Hargreaves, engine £1,750; alternator £1,830, speed 200; Belliss and Morcom, engine £2,070, alternator £1,600, speed 250; Davey, Paxman, and Co., engine £1,450, alternator £1,612. 5s., speed 300 (accepted); Willans and Robinson, engine £2,137, alternator £1,570, speed 300; Ferranti, engine £1,760, alternator £1,600, speed 250; Siemens, alternator, £1,035; British Schuckert Co., alternator, £935. For alterations and additions to the Adamson engine—Adamson and Co., £268, with £40 additional for packing (accepted). For supply of motor-generator—British Schuckert Company, £1,210, with switchboard £130 (accepted). For alterations and extensions of the condensing plant—Korting Bros., £1,642 (accepted).

Wireless Telegraphy Monopoly. — The German Government propose to invite all the maritime powers, but in the first instance Great Britain, France, and the U.S.A., to a congress in order to come to an agreement which would prevent any monopoly in wireless telegraphy. This is stated to be a direct outcome of the action of the Marconi station at the Nantucket lightship during the recent visit of Prince Henry of Prussia. When it became known that certain messages originated from the "Deutschland," which is fitted with the Arco-Slaby instruments, the Marconi station refused to accept or transmit the message. Various letters have recently been published in a number of papers in Germany and France, as well as in England and the U.S.A., in which Prof. Slaby and Marconi make several contradictory statements, amongst which we note that Marconi says that the synchronising of his instrument prevents the reception of messages from instruments of other makes, while Slaby says that his instruments may be synchronised for Marconi's instruments.

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BUSINESS NOTES.

TRACTION.

Cleethorpes.—The authorised speed of the tramcars is to be reduced from 12 to 10 miles an hour.

Glasgow.—It is expected that the municipal tramway receipts will show a surplus this year of £100,000.

Rotherham.—The Town Council have accepted tenders in connection with the tramway scheme amounting to £72,000.

Fylde.—The Rural District Council have passed a resolution in favour of the proposed Preston and Lytham light railway.

Lancaster.—It is hoped to have the electric cars running in July, rapid progress having been made with the construction of the new lines.

Rawtenstall.—The Town Council have approved the heads of agreement with the company who are promoting the Rossendale Valley Tramways Bill.

Portsmouth.—The Corporation have retained Mr. Rotter as their consulting engineer for the tramways, and a new general manager is to be appointed.

Plymouth.—It was stated at the last meeting of the Borough Council that the Beaumont section of the tramways was not likely to be a financial success.

Clacton.—The Light Railway Commissioners have granted the application of the Clacton-on-Sea and St. Osyth Light Railway Company for an order.

Wilpshire.—The tramway extension to Wilpshire having been inspected by Major Druitt, of the Board of Trade, was last week opened for passenger traffic.

Prestwich.—The Urban District Council and the Manchester Corporation have come to terms with regard to the working of the tramway system in the district.

Nottingham.—The Mapperley section of the Corporation electric tramway system was opened last week. This is the fifth route which has been inaugurated up to the present.

Ramsgate.—The local Bench have inflicted a fine of £5 on the Isle of Thanet Electric Tramway Company for running their cars at an excessive speed—*i.e.*, 16 miles an hour.

Byker.—An electric watering-car has arrived at the car-sheds here, and is being fitted up. The travelling tank is of a capacity sufficient to carry several thousand gallons of water.

Swindon.—Application is to be made by the Town Council for an extension of time for 12 months in which to complete the tramways authorised by the Corporation order of 1901.

Maidstone.—The Rural District Council have decided that they cannot consent to the construction of a light railway between Maidstone and Barming as proposed by the Corporation.

Stalybridge.—At a meeting of the Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board last week plans were approved of the track construction in connection with the proposed tramways.

Barrowford.—A Sub-Light Railway Committee of the Urban District Council have been appointed, with power to make all necessary arrangements for the carrying into effect of the Council's light railway order.

Mansfield.—The Town Council are in communication with the promoters of the light railways as to when they are likely to commence their work. The Corporation have gone in for an expensive plant to supply the cars with electricity.

Rochdale.—The Bury-road section of the new electric tramways, which are in course of construction by the Rochdale Corporation, was opened for traffic yesterday, the Board of Trade inspection having taken place the previous Thursday.

Aberdeen.—A plumber was working at the electric tramway depôt last Saturday last when he accidentally caught hold of a live electric wire. The shock rendered him unconscious, and he only survived an hour after being taken to the hospital.

Institution of Electrical Engineers.—At the annual general meeting of the members of the above Institution last night, the house list for the session 1902-3, which will be found in our issue of 25th ult., was adopted without amendment.

Bradford.—Mr. James Hill, chairman of the Tramways Committee of the Corporation, and Mr. C. J. Spencer, manager of the city tramways, have returned to Bradford from their American trip, which was undertaken in order to see present-day tramway practice in America.

Hastings.—Last week the Town Council rescinded their resolution noted in these columns by which they declined to consent to the promotion of a Bill by a company for powers to construct tramways in Hastings. The whole matter is thus opened up for further discussion.

Common Council.—Replying to a question at the last meeting of this body, the Remembrancer stated that protective clauses to safeguard the interests of property owners along the line of route were being inserted in all the Bills before Parliament for the construction of tube railways.

Dundee.—The Fairmuir electric tramway is now so far completed that a service of cars is being run from Albert-square to the burgh boundary. The double line of rails is laid all the way except a short piece between Arklay-street and Main-street, but it is intended to use the one line at that place.

Rochester.—The City Council have decided to make application to the Light Railway Commissioners next November for an order authorising the construction of a system of light railways within the city boundaries. The Chatham Corporation have agreed to confer with Rochester as to the advisability of establishing a joint scheme.

Thornaby.—At the last meeting of the Town Council attention was called to the necessity for an improved guard to the tramcars, and it was explained that the tramways company had promised to adopt any improved system of guard which might be suggested and found practicable, but as yet none had been suggested to them.

Gloucester.—The Rural District Council have passed a resolution approving the scheme for a light railway between the Gloucester city boundary and Brockworth, and expressing the hope that the County and City Councils will agree to some practicable scheme. The Corporation intend to formally apply to the Light Railway Commissioners for an order this month.

Leicester.—The Corporation Bill came as an unopposed measure before Lord Morley's Committee one day last week. The object of the Bill is to construct tramways and make other improvements, the estimated cost of the whole being £424,356. Formal proof having been given, the Bill was allowed to pass the committee stage, and was ordered to be reported for third reading.

Scarborough.—On Thursday further Standing Order proofs relating to the Scarborough Tramways Bill were submitted to Mr. Jenne, one of the examiners of private Bills of the House of Commons. The proofs being satisfactory, the examiner ordered the measure to be reported to the House of Lords for second reading. The Bill has already passed all the stages of the House of Commons.

Yarmouth.—By the end of the present week everything will be ready at the power station for the supply of current to the tramways. The track has now only to be laid along the North Quay to the Vauxhall railway station. If the points and crossings are delivered as expected, the work will be completed within a month. Ten cars have arrived and the remainder are to be delivered within a week.

Fleetwood.—A new accumulator house has been established by the Blackpool and Fleetwood Tramroad Company between Bispham and Fleetwood. In this building are 250 cells, with a capacity three times greater than those at the Bispham generating station. The batteries are controlled by a Highfield booster. The electrical equipment has been installed by the Chloride Storage Battery Company.

Pontypridd.—A Bill to confirm certain provisional orders came before the Examiner of Bills in the House of Lords for proof of compliance with Standing Orders last week, when an order authorising the Pontypridd Urban District Council to construct additional tramways in their district was ordered to be reported for second reading, proof of compliance with the Standing Orders of the House having been given

Halifax.—A proposal is before the Town Council to proceed forthwith with the construction of the tramway extension from King Cross by way of the Pye Nest-road to Sowerby Bridge. The important question of dealing with parcels traffic by the Halifax tramways system is about to come to the front. A special committee have just been appointed to go into the question with a view to inaugurating a service.

South Shields.—At a special meeting of the Town Council at the end of last week the tramway question was fully discussed. Eventually a motion was agreed to in favour of promoting a Bill in the next session for powers to provide "an adequate scheme of tramways for the borough." A committee was afterwards appointed to settle routes, gauge, system of traction, and other preliminary details, and to report thereon.

Proposed Monorail in Scotland.—It is announced that Mr. Behr is preparing plans for a railway on the monorail principle between Glasgow and Edinburgh, and a start has been made with the survey preparatory to the promotion of a Bill in Parliament next session. The promoters of the scheme are negotiating with the North British Railway Company with a view to the measure being supported by that company.

Pontefract.—A Bill to confirm certain provisional orders which came before the Examiner of Bills in the House of Lords last week contained an order authorising the West Riding Tramways and Electricity Supply Company to construct tramways in the borough and rural district of Pontefract and the urban district of Knottingley. Standing Orders being complied with, the Bill was sent for second reading in the House of Lords.

Manchester-Liverpool Express Railway.—The *Liverpool Courier* announces the Board of Trade have given their sanction to the Manchester and Liverpool Electric Express Railway Company to proceed with the construction of the line, and it is expected that a start will be made next month at three points—Warrington and the opening country just outside the suburbs of Liverpool at one end, and outside the suburbs of Manchester at the other.

Berlin High-Speed Trials.—A note in one of the daily papers says that the high-speed experiments on the Berlin-Zossen Electric Railway are to be resumed shortly. It may be remembered that the special car was expected to reach speeds of 130 miles an hour, and even more. As a matter of fact the highest speed attained was 100 miles, and this only for a short time. The permanent way is now being improved, and heavier rails are being laid on suitable sleepers placed close to one another.

Clydebank.—A sub-committee of the Glasgow Corporation's Tramways Committee have met a representative committee of the Clydebank Town Council in conference on the question of the extension of the city electric lines to that burgh. The Glasgow extension lines are already well forward towards the boundaries of Clydebank. The Town Council of Clydebank already hold a provisional order of their own for tramway construction, and the main questions of the situation refer to the terms on which that order should be handed over to Glasgow.

Hammersmith.—After several interviews with the agents representing the London County Council concerning the proposed tramway

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in Queen-street, it has been agreed with the Borough Council that the County Council will widen, at their own expense, the carriageway of Queen-street between Bridge-road and the northern boundary wall of the parish churchyard to 60ft. The County Council will also be prepared to continue the widening by taking a strip off the eastern side of the churchyard, provided it can obtain the necessary consents, and conditionally upon the Borough Council assisting in obtaining the consents and contributing one-third the cost thereof.

Madrid.—Extensions are shortly to be made of certain street car lines, and other lines are contemplating a change from mule power to electricity. The Tramway Company of Seville have obtained authority to apply electric traction on a new piece of the "Parque" line from the Avenue of Maria Luisa by the riding ground of Las Delicias to the Venta de Eritana. An application has been made by Don José Batlle y Hernandez for a concession for a system of electric tramways from Sevilla—one to San Juan de Aznalfarache, another from Castilleja to la Cuesta y Sines, and another from Camas to Santiponce.

Electrical Mail Vans.—At 8.20 on Tuesday morning the new electrical mail van started its daily run from Mount-pleasant with a special delivery of mails to Waterloo. This is the first occasion that an English-built electrical motorvan has been used for this purpose, and the postal authorities are now giving this new system an extended trial in the City and West-end services. After considerable tests the authorities have selected one of the Carl Oppermann's electric delivery vans made in Clerkenwell for this service, the motive power being furnished by a set of the "A. B. C." accumulators (Oppermann patent). The contractors for the van were Messrs. Julius Harvey and Co., of Queen Victoria-street.

Edinburgh.—The dispute between the town and the tramway company has at last been finally adjusted. The points in the agreement are first that all litigation against the company be dropped. This will permit of the cars running on Sunday. Secondly, the company agree to pay the arrears of rent and interest to Martinmas last in full. Thirdly, the half-year's rent to Whitsunday should be fixed at £35,000. The fourth clause dealing with the sliding scale of rent contains a number of sub-clauses, the chief being that payment of any interest in unpaid rent may be spread over a period, but the balance is to bear interest at 3 per cent. All claims by the company against the Corporation are withdrawn.

Walsall.—The Tramways Committee report that the South Staffordshire Tramways (Lessee) Company have fixed a number of ½d. stages for scholars and children, and have reduced the tram fares from The Bridge to Wednesbury and to Darlaston from 3d. to 2d. The Board of Trade have approved of the anchor joint being substituted for the Dicker joint in the tramways proposed to be laid by the Corporation. The question of purchasing 28 new cars has been deferred until the spring of next year, with a view to advantage being taken of the latest improvements. Instructions have been given to the town clerk to apply to the Board of Trade to inspect the tramway transformer station in Hospital-street and the cables in connection therewith as soon as the works are completed.

Railway Automobiles.—The United States Consul at Rouen, in a recent report, states that railway automobiles are beginning to be considerably used in Europe: (1) as early and late postal trains; (2) on branch lines and others where passengers are few; (3) on trunk lines where it is often difficult to secure convenient secondary trains; (4) in industrial centres and city suburbs. Furthermore, the automobile railway train can be attached for a certain distance to an express and detached at the station where the road branches. There is an economy in the *personnel* of the train, and in the expense of traction, in material, capital, and maintenance, and an additional traffic because of the increased number of stations made possible by the facility of stopping and starting. Up to the present time the carriages constructed are steam and electric.

Barton Bridge.—At the last monthly meeting of the Davyhulme Parochial Committee, plans were submitted of a proposal for the construction of a system of tramways which will connect Barton Bridge with Glossop. It is intended to promote the scheme in the next session of Parliament. After leaving Barton, where it is proposed to connect with the Trafford Park tramways, the line will proceed to Davyhulme and Urmston, and crossing the River Mersey by a bridge will enter Sale. The tramways will also cover the following places: Northenden, Cheadle and Gatley, Bramhall, Poynton, Hazel Grove, Marple, Ludworth, Chisworth, Charlesworth, Broadbottom, Mottram, and Glossop. The Davyhulme Parochial Committee offered no objection to the proposed tramways, but the plans are to be submitted to the Parish Council for acceptance.

Hampstead.—Protests continue to be raised in this district against the proposed extension beneath the heath to Golder's Green of the Hampstead Heath, Euston, and Charing Cross Tube Railway, which has been passed by the House of Lords Committee. The objections to the tube passing under the heath may be stated as follows: (1) No underground railway should be allowed to go under London's open spaces for fear of spoiling the vegetation by draining off the soil, and for fear of disfiguring their beauties by the erection of stations, ventilating shafts, etc. In this case the promoters have promised that there should be no station on the heath. (2) The readiness of people to subscribe for open spaces will be less than it is if the open spaces are to run the risk of being spoilt as soon as secured. (3) The object of tube railways should be to tap centres of population.

Wolverhampton.—The deadlock between the Corporation and the British Electric Traction Company with reference to tramway communication with Bilston and Willenhall continues. The whole difficulty arises over a short piece of track, about a quarter of a mile in length, which still remains unconstructed. The Corporation will not do the work, and the British Electric Traction Company contend that they cannot undertake it until a mutual arrangement is arrived at. While this edifying controversy is going on the townships mentioned above are totally deprived of any through communication with Wolverhampton, which they ought to have had months ago. It is time that the Corporation awoke to the fact that prompt action is necessary, and if they will not make the few hundred yards of tramway in question themselves, they should at least allow the company to undertake the work.

Leeds.—Amongst the provisional orders included in a confirmatory Bill considered by the examiner in the House of Lords on Friday was one authorising the Corporation to construct additional tramways. The examiner, finding that the Standing Orders of the House had been complied with, sent the Bill for second reading. The latest extension of the city tramways is a circular route between the existing termini at Chapeltown and Roundhay by way of Moortown. This line has been in course of construction for the last two months, and the work has been pushed forward as rapidly as possible with a view to running cars on at least a section of it by the Whitsuntide holidays. The western portion between Chapeltown and Street-lane was completed about a fortnight ago, and the overhead equipment has been supplied for this section in the meantime. Part of the route was open for traffic on Whit Monday.

Motorcars in Burma.—The French Consul at Rangoon has forwarded to his Government some interesting information on the subject of the importation of motorcars into Burma. He says that the great obstacle in the way of importing the cars into that country is to be found in the impossibility of securing essence of petrol of the density of 680deg., which is usually required for such motors. The only essence which could be manufactured on the spot from oil found in Burma attained at best a density of 760deg. to 770deg., no lower degree being obtainable from this raw material. Ordinary petrol, steam, alcohol, or electric motors are, therefore, the only ones that can satisfactorily be employed in Burma. The consul especially recommends the import of voiturettes, and reminds the manufacturers that the duty is 5 per cent. *ad. valorem*, and that no special license is required for driving an automobile in Burma.

Tramway Track Work.—We have received from Messrs. Askham Bros. and Wilson, Limited, Yorkshire Steel and Engineering Works, Sheffield, a very fully illustrated pamphlet describing tramway junctions, cross-overs, lay-outs, depôt sidings, etc., constructed by the firm for a large number of municipal authorities, etc., in various parts of the country. We are informed that five acres of floor space have been specially equipped at the Sheffield works for the construction of this class of track work. Besides views of the works, premises, and the various construction shops, some good examples are shown of intricate sections of tramway cross-overs and junctions which have been constructed by the firm, including those at Farnworth, Sheffield, Leeds, Grimsby, West Hartlepool, Nottingham, Huddersfield, Halifax, etc. An interesting sketch map shows the extent of the firm's operations in connection with the tramway and light railway work of the kingdom.

Cardiff.—The whole of the tramway track in Cardiff has now been reconstructed, and the overhead equipment is making rapid progress towards completion. Horse-car traffic has been resumed on the Bute-road route to the docks, and it is probable that electric traction will be commenced on this route in a fortnight or three weeks. The Board of Trade inspector was to have visited Cardiff this week, but a letter received has intimated that he could not come. He will, however, be in the South Wales district at an early date, and will then make the final inspection of the Cardiff system. The Sunday cars will probably commence running a week hence. Whit Monday proved an unusually profitable day for the new electric cars. No less than 103,000 passengers were conveyed from one part of the town to another—the total receipts amounting to £429 odd. This sum is nearly three times the ordinary day's takings, and almost twice as much as was taken last Whitsuntide, when horse traction was in vogue.

Cheltenham.—At the end of last week the Light Railway Commissioners (the Earl of Jersey, Colonel Boughey, and Mr. H. A. Steward) held a local enquiry into the application of the Cheltenham and District Light Railway Company for powers to extend their light railway to Charlton Kings and to Leckhampton. The case for the promoters was that the extensions were necessary to connect the districts mentioned, which were really suburbs of the town, with the centre and business parts of Cheltenham and with the Midland station at Lansdown. As to the outlying districts themselves, a number of witnesses both from Charlton Kings and Leckhampton gave evidence in favour of the extensions, and largely signed memorials from both parishes to a like effect were also put in. After hearing counsel on both sides, Lord Jersey announced that the Commissioners had decided to recommend the Board of Trade to issue the order as asked for, subject to the elimination of the portion of the High-street route between Cambray and Bath-road.

Birkenhead.—In moving the Tramways Committee's minutes at the last meeting of the Town Council Dr. Pearson said that they had not yet been able to get the actual figures made up with regard to the first year's working of the electric trams, but the net profit would be something over £5,000 after paying all charges, interest and sinking fund, and depreciation. Of course, it was not yet possible to absolutely estimate the depreciation of a tramway electrical undertaking, so that it was proposed to pay the £5,000 into a reserve fund, which would certainly more than cover everything. He pointed out that only one line—New Ferry—had had a full year's working; Conway-street, Higher Tranmere, and Claughton-road had been running seven months; Prenton and Shrewsbury-road five months; and Docks Station three months. On last year's basis they might look for a very big increase on that £5,000 next year. The Tramways Committee recommend the borrowing of £3,700 for the erection of tramway offices at the Laird-street depôt.

London County Council Tramways.—Last week Mr. H. Hobhouse's Committee of the House of Commons further considered

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the London County Council's Tramways and Improvements Bill, the portion immediately dealt with being that authorising the widening of Hampstead-road at its Tottenham Court-road end, so as to give a width between the walls of the houses of 80ft. A proviso in the Bill stated, however, that the widening should not be commenced until the St. Pancras Borough Council had sanctioned the introduction of a Bill for the continuation of the line of tramways, at present terminating in the Hampstead-road, along Tottenham Co rt-road to Oxford-street. The Chairman announced that the committee were agreed that the proviso must go out. It would tend to prejudice the question of the tramway next year, and the County Council would have full discretion to carry out the widening or not as they chose. The preamble having been found proved, the clauses were adjusted, and the Bill, as amended, was ordered to be reported to the House.

Wigan.—Major Druitt on Friday inspected the extensions of the Corporation electric tramways to Boar's Head, New Springs, Martland Mill Bridge, and Frog-lane, and, after travelling over the various lines, sanctioned the opening of the new services. The first annual report of Mr. H. Collings Bishop, the borough electrical engineer, just issued, gives interesting details of the working of the Corporation tramway system during the past year. The total revenue from this source has amounted to £8,771. 10s. 1d., which works out at 10·61d. per car mile. The expenditure has been 9·83d. per car mile, including sinking fund and interest 3·24d., wages 3·18·l., traffic expenses, comprising current, management, etc., 3·41d., leaving a profit of ·78d. per car mile, representing a sum of £638. 15s. 9d. This has been handed over to the borough fund account. The total number of passengers carried in the year has been 1,907,244, equal to the whole population 31 times over; total revenue from fares, £8,771. 10s. 1d.; total car miles, 195,969·5; average price paid per passenger, 1·1d.; number of cars in service, 18; passengers carried per car, 105,958; revenue per car, £487. 6s. 1d.; average car miles per car, 1,887; total revenue per car mile, 10·74d.; total length of track in operation, five miles one chain; revenue obtained per mile of track, £1.754; total passengers carried per mile track, 381,448. The total capital expenditure amounted to £69,349. 10s. 10d., and the capital expenditure per mile of track open to £13,869. 4s.

Proposed Tramway Combination.—A circular has been issued to the shareholders of the North Metropolitan Tramways Company from which it would appear that the British Electric Traction Company, having come to an agreement with the County Councils of Middlesex and Hertfordshire, is prepared to absorb the first-named undertaking. The Middlesex County Council have already agreed to hand over the greater part of their district on a 30 years' lease to a private undertaking, that in the case of the Hertfordshire County Council being of 12 years longer duration. The lines which have been authorised, or for which applications for authorisation are pending, include the greater portion of North and North-East Middlesex, with some parts of Hertfordshire; and the promoters have recognised that the new system would be incomplete without such a "feeder" as would be supplied by the lines of the North Metropolitan Company, hence the offer which has been made to the shareholders in this company to exchange their holdings. The proposition is one which directly affects the London County Council, who already own the bulk of the North Metropolitan lines, and in eight years' time the lease which the company now holds will expire. If in 1910 the Council are in the same mind as at present that lease will not be renewed, and the traffic will be worked direct. But in the meantime the Council have deposited its plans for the electrification of all the lines, and this will have to be carried out in any case. All that the proposed new arrangement would secure would be the lines in Hornsey, Tottenham, and Edmonton, which are purchasable in 1905, the unexpired lease of eight years, and the plant and rolling-stock of the old company.

Swansea.—On Friday last the Earl of Jersey, Colonel Boughey, and Mr. H. A. Steward, Light Railway Commissioners, held an enquiry into the application of the Glamorgan County Council for power to construct light railways from the Swansea borough boundary at Morriston to Pontardawe. Mr. Littler, for the promoters, said the application was to construct two railways, but they were continuous, and only divided for the purpose of convenience. He recalled the fact that in 1899 the British Electric Traction Company applied for similar powers, but were opposed by the Swansea Corporation and the Glamorgan County Council, and did not succeed. The railway would run from Morriston along the highway, where a very considerable number of steel, tinplate, and chemical works and collieries were situated. Recently Swansea had been extending in the direction of Pontardawe, beyond which there was Ystalyfera. It was not at present proposed to carry the line beyond Pontardawe, because the County Council did not consider it would be wise to do so as yet. The line would be 5¾ miles in length, and the estimate of its cost was £38,010, with £6,110 for overhead equipment and £3,860 for feeders. The number of cars required for a quarter-hour service on weekdays and a half-hour service on Sundays was eight. Taking these at £600 each, and £2,000 for stabling, gave a total capital expenditure in round figures of £55,000. The South Wales Electrical Power Company were prepared to enter into a lease and pay a rent which would at least cover the interest and sinking fund, and there would be an arrangement by which the County Council would share in the profits, and although terms had not been completely arranged as yet, he could assure the Commissioners that the line would not cost the county anything. The Earl of Jersey, at the conclusion of the evidence, said the Commissioners had decided to recommend the Board of Trade to grant the necessary order. The objection of the Swansea Corporation to the repeal of part of their order of 1901 will be settled through the Board of Trade.

Blackpool.—The borough treasurer's report of the past year's working of the municipal tramways shows a deficiency of actual profit below estimate of £4,562. The income amounted to £41,817, as against expenditure amounting to £28,259, leaving a gross profit of £13,558. Against this gross profit there were charges amounting to £10,079, leaving a disposable profit of £3,479. The estimated profit was £8,041, so that on this estimate the actual result is somewhat disappointing. From the £4,562 below estimate, however, must be deducted £1,723, the excess expenditure over loan on conversion of Promenade route from conduit to overhead system, as this item was not taken into account in the estimates, so that had this amount not been charged against the year's revenue, the disposable profit would have been £5,202, as against an estimate of £8,041, or a difference of £2,831. The total capital outlay is £214,099. 10s., towards the redemption of which there is accumulated the sum of £16,725. The total of the reserve fund is £2,778, of which £2,500 is invested on mortgage of realty, and the balance is in the hands of the Corporation's bankers. Under Section 57 of Blackpool Improvement Act, 1901, the Corporation may provide out of revenue a reserve fund, if they think fit, by setting aside out of revenue such sum as they may from time to time think reasonable. Such fund may be accumulated until it amounts to one-fifth of the aggregate capital expenditure on the undertaking. The reserve fund already accumulated amounts to about 1¾ per cent. on the capital outlay to March 31, 1901, but the amount carried to the fund has not, says the report, been based upon any well-defined principle; rather has it been determined by the contingency of available surplus profits. The treasurer suggests that the committee consider this question of depreciation with a view of arriving at a rate of percentage of amortisation of the capital assets commensurate with the life of the different classes of capital expenditure. Out of this sum should be provided the sinking fund for redemption of the loan debt, the balance being carried to "reserve." The advantages of forming a substantial and scientific reserve fund, he says in conclusion, are too obvious for comment.

LIGHTING AND GENERAL.

Oban.—The sites for arc lamp-posts have been selected.

Stalybridge.—Active steps are being taken to procure sites for transformer stations.

Chatham.—The question of appointing an electrical engineer has been referred back to committee.

Redruth.—The agreement between the electric lighting company and the Council has been sealed.

Londonderry.—Specifications are being prepared preparatory to an application for sanction to a loan of £35,000 for electric lighting.

Edinburgh.—The Town Council have agreed to the electric lighting of Causewayside from Grange-road to Mayfield Free Church at a cost of £104.

Burton.—A number of extensions of electric light mains will be made, which, according to reports, promise to be very profitable to the department.

Guildford.—The proposal of the Town Council to purchase the works of the Guildford Electricity Supply Company, Limited, has been abandoned.

Callender's Cable and Construction Co.—The directors have resolved to pay a further interim dividend of 10s. per share on shares 1 to 30,000 in respect of 1901.

Lytham.—The *Blackpool Times* says if Lytham must have the electric light, they may do far worse than obtain it "in bulk" from St. Annes; or arrange a joint scheme.

Beckenham.—Mr. Cairns has resigned his seat on the Electric Lighting Committee, and the vacancy has been filled by Mr. Blake. Mr. London has been elected chairman and Mr. Mann deputy chairman.

Bangor.—The electrical engineer (Mr. Price White) in his last report states that 25,823 units of electricity had been sold during the March quarter, an increase of 7,026 units as compared with the corresponding quarter last year.

Stock Exchange.—Application has been made to the Stock Exchange Committee to appoint a special settling day in Marconi's Wireless Telegraph Company's further issue of 7,264 shares of £1 each, fully paid, Nos. 149,820 to 157,083.

London Gazette.—A first and final dividend of 2s. 1¼d. per £ has been declared in the estate of R. Foster and W. Baker (trading as R. Foster and Co. and the Nelson Electrical Engineering Company), Scott-street, Nelson; payable at official receiver's office, 14, Chapel-street, Preston, from May 27.

Margate.—Questions were asked at the last meeting of the Town Council respecting the introduction of electric lighting for the streets. It was stated that at present there was no possibility of electric light being utilised, as the Corporation could not come to terms with the Isle of Thanet Electric Light Company.

Groenock.—For the five weeks ended May 3 36,594 units of electricity have been generated for lighting, and 29,640 units sold, and 67,437 units have been supplied for traction. In consequence of a report by Mr. W. M. Nelson, engineer, regarding the necessity of providing additional generating machinery to meet the probable demand during next winter, the Council have agreed that the engineer be instructed to prepare a specification for a 300-kw. generating set, and advertise for offers.

Sale of Plant.—The Electric Lighting Committee of the Leyton Urban District Council, having adopted steam plant of much larger units, are prepared to sell a number of gas-engines, Dowson gas generators, and accessories, the whole forming a complete plant capable of supplying electricity to a small district, and certain engines, dynamos, and gas generators taken together will make suitable sets of plant for factories. The plant is sold as in good working order, and may be inspected on application at the works. Offers for the whole or parts will be considered, and must be sent in by June 25 next.

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Surbiton.—The Council have obtained the formal sanction to the borrowing of the £50,000 required for the electric lighting, and have sealed the agreement with Messrs. Callender.

Stonehaven.—The Town Council are corresponding with Messrs. Barlow and Young, who propose to apply to the Local Government Board for an electric lighting order for Stonehaven.

Bridgwater.—The Town Council have consented to the application of the Bridgwater and District Electric Supply and Traction Company, subject to clauses being agreed to, for a provisional order for electric supply for lighting and power purposes.

Kensington.—The Borough Council are purchasing from the Brompton and Kensington Electricity Supply Company the seven electric arc lamps and columns erected by them on the south side of Kensington High-street at £24. 10s. per column.

Competition.—As a sequence to the promise made by Signor Pini two years ago at the Como Volta Festival, the Agricultural Society of Lombardy offers now a prize of 1,500 lire (£60) for the best essay on the influence of electricity upon vegetation, and especially agricultural produce.

Nuneaton.—The Urban District Council are taking steps to raise the sum of £5,000 (by two instalments of £3,000 and £2,000) required in connection with the electric undertaking. It is proposed to commence with laying of cables in Manor Court-road and the lighting of that portion of the town.

Radcliffe.—Messrs. W. Allen, Hardman, Lund, Slingsby, and Yates have been appointed by the District Council a Works Sub-Committee to consider matters relative to the position, construction, and the general arrangement of the buildings and machinery required for the electricity undertaking.

Burnley.—The Rural District Council are canvassing the ratepayers within the area to be included in the suggested application to the Board of Trade for a provisional electric lighting order with a view to ascertain the number of persons likely to use electric light in the event of the Council being able to supply the same.

Islington.—Extension of mains are to be made as follows (subject to the London County Council's sanction to loan): Sunnyside-road section, £1,723; Warltersville-road section, £2,016; Hornsey-lane section, £2,730; sub-station and fittings, £661; Highbury-terrace, £252; Liverpool-road, £190; City-road, £330.

Electric Launches.—An international exhibition of motor launches will be held at Wannsee, Berlin, next month. Particulars may be obtained from the Secretary-General, Berlin Universitätstrasse.—The King is having a new summer house built at Virginia Water and also a slip for the electric launch he is about to place upon the lake.

Canals.—A proposal is on foot to introduce steel barges to be worked by electricity on the Birmingham and Worcester Canal. This will also probable involve the widening and deepening of the Severn and the Birmingham and Worcester Canal, so as to form a continuous water route for vessels of 300 tons burden from the Midland metropolis to the sea.

St. Paul's Cathedral.—The electric installation is now complete. The choir pendants were first used at Easter; the dome and the nave were also lighted for the first time with electricity on Whit Monday. Under the dome handsome new pendants, suspended from brackes fixed near the arcs of the quarter-domes, have been put up during the last few days.

Nernst Lamps.—We have received from the Electrical Company, Limited, Charing Cross, a new price list for Nernst lamps, type A 1,902. It contains only a few small alterations, but we notice that the company point out that to ensure good working the voltage of burner and resistance combined should not be lower than the highest pressure ever received in the mains.

Bolton.—The following reduced scale of charges has been adopted for current for motive power from April 1, 1902: first 500 units per quarter, 2½d. per unit, less 10 per cent. if paid within 21 days; second 500 units, 1½d. per unit, less 10 per cent. if paid within 21 days; all units above this, 1d. per unit net. The price for tramway current has been reduced from 1·5d. to 1·4d. per unit.

Leeds.—We note from the accounts of the Corporation's electric lighting department for the year ending March 25 last, an abstract of which appears in another column, that in comparison with the previous year the revenue has been affected to the extent of about £8,000 by a reduction of prices and the abolition of meter rents. The accounts, however, after providing for interest and sinking fund charges, show a surplus of £3,170. 0s. 2d.

Wireless Telegraphy.—It is stated that Prof. Fessenden's and Mr. Marconi's wireless systems will be installed in Alaska. The first system guarantees 30 words per minute, and supplies two sets of instruments for 13,000dol. Under the latter a guarantee of 12 words over a longer distance is given—viz., 165 miles—and two sets of instruments will be supplied for 22,010dol., with a royalty of 500dol. after the first year and one-half of all commercial earnings.

Cardiff.—Mr. A. Ellis in his last report states that during the last month the voltage generated showed an increase of 32 per cent. on the same month last year, the output 31 per cent. and the revenue 30 per cent. The public and private supply had been well maintained. Permission was given to extend the mains along Tudor-road to the car depôt at Clare-street. The estimated cost was £224, and the engineer thought that there would be a profit on the present basis.

Cults.—Mr. Balfour, of the firm of Messrs. Lowdon Bros. and Co., electrical engineers, Dundee, who has purchased the property of the Cults Electricity Supply Company, has made a thorough inspection of the engines and boilers at Cults, and proposes to put in extra mains at once in order to supply customers who are without the boundary of the present mains. We learn that operations will be commenced immediately the sanction of the court has been obtained to the bargain, this being necessary on account of the sellers being in liquidation.

Hamilton.—At the last meeting of the Town Council the Electric Lighting Committee reported that the price offered by Messrs. Edmundson, London, the contractors for the lighting of the town, for the generating station at Almada Hill, inclusive of buildings, was £32,302. In view of the fact that Messrs. Edmundson had agreed to have the works completed and the light turned on by the end of the year, the committee's recommendation that the agreement be now completed was adopted.

Hammersmith.—Since the last Council meeting 11 additional consumers have been connected, representing a maximum of 307 8-c.p. lamps, and during the same period two consumers have been disconnected, the present number of consumers now taking current from the mains being 1,008. The Council have agreed to the London and North-Western Railway's scheme for the extension of the electric supply mains to the north of the borough, including the laying of a main along Hythe-road.

Personal.—Much interest was centered in a very pretty wedding which took place at St. James's Church, Exeter, on the 15th inst., the building being crowded with spectators. The marriage was between Mr. Harold Rippon, electrical engineer and contractor, of Exeter, and Miss Miriam Adelaide Stevenson, eldest daughter of Mr. C. H. Stevenson, of the same city. Amongst the many serviceable and handsome wedding presents we note a silver cigarette case to the bridegroom from his employés.

Maidstone.—The Urban District Council's Electric Light Committee state in their last report that the following lamps have been applied for and connected: number of consumers who have applied, 128; number of consumers connected, 101; total current applied for in 8-c.p. lamps equivalent 14,727, made up as follows: private lights, 8,217; motors. 5,730; public 780—total 14,727; total lamps connected to date 7,576, made up as follows: private, 4,326; motors, 2,530; public, 720—total, 7,576.

Whitehaven.—The following new scale of charges for current supplied for purposes of power is proposed: to consumers using 75 per cent. of their maximum demand for an average of 40 hours per week throughout the quarter, 2d. per unit; to consumers using 75 per cent. of their maximum demand for an average of between 40 and 100 hours per week throughout the quarter, 1½d. per unit; to consumers using 75 per cent. of their maximum demand for an average of over 100 hours per week throughout the quarter, 1d. per unit.

Walsall.—According to the last report of the Electric Lighting Committee, the total number of consumers supplied on April 30 last was 225. During the past month the total units generated at the station was 36,823. The total output from the main generators was 35,383 units. The total units from the transformers was 27,188 (estimated). The machinery was run for 473 hours. The wages paid amount to £90. The tenders for the supply of a battery and booster for the Hospital-street sub-station have been referred to the electrical engineer for report.

Middlesbrough.—The Electrical Lighting Committee last week recommended a reduction in the price for current as follows: for anything up to 250 hours' use of the maximum supply demanded, 2d.; for anything over 250 and under 500 hours' use of the maximum supply, 1¾d.; for anything over 500 and under 750 hours' use of the maximum supply, 1½d.; for anything over 750 and under 1,000 hours' use of the maximum supply, 1¼d.; and for anything over 1,000 hours' use of the maximum supply demanded, 1d. After discussion the matter was referred back.

Aberdeen.—A report is being prepared showing the cost of lighting in all the streets at present lit by gas, and what the estimated cost of the electric light for the same area would be. Four Bremer arc lamps have by way of experiment been erected in Albyn-place under the direction of the city electrical engineer, Mr. J. A. Bell, and so far as they have been tried have given satisfaction. The lamps have been placed at a distance of 80 yards apart, while those in George-street are only 40 yards apart, and those in Union-street, which were the first of their kind to be erected in the city, are 75 yards apart.

American Railroads and Telegraphs.—A Reuter dispatch states that the Pennsylvania Railroad Company has notified the Western Union Telegraph Company that the existing agreement, under which the telegraph company's lines are operated over the Pennsylvania Railroad Company's system, will terminate at the close of six months. The decision is a result of the failure to secure certain concessions from the Western Union Telegraph Company. The railway company's decision, however, will not prevent a renewal of the agreement with the telegraph company should the directors decide that it is advisable.

Australian Telegraph Rates.—The Eastern Extension, Australasia, and China Telegraph Company notifies that a tentative arrangement has been come to with the Federal Government of Australia by which the reduced tariffs now in force in the four contracting States—namely, 3s. per word for ordinary telegrams, 2s. per word for Government telegrams, 1s. per word for Press telegrams—will be applied to the States of Victoria and Queensland pending the negotiations which the Prime Minister (Mr. Barton) proposes to conduct with the company's directors in London for a uniform agreement for the whole Commonwealth. The reduced rates will come into force on 1st prox.

International Cables.—The Association of Chambers of Commerce having urged on the Post Office the establishment of additional and improved cables between the United Kingdom and the Continent, a reply has been received stating that besides the additional cable laid last year to the Netherlands, a new cable to Germany has been laid. These are constructed to yield the best attainable results in practical working. A direct wire has also been opened between Liverpool and

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Paris. With regard to telephonic communication, a new cable to Belgium has been laid this month, and the negotiations for an extension of the Anglo-French telephone service to the principal towns in both countries have recently been brought to a successful conclusion.

Earl's Court.—Paris in London is already a very attractive show, although the principal electrical wonders, such as the moving spiral way, for instance, are only in the stage of construction as yet. Some of the features of last year have been transformed by means of new paint and new names, and the Chinese dragon has become Le Dragon rouge, and carries its passengers on its accumulator cars as merrily as ever. The trip to Canton has become the River Styx—sticks used to be the word as far as the punts were concerned, and the more they stuck the greater was the fun. The inclined electric stairway is still in use, the moving diorama, the theatrephone, etc. The main show is, of course, the Palais des Costumes—of great artistic value and beauty.

Broadstairs and St. Peter's.—At the last meeting of the Urban District Council a communication was received from the Board of Trade with reference to the Broadstairs electric lighting order, formally transmitting, for the observations of the Council, a description of the system the undertakers proposed to carry out for the supply of energy. It was stated that the Board, with the concurrence of the Postmaster-General, had provisionally approved the proposal of the undertakers to make a connection with earth, on the condition that such connection must be made at one point only—viz., at the generating station. It was notified that this might be at any time revoked by the Board of Trade. The work of laying the cables has been commenced in Albion-street.

Lowestoft.—All places of worship are to be supplied with current at a fixed rate of 6d. per Board of Trade unit. A cable is to be laid from the Grand Hotel to the new Congregational Church at a cost of £45. The resident electrical engineer in his last report states that there are now 11,495 8-cp. lamps connected to the mains, representing 243 consumers, thus giving a total of 310 extra 8-c.p. lamps for the month, representing eight consumers. Applications for about 1,100 lights are in hand. The switchboard house on the south side of the river has been completed to his satisfaction. The town clerk has been directed to look into the policy for the insurance of the workmen under the Workmen's Compensation Act, and in case the outside workmen are not covered thereby, to effect a further insurance for them.

Sudbury.—An enquiry has been held by Mr. H. H. Law into an application by the Corporation for sanction to a loan of £12,000 for electric lighting. The following is the estimate of the capital outlay proposed: purchase of site for electricity works (proportion of cost), £100; proportion of buildings for electricity works, including foundations for generating plant, brickwork for boiler, etc., £850; generating plant, including boiler, steam dynamos, exhaust feed-water heater, pipework, feed pump, battery of accumulators, main switchboard, station lighting, £5,900; underground mains for public and private lighting, including 91 new lamp-posts and lamp brackets, with fittings and connections complete (but not including incandescent lamps), £3,350; house service connections, meters, and cut-outs, £1,000; legal and expert services and contingencies, £800.

Bermondsey.—At the last meeting of the Borough Council the Finance Committee reported that the loans already raised for the electricity and dust-destructor works and flag-making plant, including purchase of land, amount to £33,899. 8s. The Council on Feb. 18 last sanctioned further loans amounting to £31,700, but in order to cover the liabilities already incurred, and to be incurred, it is necessary that an additional loan of £10,300 be raised. They recommended that the loan be applied for, which was agreed to. The Council have accepted the electric lighting order as granted by the Board of Trade. The Board have struck out St. Olave district from the order, and inserted a clause relative to Rotherhithe, providing for the sale of the undertakings of the London Electric Supply Corporation comprised in the parish of Rotherhithe to the Council, should the company desire to sell. The Council in those circumstances would have to pay the company the fair market value of the Rotherhithe part of the company's undertaking as a going concern, the value to be determined, in default of agreement, by arbitration.

The Mordey-Fricker Meter.—This meter, which is being manufactured for the Mordey-Fricker Electricity Meter Company, of 82, Victoria-street, by the British Insulated Wire Company, was on view at the Royal Society conversazione last week. The meter is of the clock type arranged on novel lines, in that the clock only goes when the current is on, and its rate depends on the amount of current which passes. In this way the counter on the clock train serves as a record of the electricity. The hairspring of the clock is replaced by a magnetic control, which consists of a disc of slate in which a number of small needles of iron are embedded. Two coils, through which the current to be measured is passed, embrace this oscillating disc. The proportions of the apparatus are so arranged that the iron is worked on the rising part of the characteristic curve, which is essential to give accurate results. The meter has to be wound by hand. The claim made for this new type of meter is that it is accurate, it is independent of the kind of current supplied, working equally well with direct and alternating currents of any frequency, and last, but not least, that it can be supplied at reasonable rates. We understand that the new company will be introducing a prepayment type of meter in the course of a month or two.

Birmingham.—The Electric Supply Committee of the City Council on Friday issued their report giving the financial results of the working of the department during the year ended March 31 last. The units sold during the year, as compared with the previous year, were as follows: 1902—3,391,099 units, £61,384. 4s. 4d.; 1901—3,040,822 units, £55,810. 4s. 2d., being an increase of 11·5 per cent. in units sold, and 9·9 per cent. in money value. The revenue account shows a gross profit of £18,514. 2s. 9d., and as the charges for interest and sinking fund amount to £23,327. 2s. 3d., the net result is a deficiency of £4,812. 19s. 6d. This is due to the charge of £8,731. 11s. 6d. for the conversion of a portion of the system from 110 to 220 volts with which the revenue account had been debited. This sum, being of the nature of special expenditure, largely increasing the efficiency of the system, might not unreasonably have been charged against the renewal fund, in which case there would have been a gross profit of £27,245. 14s. 3d., and a net profit (after providing for interest and sinking fund) of £3,918. 12s. The change of the system to the higher voltage has been nearly completed, and at the present time there only remains a small district to be dealt with, the cost of which it is estimated will not exceed £3,000.

Spennymoor.—A start has been made at the Northern Counties Electricity Supply Company's large power station. The building has been erected by Messrs. Douglas Bros., of Heaton-on-Tyne, the Callender Cable Company laying the mains. The plant consists of two water-tube boilers, by Messrs. Babcock and Wilcox, fitted up with mechanical chain-grate stokers; two combined three-crank engines, running at 450 revolutions per minute, and giving 350 h.p., supplied by Messrs. W. H. Allen and Son, of Bedford, direct coupled to a 200-kw. machine from Messrs. Crompton and Co. The switchboard was supplied by Messrs. Dorman and Smith, of Salford. There are also two batteries of 250 accumulator cells of R-17 plates, supplied by the Chloride Company, Manchester. On Monday last the engines were set in motion in the presence of a Board of Trade representative, who also tested the cables with about 1,000 volts. In all there are already over 2,000 lamps connected in places of business, and in a large number of workmen's dwelling houses, on the penny-in-the-slot principle, with a guaranteed light for 5½ hours for 1d. for six lights. The first light was switched on on Saturday by Mrs. R. Clark, wife of Mr. R. Clark, of the firm of Clark and Co., electricians, Spennymoor, and everything passed off without the slightest hitch. The company have been invited by the Urban District Council to tender for next season's street lighting.

Wigan.—The electricity generated during the year ended March 31, 1902, totalled 725,043 units. Of this 579,904 were sold, 76,000 were used on the works, and 69,144 were used in distribution and unaccounted for. Of the units sold each successive quarter shows an increase over its predecessor, which is encouraging. At the commencement of the year 11,401 lamps were connected, and these have been augmented by 22,498 during the year, which brings the total at the end of the year to 33,899. The total motors connected to mains number 86. The total capacity of the station is 1,200 kw. The maximum load demanded is 453, to be held as reserve 300, leaving available for fresh connections 447. Four boilers have been installed. Two are in use, one to be held as reserve, and one available for extra demand. We extract from the accountant's report as follows: "Electric revenue—the balance to credit of revenue account is £2,202. 11s. 10d., against a debit balance the previous year of £1,271. 7s. 8d., and the balance to debit of profit and loss account £2,300. 5s. 6d. against a debit balance of £4,221. 1s. 2d. the previous year. The amount expended on motors and fixing same—viz., £5,613. 11s. 3d.—appears in the balance sheet as stock in hand, your committee having decided to capitalise this account as soon as the necessary formulæ have been completed. Electric capital—the total expenditure on this account is £86,312. 2s. 4d., loans outstanding £77,242. 5s. 6d., and loans repaid £2,757. 14s. 6d."

St. Petersburg.—The annual report and balance-sheet of the Eclairage Electrique de St. Petersburg, Limited, has just been issued. During the last year new boilers and plant have been added, bringing the total up to 8,000 h.p. An agreement has been entered into between the three companies supplying the city, which has had the effect that all competition with regard to acquisition of customers from each other has ceased to exist. The length of feeders and cables has increased from 241,846m. in 1900 to 257,624m. in 1901, exclusive of 67,017m. for public lighting; 1,023 transformers, aggregating 9,173 kw., have been installed; the number of meters increased from 2,958 to 4,230, and that of subscribers from 4,287 to 5,340. The lamps connected rose from 183,790 to 217,776 giving with the public lamps a total of 222,741. Amongst the total lamps and motors connected there are over 88 per cent. incandescent and about 5½ per cent. arc lamps, 5·2 per cent. motors and 0·7 per cent. fans, etc.; 85·6 per cent. of these pay by meter. The receipts from all sources amounted to £108,000, against £86,150 in the preceding year. The receipts by meter increased by 34 per cent., and those for motors 54 per cent. The expenses were about £400 less than in the previous year, and came to £72,480. There was a great reduction, about £2,000, in the cost of production, and £1,000 in that of distribution, but new fuses made up for this saving. The cost of production per unit works out as follows: fuel, 1900, 0·9—1901, 0·792; oil and other material, 1900, 0·072—1901, 0·033; salaries and wages at station, 1900, 0·148—1901, 0·120; maintenance and various, 1900, 0·063—1901, 0·071. Total, 1900, 1·183—1901, 1·016. The total of units produced in 1900 was 8,798,342, and in 1901 9,878,815. Without counting the bonus payable on redemption, the 4½ per cent. shares of this company at the present price bring in 6 per cent.

LEEDS ELECTRICITY ACCOUNTS.

From the accounts of the Leeds electric lighting department just received it appears that the total expenditure on capital account up to March 25, 1902, amounts to £505,029. Abstracts of the revenue account and general balance sheet are given herewith.

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REVENUE ACCOUNT.

Dr. Generation of Electricity.	£	s.	d.
Coal	£3,456	16	4
Oil, waste, water, and stores	475	19	8
Wages at generating station	2,279	11	5
Repairs, etc., of plant, etc.	855	1	1
	7,067	8	6
Distribution of Electricity.			
Wages	552	0	0
Water supply to sub-stations	34	4	0
Stores	24	12	3
Repairs, etc., of mains, etc.	239	18	3
	850	14	6
Rents, Rates, and Taxes.			
Rents	1	1	0
Rates and taxes	1,809	11	5
	1,810	12	5
Management Expenses.			
Salaries—Engineer's department	1,749	2	6
Clerical staff	948	12	5
Stationery and printing	151	12	4
General establishment charges	250	11	5
	3,099	18	8
Law expenses—town clerk's disbursements	1	0	5
Insurances	201	7	1
Expenses incidental to raising of loans	224	10	0
Charges incidental to change of system	1,754	9	7
Interest	18,017	12	0
	33,027	13	2
Balance, being net profit for the year	12,304	15	4
	45,332	8	6
Sinking fund—amount set aside for redemption	9,134	15	2
Balance, being surplus profit	3,170	0	2
	£12,304	15	4

Cr.	£	s.	d.
Sale of current	47,981	7	11
Rentals of meters	37	13	9
	48,019	1	8
Less estimated discounts and leakage	2,686	13	2
	45,332	8	6
Balance brought down, being net profit	£12,304	15	4

BALANCE-SHEET.

Liabilities.	£	s.	d.
Loans	491,425	0	0
Treasurer, revenue account	8,771	13	2
Sundry creditors	25,020	1	6
Surplus	34,417	1	10
	£559,633	16	6

Assets.	£	s.	d.
Capital expenditure	505,029	9	11
Treasurer	22,378	6	2
Cash in hand	20	0	0
Stock-in-trade and stores	15,876	11	9
Sundry debtors for current and meter rents	16,419	8	8
	£559,633	16	6

PROVISIONAL PATENTS, 1902.

MAY 12.

10822. Improvement in or in connection with overhead wires used for electric traction and similar electric installations. Henry Cracknell, John William Cracknell, and Charles Thornes Phillips, 30, Park-row, Leeds.

10826. Improvements relating to clockwork operated electrical switches. Francis Collins, 10, St. George's-crescent, Liverpool.

10837. Improvements in and relating to starting switches for electric motors and the like. Thomas Harrison and George Alexander Smith, 47, Henry Nelson-street, South Shields.

10841. An improved form of insulator for electric fittings. Charles Thomas Arnold Henshaw, 7, Meadowbank-crescent, Jock's Lodge, Edinburgh.

10856. Improvements in switchboards for illuminating electric lamp signs, and cards or tickets for automatically actuating the same. Mortimer Norden, 33, Chancery-lane, London. (Complete specification.)

10881. Improvements in electric incandescent lamps with rare earth filaments. William Alfred Crook and Edward Mines, 6, Lord-street, Liverpool.

10888. Improvements in electromagnetic devices. Luigi Cerebotani and Albert Silbermann, 111, Hatton-garden, London. (Complete specification.)

10889. Improvements in or relating to telephone receivers and transmitters. Walter C. Runge, 111, Hatton-garden London.

10890. Improvements in or relating to telephone systems and apparatus therefor. Walter C. Runge, 111, Hatton-garden, London.

10899. Improvements in electric circuit protecting devices. Sebastian Ziani de Ferranti and Charles Cornfield Garrard, 18, Southampton-buildings, Chancery-lane, London.

MAY 13.

10934. Improvements in arc lamps. Joseph Devonport Finney Andrews and Electrical Productions, Limited, 61, Carey-street, Lincoln's-inn, London.

10938. An improved electric switch. William White, 165, Queen Victoria-street, London. (Friedrich Rohr, Spain.)

10945. Improvements in and relating to electric detonating fuses for blasting and mining purposes. Harold Bonser, 33, Chancery-lane, London.

10952. Improvements in and relating to electric alarms operated by clockwork. Emil Richard Männel, 27, Chancery-lane, London. (Complete specification).

10957. Improvements relating to electricity meters. Friedrich Lux, 45, Southampton-buildings, Chancery-lane, London.

10971. Improvements in or relating to electric arc lamps. Frederick William Le Tall, Westinghouse-building, Norfolk-street, Strand, London. (Hugo Bremer, Germany.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published June 5.

1901.

5172. Electric thermal device for working switches, registering apparatus, and the like. Charlton and Barton.

5427. Manufacture of electric cables and apparatus therefor. Dover.

7629. Secondary batteries. Celestre and Gondrand.

10206. Electric railways and tramways on the surface-contact system. Cruvellier.

10374. Step-by-step telegraphic apparatus. Mordey and Steljes.

10374. Train control systems for electric railways. British Thomson-Houston Company, Limited. (Case.)

11857. Armature windings for dynamo-electric machines. Arnold and Collischonn.

12975. Secondary batteries. Madden. (Date applied for under International Convention, March 19, 1901.)

13182. Manufacture of ornamental vases, bottles, and other ornamental vessels, electric switch caps, and other articles. Deacon, Birkett, and Faulkner.

14237. Electric arc lamps. Girdlestone and Thorkelin.

15155. Conduits for carrying electric conductors. Hirst and Boyes.

15918. Method of electrical distribution for traction Marillier.

17105. Machines for perforating strips of paper for use in telegraphic transmitters, automatic musical instruments, and for other purposes. Wright and Green.

18830. Automatic electric fire-alarm. Brewster.

20384. Variable-pressure electric current transformer. Ritzer. (Date applied for under International Convention, March 11, 1901.)

20561. Feeder or junction box for electric mains. McGillivray and Carr.

24054. Resistances for arc lamps and other electrical apparatus. Davies.

24239. Cases or holders for Nernst lamps. Drake, Sheppard, Ram, and Nernst Electric Light, Limited.

26604. Instruments for recording varying magnetic fields or the currents producing them. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

1902.

1736. Arrangements for controlling and regulating the supply of electricity to medical heating apparatus and the like. Phillips.

5103. Method of and apparatus for connecting the conductors or armour of electric cables and the like to junction boxes, earth-plates, and other parts. Callender's Cable and Construction Company, Limited, and Ward.

5663. Electrical fuse boxes. Waterhouse, and Simplex Steel Conduit Company, Limited.

6229. Electric typewriters. Kochendörfer.

6379. Continuous-burning arc lamp with inclined carbons. Rignon and Eisenmann.

6648. Signal telegraphs. Lavens and Lavens.

7383. Electric arc lamps. Högner.

7851. Electrical sterilising and preserving apparatus. Lake. (Giroux and Seddon.)

7858. Electric vacuum discharge tubes. Krouchkoll.

7898. Conduits. Budd.

7995. Production of metallic deposits by electrolysis. Jensen. (Firm Dr. G. Langbein and Co.)

8667. Method of regulating the pressure of alternating-current dynamo-electric generators. Siemens Bros. and Co., Limited. (Siemens und Halske Actiengesellschaft.)

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TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	May 17	626	672	− 46	35,350	33,242
Birmingham Tramways	,, 17	4,802	4,670	+ 132	82,881	83,769
Blackburn Corporation	,, 16	733	710	+ 23	12,810	11,370
Blackpool Corporation	Apr. 19	278	269	+ 9	3,601	2,242
Blackpool-Fleetwood Tramways	May 17	292	413	− 121	4,870	4,698
Bolton Corporation	,, 18	1,401	1,428	− 27	27,158	25,299
Bradford Corporation	,, 4	2,786	930	+ 1,856	38,796	14,308
Bristol Tramways Company	,, 17	4,352	4,429	.. 77	—	—
Carlisle Tramways Company	Mar. 15	122	123	− 1	1,282	1,192
Central London Railway	May 17	6,885	6,399	+ 486	133,769	123,937
City and South London Railway	,, 18	3,080	1,909	+ 1,171	59,587	39,767
Cork E. T. and L. Company	,, 15	513	558	− 45	7,841	7,593
Darwen Corporation	Mar. 22	169	154	+ 15	1,951	1,844
Darwen-Hoddlesden	,, 14	26	—	—	—	—
Dover Corporation	May 10	182	197	− 15	3,371	3,268
Dublin & Lucan Electric Railway	,, 18	97	122	− 25	1,249	1,730
Dublin U. T., electric cars	,, 16	3,722	3,776	− 54	—	—
Dublin S. District, Electric	,, 16	1,054	912	+ 142	—	—
Dundee Tramways Company	,, 14	647	678	− 31	—	—
Glasgow Corporation	,, 17	11,667	11,441	+ 226	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 17	1,618	1,600	+ 18	—	—
Liverpool Corporation	,, 10	9,149	8,850	+ 299	170,172	155,092
Liverpool Overhead Railway	,, 18	1,433	1,644	− 211	28,090	30,811
Newcastle-on-Tyne Corporation	,, 17	2,464	—	—	—	—
Portsmouth Corporation	,, 17	1,296	542	+ 754	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 18	3,790	—	—	—	—
Southampton Corporation	Mar. 27	775	537	+ 238	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £473 decrease.
Barcelona Ensanche y Gracia, £53 increase. Barcelona, £2,113 increase.
Brisbane, £384 increase (month of March, £10,934; increase, £1,789).
Buenos Ayres and Belgrano Electric (month of April, receipts £11,872; decrease £613), £78 increase.
Calcutta, £20 decrease.
Cape Town (month of March), receipts, £17,888; expenditure, £7,343.
Isle of Thanet Electric, £60 increase.
Mexico Electric (month of April), receipts, £19,350; expenditure, £10,620.
Perth Electric, £240 increase.
Port Elizabeth (month of March), receipts, £3,818; expenditure, £1,947.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	½-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	½-¾
—— Ordinary, 1-125,000	1 ..	⅜-½
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-5⅜
—— 5 per cent. Mortgage Debentures	100 ..	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5⅜-5¼
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1½-2
—— 4½ per cent. 1st Debenture Stock	100 ..	101-104
—— 4½ per cent. 2nd Debenture Stock	100 ..	95-100
Callender's Cable, Debentures	100 ..	111-115
—— Ordinary	5 ..	17-18
—— 5 per cent. Pref.	5 ..	5¼-6
Crompton and Co.	3 ..	3-3¼
—— 5 per cent. Debentures	— ..	103-108 p.c
Edison and Swan United, Ordinary	3 ..	¼-⅜
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	75-80
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-1⅜
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9¾-10⅛
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	98-101
W. T. Henley's Telegraph Works, Ordinary	5 ..	17-18
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	99-102
Parker, Thos., Limited, Ordinary	10 ..	15¼-16½
Telegraph Construction and Maintenance	12 ..	34-37
—— 5 per cent. Bonds	100 ..	103-106
Telegraph Manufacturing, Ordinary	5 ..	10-11 xd
—— 5 per cent. Cum. Pref.	5 ..	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	8¼-9½
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6⅝
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107
Electric Railways.—		
Central London, Ordinary	100 ..	103-106
—— 4 per cent. Pref.	100 ..	103-106
—— ,, ,, deferred	100 ..	100-103
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-118
City and South London, Consolidated Ordinary	100 ..	73-75
—— 4 per cent. Debenture Stock	100 ..	113-117
—— 5 per cent. Pref. Stock '91	100 ..	128-133
—— ,, ,, ,, '96	100 ..	125-128
—— ,, ,, ,, '01	100 ..	120-124
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	91-94

Name.	Amount paid.	Last price
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	¼-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	100-104
Bournemouth and Poole, Ordinary	10 ..	11-12
—— 4½ per cent. Cum. Pref.	10 ..	9¼-10¼
—— Debenture Stock, Red.	100 ..	103-106
Brompton and Kensington, Ordinary	5 ..	9-9½
—— 7 per cent. Preference	5 ..	8¾-9¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	8-9 xd
—— Nos. 20,001-30,000	5 ..	8-9 xd
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½ xd
,, ,, ,, £10 Ord.	6 ..	10½ xd
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	106-108
Charing Cross and Strand	5 ..	9-10
—— Nos. 50,001-70,000	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5-5¼
—— 4½ per cent. Debentures	100 ..	110-113
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	103-106
County of London and Brush Provincial, Ordinary	10 ..	8-9
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6¼-6⅜
—— 6 per cent. Cum. Pref.	5 ..	6-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4-4¼
—— 5 per cent. Debenture Stock, Red.	100 ..	101-104
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5⅜-6¼
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10-11
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	95-100
Metropolitan, Ordinary	10 ..	16-17
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	14-15
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7¼-8
—— £2½ Shares, New	2½ ..	6¾-7¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	98-101
River Plate Electric Light and Traction, Deb.	100 ..	68-73
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1¾-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2¼-2⅜
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14¼-15¼
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	98-101
Westminster, Ordinary	5 ..	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	2½ ..	3¼-4
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	127-132
Blackpool and Fleetwood Tramroad	10 ..	13¼-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	3-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5 xd
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	104-107
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	6¾-7¼
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¾-10¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	102-104 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13¼-14½
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12¼-12¾
—— 5 per cent. Perpetual Debenture Stock	100 ..	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1¼-1⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4¾-5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2⅛-2⅜
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11¼-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	96-99
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10 ..	10¼-11
,, ,, ,, ,,	5 ..	5¼-6
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	104-106
—— ,, ,, Prov. Crts.	50 ..	53-55
New General Traction, Ordinary	5 ..	2-3
—— 6 per cent. Cum. Pref.	10 ..	3-4
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10⅜
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	100-103
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	9¼-10¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	105-108 xd
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	12s. ..	¾
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	60 p.c. ..	60 p.c.
Telephones.—		
National Telephone, Preferred	100 ..	95-99
—— Deferred Stock	100 ..	55-59
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— Preferred, 590,001-790,000	3½ ..	3⅛-3⅜
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-5¼
—— 4 per cent. Deb. Stock, Red.	100 ..	94-97
—— 3½ per cent. Deb. Stock, Red.	100 ..	103-107
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16 xd

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NOTES.

Acknowledgment.—We beg to acknowledge the current number of *Science Abstracts*, which, as usual, has its full complement of abstracts of current scientific literature.

Faraday House.—Prof. C. A. Carus-Wilson, M.A., M.I.E.E., commenced a special course of lectures to the senior students of the Electrical Standardising, Testing, and Training Institution upon dynamo, motor, and transformer construction on Monday evening last.

Society of Arts.—It is announced that the annual conversazione of the above society will take place at the Royal Botanic Gardens, Regent's Park, on Tuesday, June 24, from 8.30 to 12 p.m. Each member is entitled to a card for himself and lady, and he can also obtain extra cards of admission at his own cost on application to the secretary of the society.

State Laboratories.—We note that a commission of the State of New York has been appointed to consider the question of the establishment of a State electrical laboratory to provide independent authoritative information on questions of electrical science, and an official standardising laboratory for electrical measuring instruments, apparatus, and standards for the protection of municipalities and the general public in the use of electrical energy. The commission is not expected to issue its report till the fall of 1903.

Lectures on Space Telegraphy.—Present lecture arrangements at the East London Technical College, Mile End-road, include two special courses by Mr. J. T. Morris, A.M.I.E.E., on interesting subjects. The first course, consisting of six lectures, deals with the principles involved in wireless telegraphy and their practical applications. This course is very fully illustrated by experiments. The other subject on which Mr. Morris is lecturing at the above college is "Electric Traction Principles and their Application to Electric Railways." A syllabus of the courses may be had on application to the director of studies at the college.

Water Power in Spain.—We hear that it is proposed to utilise a waterfall on the Jarama River, about 11 miles distant from Madrid, to generate electricity for lighting and power purposes in the city. In the first instance about 3,000 h.p. will be developed. It is thought that electrical energy for power purposes would have a large demand in and around Madrid from the considerable number of factories which already exist and others projected in the district. The tramways in the city, also, are expected to be extended very soon, when a change will be made from mule to electric traction, so that the development of electrical power in the neighbourhood is likely to prove a successful enterprise.

Power Transmission in California.—An electrical water-power plant, the largest in the United States, and capable of generating upwards of 300,000 h.p., is about to be laid down in California for the transmission of power to San Francisco, a distance of 175 miles. According to a San Francisco newspaper, the scheme involves the construction of about 10 miles of canal and tunnel in order to obtain a vertical fall of 1,600ft., the water being obtained originally from the Feather River. Recently several water appropriations have been made on the part of the Feather River, with the object of converting 13,000 acres of peat swamp into storage reservoirs, and it is in connection with this work that the above scheme is to be undertaken.

Institution of Junior Engineers.—A large party of the members of the above institution recently paid a visit to the Great Eastern Railway Works at Stratford. In the locomotive machine shop, automatic bolt machines and general machinery for dealing with locomotive work were seen, and large planing machines, etc., were in operation in the erecting shop, where locomotives, both new and repaired, were in various stages of construction; in this shop, also, pneumatic tools were seen tapping and drilling. Pneumatic tools were also at work in the boiler shop, and hydraulic riveters and flanging machines, together with general machinery appertaining to boiler work. The party also visited the locomotive department and the Westinghouse brake shop.

Students' Section.—The report of the hon. secretary, Mr. H. D. Symons, on the work of the above section of the Institution of Electrical Engineers for the session 1901-2, states that 13 meetings have been held during the period. The average attendance of students has been good, and the discussions on the papers have been well maintained. Thirteen works and installations of special interest in the neighbourhood of London have been visited on various Saturdays during the session. Reference is also made in the report to the students' visit to Newcastle at Easter, occupying five days from Tuesday, April 8, to Saturday, April 12, during which time Stockton-on-Tees, Sunderland, and Jarrow, besides other works in Newcastle, were separately visited.

Electric Lighting in East London.—It may be within the memory of some of our readers that some four years ago the County of London and Brush Provincial Electric Lighting Company obtained parliamentary powers to supply electricity in the hamlet of Mile End Old Town, the Limehouse district, and the parish of St. George's-in-the-East. For various reasons the company did not put their powers into effect, and eventually the districts concerned applied for and obtained their own provisional order subject to arrangement with the Brush Company, who, however, claimed as much as £22,000 for the extinction of their rights. The matter was according referred to arbitration, with the result that the arbitrator has reduced this claim by no less than £17,000, and ordered the payment of a sum of £5,000 to the company. This is to be levied on the three parishes and districts named, who will then be free to put their provisional orders into operation.

The Factory Act of 1901.—It was announced in the early part of the week that the President of the Board of Trade has consented to receive a deputation from the Institution of Electrical Engineers on the question of the incidence of the Factory and Workshops Act of 1901 in its application to the generation and sale of electricity in this country. The reception was originally fixed for 12 o'clock noon yesterday, but owing to urgent business Mr. Ritchie has been compelled to postpone the meeting to next Thursday, June 5, at the same hour. It will be understood that the sending of a deputation to the President of the Board of Trade is the direct outcome of the conference of representatives of the electrical industry held the week before last to decide what action should be taken with regard to the framing of regulations for electrical undertakings under the new Factory Act, and the Institution are to be congratulated on having secured an appointment with Mr. Ritchie in so short time.

The Electric Searchlight.—We understand that some practical tests as to the efficiency of the electric searchlight for purposes of coast defence will commence at Sheerness next Monday and continue all next week. Orders have been issued for the mobilisation of a body of troops on that day, who will be responsible for the defences of Sheerness and the Isle of Grain while the electric searchlights at the entrances to the Rivers Thames and Medway, and on Bruntwick Island and the opposite shore, where

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the Medway boom crosses the river, will be tested. The searchlights will be operated by a detachment of Royal Engineers. Official announcement is further made that the coast defences in the West of England also are being tested this week. The two ports of Plymouth and Falmouth are to sustain an attack by torpedo craft, and the searchlights will consequently be brought into use as in wartime. The efficacy of the electric searchlight to locate these vessels—which will steam at full speed, and without lights—at night time will thus be practically demonstrated.

Royal Meteorological Society.—The first of the afternoon meetings of the session was held on the 21st inst., when Captain D. Wilson-Barker read a report prepared by Mr. W. H. Dines and himself on the wind force experiments which had been made on H.M.S. "Worcester" off Greenhithe and at Stoneness Lighthouse, 817 yards from the ship on the north bank of the river. These experiments were in continuation of those on the exposure of anemometers at different elevations which were carried out on the "Worcester" a few years ago. All the observations were made with the pressure tube anemometer. The broad general result is that the lighthouse experiences steadier and stronger winds than the "Worcester," the velocity being about 6 per cent. greater, notwithstanding the fact that the elevation is less than half, but that in both positions the extreme velocities reached in the gusts are about equal. Dr. H. R. Mill also read a paper on "The Cornish Dust Fall of January, 1902." From a consideration of the meteorological conditions at the time and for several days before, the author is inclined to believe that the evidence points to the dust having been transported in the upper air from the African deserts.

Electric Lighting in South Africa.—Mr. Bennet Burleigh, the able war correspondent of the *Daily Telegraph*, in a lengthy dispatch from South Africa, has some information to give which will be read with interest by electrical engineers. Writing on the recent Boer peace conference, and describing the arrangements made for the reception of the Boer delegates at Vereeniging, Mr. Burleigh says that both electric lighting and water were laid into the camp. The electrical installation consisted of arc and incandescent lights, the former for the open spaces and the latter for the tents. As is well known, most of the mines in South Africa have their own electrical generating plants, and current for the impromptu installation referred to was obtained from this source. The laying on of electric lighting to the temporary encampment erected for the conference is, perhaps, not a great achievement in itself, but it serves to show the progress of electricity as a lighting agent in what is comparatively a new country. Indeed, in New South Africa it is a small and poor village that does not boast of having the electric light, and, as in this particular instance, the current is often obtained in out-of-the-way places from the mines having their own generating plants. It may be recalled that many of the temporary hospitals in South Africa on the veldt and in the towns are lighted by electricity, the installations being similar to that quoted above.

Electrolytic Preparation of Paris Green.—The following interesting and simple method for the preparation on a commercial scale of Paris green, the aceto-arsenite of copper, is proposed by Mr. Richard Franchot, of Niagara Falls: A copper anode is dissolved in a mixed solution of calcium acetate and arsenious acid, whereupon the separation of the insoluble double salt occurs directly. The reaction is strictly anodic, and in order to maintain the separation of the cathode products, the cathode, a sheet of copper, is enclosed in a linen bag, which performs the function of a diaphragm. It is essential that this separation should be complete, since either the hydrate or the hydrogen formed at the cathode would destroy the regular course of the reaction, the former by the precipitation of the corresponding copper compound, and the latter by the reduction of arsenious oxide with liberation of the highly poisonous gas, arsine. It would seem that investigators have not touched upon this field to any extent, though Mr. Franchot's work recalls the method whereby Scheele's green has been produced by the electrolysis of an 8 per cent. solution of sodium sulphate with copper electrodes in the presence of suspended arsenious oxide. In this case the copper is dissolved as a sulphate, and the arsenic as sodium arsenite and the regeneration of the sodium sulphate. Mitis green has also been produced in an analogous manner, the arsenious oxide being replaced by a solution of the pentoxide, which trickles slowly into the bath around the cathode.

Internal Resistance of Galvanic Cells.—A paper by Mr. C. H. Ayres, jun., in which are given the results of an investigation to determine experimentally whether the internal resistance of a cell is a function of the current, is abstracted in the current number of *Science Abstracts*. The method adopted was a modification of that due to Kohlrausch, one of the resistance arms of the bridge being made up of a fixed capacity in series with a variable resistance, and the other arm of a fixed capacity in series with the cell. The remaining arms consist of a slide wire. If a b are the sections of the wire, then for equilibrium we have $r_1/r_2 = a/b = c_2/c_1$. The method of operation is to move the slider until a minimum is found, then vary r_2 (r_1 being supposed fixed) so as to improve the minimum; then move the slider again, and so on. The value of r_2 was found by measurement on a separate Wheatstone bridge. The cell is either on open circuit or shunted with a known resistance as desired. Any capacity effect due to polarisation unites itself with the capacity already in circuit, and thus an error of that kind is avoided. This method determines both capacity and resistance, but the figures given only refer to the latter. Both paper and mica condensers were used, the latter having a capacity of 30 microfarads. Measurements on known resistances showed that the method was accurate to $\frac{1}{2\frac{1}{2}}$ per cent. Upon testing Daniell, Leclanché, and dry cells the author found the resistance was independent of the current. The experimental part of the paper is followed by a theoretical part which shows how the accuracy depends upon the inductance, capacity, and resistance, and upon the frequency of the current.

Modern Induction Coils.—Prof. Trowbridge has a short article in last month's *Philosophical Magazine*, in which he describes a recent development of the induction coil. The high-frequency discharges of a Thomson-Tesla coil are probably the largest sparks yet obtained from any kind of induction coil, but although these may possess enormous voltage, yet the total quantity of power usually obtained from a Thomson-Tesla coil is not very large. Of the primeval induction coils, the Apps inductorium is said to have given a 6ft spark. From an apparatus of the Planté type, in which condensers are discharged n series, but are charged in parallel, the author says he was unable to produce a spark more than 7ft. long. He believes, however, that suitably constructed induction coils may be capable of considerably exceeding this sparking distance. The principal features of the coil used by Prof. Trowbridge are the relative short but powerful primary winding, consisting of a single layer of wire, and

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a special form of electrolytic interruptor on the Wehnelt principle. These two elements are connected in series across 110-volt mains. A small motor is employed to impress a definite frequency upon the electrolytic interruptor. The current in the primary circuit varies between 5 and 10 amperes, representing, roughly, from ½ kw. to 1 kw. of primary power, with a secondary sparking distance of 30in., at a frequency of from 5,000 to 60,000 interruptions per minute. It is mentioned, however, that the primary current is probably much in excess of the indicated current at the commencement of each cycle of induction. From his experiments in this direction, Prof. Trowbridge deems it possible that by suitable design, developing the electrolytic interruptor in the primary circuit, long sparks liberating many kilowatts of power may soon become available.

New Form of Cavendish Balance.—An interesting study by Mr. G. K. Burgess on a new form of Cavendish balance is abstracted in the current number of the *Electrical Review* of New York. According to this writer, the sensibility of Cavendish's method for the determination of gravitation constants would be much increased if, while still preserving heavy masses hung from the balance arm, the tension which this weight exerts on the suspension wire could be suppressed. This possible, nothing would prevent realising a measurement as sensitive as might be desired. The attraction between the two systems of spheres—the fixed and moving systems—would remain a definite quantity, and allow increasing the deflection of the movable system by reducing more and more the diameter of the torsion wire. With this object in view, the weight of the turning system is compensated by a float immersed in a mercury bath, and capillary action that may tend to hinder the mobility of the system is eliminated, and if the zero remains constant under this condition, an instrument of unlimited sensibility is secured. A length of 12cm. was chosen for the lever arm, and from the ends of the balance arm two lead spheres of 2 kg. each were hung, the whole being buoyed by a cylinder immersed in mercury, whose surface was covered by dilute sulphuric acid; a rod passing through the mercury and acid connects the cylinder to the balance. The points of support for the spheres are below the centre of inertia of the system, giving the balance arm the form of three sides of a rectangle. With this arrangement the torsion fibre has to support a weight of only 5 grm. or 10 grm., which allows of using a fine quartz fibre. Besides a gravimeter, this apparatus might become accidentally both a magnetometer and electrometer, thus introducing sources of error due to magnetic or electrostatic attractions. These effects must be carefully eliminated.

Glass-making in the Electric Furnace.—In the course of an interesting article in the *Electrical World* on the subject of recent developments in electro-chemistry, Mr. C. T. Townsend mentions two patents granted to German inventors which relate to the utilisation of the electric current in the manufacture of glass. The first of these patents, issued to August Voelker, describes a device which both melts the raw material and refines the glass, applying to the former operation the arc and to the latter the resistance principle. The electric furnace chamber devised by Chamatte, surmounted by the reflecting dome, carries electrodes, beneath which the raw material is fed from hoppers. The molten mass overflows into a refining pot, which is constructed with integral perforated partitions. Into the lateral chambers formed by these partitions dip carbon electrodes, between which the circuit is closed by the molten mass. Under the influence of the heat developed the glass becomes fluid and is rapidly cleared from gas bubbles, while the perforated partitions prevent its contamination by fragments from the electrodes. With reference to the current used, the statement is made that it may be assumed that five amperes for each square millimetre of electrode surface is a fair maximum. The other patent referred to was taken out by Johann Zuhne, and describes a rather complicated structure operating on analogous principles. The raw material is melted by passing through a series of arcs, developed between a horizontal prismatic bar of carbon and a series of horizontal electrodes ranged along either side. The central bar is hollow and laterally perforated for the injection of hydrogen to raise the temperature of the belt of arcs. The raw material thus fused flows through a run-way in the base of which are embedded any of the usual Nernst conductors, by the heat of which it is brought into a highly fluid state before it is discharged into the refining pots. This furnace is said to be applicable to the highest grades of optical glass, colourless, and absolutely uniform in structure.

A Wireless Telegraph Tuning Device. — Mr. Marconi now claims to employ in his wireless telegraphy operations a tuning apparatus which makes the messages exchanged between any two stations, or between ship and shore, absolutely secret. It will be remembered that some time ago the possible "tapping" of wireless messages by a third party was one of the principal objections to Mr. Marconi's system, but, as he recently explained in the course of a lecture to a Dundee audience, he has completely overcome this difficulty. As bearing on the point, we understand that an agreement has been entered into between Prof. M. I. Pupin, of Columbia University, U.S.A., and the Marconi Wireless Telegraph Company by which this company obtain the right to the use of a tuning apparatus invented by Prof. Pupin, which is also said to ensure absolute secrecy in the transmission of wireless messages. It is further claimed for this arrangement that it will enable as many as 12 messages to be sent simultaneously between two stations. The apparatus is also available for ordinary messages by wire, and for such purposes Prof. Pupin still retains the right to it. He believes that it will greatly increase the sending capacity of telegraph wires. Taking the professor's own description of his invention, "there is an infinite number of points on the scale of inductance, and it is possible so to adjust two wires that they may receive messages from each other at this infinity of attunements." This would make it extremely difficult for a hostile operator to pick up a wireless message. It would have been interesting to hear what Mr. Marconi has to say on this subject of tuning at the Royal Institution to-night, but unfortunately he is at present laid up by an attack of influenza, and the discourse which he was announced to deliver on the progress of electric space telegraphy has been postponed to a special Friday evening on June 13. In this emergency Prof. J. A. Fleming has kindly agreed to deliver a lecture on "The Electronic Theory of Electricity" at the Royal Institution to-night.

Lightning Conductors.—A correspondent of the *Standard* in a short communication under the above title offers a number of useful hints on the subject of lightning conductors, which he commends to the attention of the Lightning Research Committee. The earth connection he regards as "the very heart of a lightning conductor," and should, therefore, receive more attention than is usually bestowed upon it. From actual experience the writer makes the following suggestions: The conductor should be of only one kind of metal from earth-plate to point; if of iron, the pieces should be welded; if of copper, very hard brazed, with protection of brazed part against decay.

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Where joints are unavoidable, care is to be taken, not only that the electrical connection is sound at the time, but that without attention it will be likely to remain so. An easy means is required for testing the connection between each earth-plate and its lead above ground. In his judgment, the first object of a conductor is to establish connection between earth and sky in such a manner that there is a constant flow, restoring gradually, instead of suddenly, the balance of electrical pressure, thus anticipating and preventing, or, at any rate, greatly mitigating, the violence of a discharge For this purpose he thinks that an electrically perfect connection between one steeple conductor and a good earth connection (more than one if possible) would protect a good area all round, forming, as it would, a cloud of earth electricity, on which that of the storm would expend its force. That such a flow takes place the writer is assured by the evidence of his galvanometer when testing on the approach of a storm. The second object of the lightning conductor—but one which in the minds of the majority seems to be the first idea—is the carrying off of a strong discharge. In this case a large amount of wire entanglement is required to catch the lightning. He advocates separate systems, with loose, detachable wire connections, through which lightning will pass, as thus it is easy to test the efficiency of each system and the connection with and resistance of its earth, both important matters.

Electricity in Cotton Mills.—The advantages of electricity for driving purposes in the large cotton mills of America is the subject of an interesting article by Mr. W. B. S. Whaley, recently published by *Dixie*. It seems that in these electrically-driven mills the motors are placed overhead, so that they occupy no floor space, with the additional advantage that they are quite out of reach of the hands employed in the works. No special machinery is required for lighting the mill, as current for this purpose is taken from the generator producing the power. By actual experience with electrical driving, there is a saving in friction alone of 20 per cent. Also, the producing capacity of the machinery operated is, in actual practice, increased about 4 per cent., due to the steadiness of this method of driving over the ordinary practice of ropes and belts, and to the more uniform speed obtained throughout the plant. The economic problems solved by the installation of these electrically-driven cotton mills are, therefore, very important, and are a great advance on all previous practice. The plants are also readily available for furnishing current for power purposes outside the mill itself, and a considerable additional revenue from this source is often secured, as they can supply power at a lower figure than that at which isolated plants can generate. For example, in Columbia, S.C., the Olympia Mills power plant not only drives three different cotton mills, but also furnishes the light and power company with current for working their street cars and for lighting purposes, and more economically than the individual companies could maintain separate plants, while the Olympia Mills sell the current at a substantial profit. Another State which is making great advances in this direction is South Carolina, which will shortly have no less than 15 of these electrically-driven cotton mills in operation. Electricity is also finding extensive use in the sawmills of America. In one instance the company not only supplies power for its machine shops, etc., but also lights a large hotel and several other buildings in the neighbourhood of its works. The electrical plant installed consists of four 45-kw. and two 400-kw. 250-volt direct-current dynamos, the former being driven by a 225-h.p. Reynolds-Corliss engine and the latter by a direct-connected Harrisburg engine of 150 h.p. The combined electrical horse-power is over 300, and capable of 50 per cent. overload for long periods, or 100 per cent overload for short periods.

Fuel Oil.—In an interesting paper presented to a scientific society in Texas last month, Mr. W. W. Reed discusses the comparative advantages of oil and coal fuel for steam purposes, deciding ultimately in favour of the former, not only on account of its low cost, but because of the many other advantages to be gained by its use. In comparing the heat values of the two fuels, the author takes as his basis of comparison the number of heat units contained in each. Thus he gives as the heat value of petroleum from 17,000 to 20,000 British thermal units, and assumes an average value of 18,500 British thermal units. For the different coals found in the States he gives values ranging from 9,900 to 13,500 British thermal units, with an average value of American coal of 12,225 British thermal units. On this basis one barrel of crude petroleum weighing 320lb. net would be equivalent to 491lb. of coal. From this value, then, a calculated number of barrels of oil to equal one ton of coal would be 4·12. Of course, in actual practice the value of oil, as compared with coal, would vary, depending on many factors, such as grade of coal, efficiency of the burner or atomiser, furnace construction, etc. But results based on actual practice are from 2½ to 4 barrels of oil to a ton of soft coal. In using fuel oil, the cost of handling the fuel in a steam plant is said to be greatly reduced, and, moreover, the steaming capacity of the boilers is increased in the neighbourhood of 35 per cent. In an instance which the author quotes, that of the Houston Lighting and Power Company, with a certain load on the generators, one boiler using oil now does easily what formerly required two boilers using coal. A test was recently made by this company on two Babcock-Wilcox boilers, and an evaporation of 13·48lb. of water per pound of oil was obtained from and at 212deg. F. In another case an evaporation of 14·71lb. of water per pound of oil was got from and at 212deg. F. At the works of the Houston Company the oil is stored in steel tanks of 12,000 gallons capacity each, which are provided with heating coils to heat the oil in cold weather. The oil is pumped from the storage tanks into a small receiver, where it is heated to a high temperature by the exhaust steam from the pump. It is then forced to the burners under pressure, the pump, being automatic in its action, maintaining a constant pressure of oil, no matter how much oil is being used. While the author admits that oil, which he describes as an ideal fuel, will never entirely replace coal in steam plants, its use in Texas and many other parts of America will be very extensive in the near future.

The Electrolytic Rectifier.—Some experimental results obtained by Messrs. C. F. Burgess and C. Hambulchen, and recently explained before the American Electro-chemical Society, tend to show that the electrolytic rectifier may become an industrial apparatus, which for certain cases may successfully compete with rotary converters and motor-generators. The principle of the electrolytic rectifier is based upon the well-known property of the aluminium plate to allow a current to pass in one direction, but not in the other. Instead of aluminium, certain other materials may also be used; but at present aluminium seems to be the most promising material. The fact that an aluminium plate, when used as an anode, does not allow a current to pass is assumed to be due to a coating of aluminium oxide, which is insulating. This oxide film is, however, not a perfect insulator, as it does not prevent a small leakage current which passes through spots of the plate irregularly distributed over the surface.

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The authors discussed the different losses in the cell. There is the $C^2 R$ loss, which cannot be determined as though the total surface of the plate was conducting, because the active aluminium surface is much reduced. Another loss is E C, where E is the counter E.M.F. due to decomposition. There is also the leakage current loss. The first experiments were made with electrodes of aluminium and lead in potassium phosphate, but the authors were unable to get a higher efficiency than between 30 and 40 per cent. The amount of leakage, however, was the main point to which they gave attention. They found that with continuous pressure applied the amount of leakage is very small, while it is much larger with alternating pressure applied. There is a similar difference regarding the point of breakdown due to excessive sparking. The plate breaks down at a much lower voltage with alternating pressure than with constant pressure. It is therefore not allowable to use results obtained with constant pressure for drawing conclusions regarding the behaviour under alternating current. While the experiments with solutions were not very promising for an industrial application of the electrolytic rectifier, they obtained far better results by the substitution of a fused electrolyte for the solution. They employed fused sodium nitrate and obtained an efficiency of over 80 per cent. This result makes it quite possible that the electrolytic rectifier in this form may be used in practice. It may be used, for instance, for charging storage batteries in localities where only alternating current is available, and the authors have made elaborate tests concerning the question whether a pulsating current, such as obtained from a rectifier, has any advantages over a steady direct current for charging a battery. They, however, could not detect any difference between the two types of current for the resulting efficiency and capacity of the battery. We understand from our contemporary, the *Western Electrician*, that a continuous test of the rectifier, lasting over a considerable period, has also been made in order to determine the cost, which comes out at about one-eighth penny per kilowatt hour. This result makes the apparatus appear promising for industrial application.

Magnetic Shielding.—The current number of the *Proceedings* of the Royal Society of Edinburgh gives a very concise abstract of a paper read before the society last March on the subject of magnetic shielding in hollow iron cylinders, by Mr. James Russell. The author's investigation deals with the shielding which exists within hollow iron cylinders when placed in a uniform transverse magnetic field. This transverse field divided by the internal magnetic field is defined as the shielding ratio. For the thin iron cylinders experimented with, it appears from various mathematical contributions to the subject that the shielding ratio minus unity may for present purposes be taken to be proportional to certain geometrical data and to the permeability (the permeability being large). By means of a rotating inductor within the shield, connected with a ballistic galvanometer, experimental determinations of the shielding ratio are made under various conditions of magnetisation; and an endeavour is also made to show how far and under what conditions these results approximate to theoretical formulæ which assume the permeability to be uniform all round the shield, and the absence of retentivity and coercive force in the iron. Two iron shields were experimented with, the hysteretic constants (η) being ·0015 and ·0028 respectively. The following results have been arrived at—viz.: First, that when no other magnetising force is acting upon the iron than that due to the transverse field increased by increments from zero, the shielding ratio minus unity is proportional to what may be called the ratio permeability (B/H), and not to the differential permeability (d B/d H). If, however, the transverse field is decreased by steps from a maximum, the theoretical conditions are not fulfilled, and the shielding ratio increases very rapidly and becomes infinite, but does not change sign if account be taken of the negative residual field within the shield when at each step the transverse field is withdrawn. In the second place, when a circular magnetising force is acting upon the iron in addition to that due to the transverse field, the order and manner in which the one field is superposed upon the other affects the shielding ratio to an enormous extent. The conclusions arrived at are not in harmony with the inductions drawn from the investigations of Stefan and Du Bois which "lend support to the assumption made throughout that shielding against moderate disturbing fields depends within due limits upon the constant permeability for small increments or decrements of force superimposed upon any condition of magnetisation." It is found that when, upon a pre-existing induction due to the transverse field, increments of the circular field are superposed (T C conditions), the shielding ratio minus unity is proportional to the differential permeability as impressed upon the iron by the circular field. The shielding ratios plotted as ordinates against the corresponding values of the circular field as abscissæ rapidly increase, attain a maximum, and then decrease, finally approximating to a minimum asymptotic value. If, however, upon a pre-existing induction, due to the circular field increasing from zero, the transverse field is superposed at each increment (C T conditions), the shielding ratio curves take much lower values. The superposition of repeated reversals of the transverse field (C T T conditions) still further lowers the shielding ratio, and in this case there appears to be no initial rise as the curve leaves its origin in the vertical axis. On the other hand, the superposition of repeated reversals of the circular field (T C C conditions) increases the shielding ratio so long as the values of (d B/d H) are high. When the values of d B/d H are a maximum, the shielding ratio under the T C C conditions are six to seven times greater than under the C T T conditions. The curves obtained under all the conditions of superposition of fields appear to approximate to the same minimum value as the circular magnetising force is further and further increased. A distinction is drawn between the permeability of the iron to the circular field and the permeability of the iron to the transverse field. Thus, while under the T C conditions the shielding ratio minus unity is proportional to the permeability (d B/d H) of the iron to the circular force, the same does not hold good under, say, the C T conditions. The effect of repeated reversals of the transverse field is shown to increase the permeability of the iron to the force which remains constant—viz., the circular field—and, in virtue of the phenomena associated with hysteresis, to lower the permeability of the iron to the transverse field, and consequently also to lower the shielding ratio. Further, when, upon a pre-existing induction due to the transverse field, the superposed circular field carries the iron round a complete cycle, the shielding ratio curves resemble the theoretical curves obtained from the corresponding values of d B/d H impressed upon the iron by the circular field. The effects of a longitudinal magnetising force acting upon the iron in addition to that due to the transverse field have not yet been fully investigated. Preliminary experiments show that in this case also the order and manner of field superposition largely determine the shielding ratios; also that when, upon a pre-existing induction due to the transverse field, increments of the longitudinal field are superposed, the differential permeability appears to be the determining factor.

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OLDHAM CORPORATION ELECTRICAL TRAMWAYS.

These tramways were formally opened last week, as a number of lines were ready for electrical working. The history of the undertaking shows that the tramways in Oldham were originally constructed by the Corporation under parliamentary powers. The first section running throughout the town was laid in 1880, and was constructed

COUNCILLOR J. ECKERSLEY, J.P., MAYOR OF OLDHAM.

for horse traffic. An extension of the tramways was made in 1884, the track being laid north and south across the borough, and this section was designed for steam traffic. The above sections were leased separately on completion to two different companies at rentals based on certain percentages on the outlay: the first to the Manchester Carriage and Tramways Company, and the second to the Bury, Rochdale, and Oldham Steam Tramway Company, the leases to the two companies being arranged so as to terminate at the same time—viz, Oct. 31, 1901—when

COUNCILLOR J. A. HANSON, VICE-CHAIRMAN OF THE OLDHAM TRAMWAYS COMMITTEE.

power to use and work the same reverted to the Corporation. For a considerable time prior to the expiration of the leases of the old tramways, reconstruction suitable for electric traction had been discussed, together with an extension of the tramway system throughout the borough, and in 1899 parliamentary powers were obtained to construct about 12¼ miles of single-track electric tramways, covering about 10 miles of route, and a car depôt to accommodate 70 cars. The new tramways were commenced in Middleton-road on Feb. 6, 1900, and within two months work on three other routes was commenced—viz., Park-road and Glodwick-road, Hollins-road and Copster-hill-road, and Egerton-street. These tramways were completed as quickly as possible, and with the exception of the Egerton-street route were opened for traffic, temporary car depôts being built adjacent to each route. In February, 1901, it was decided not to proceed with the remaining tramways under the 1899 order until the expiration of the two companies' leases of the old tramway, and so the summer of 1901 was taken up in the erection of the

ALDERMAN H. CHADWICK, CHAIRMAN OF THE OLDHAM SURVEYORS' AND TRAMWAYS COMMITTEE.

car depôt at Wallshaw, which is now complete and capable of accommodating 70 cars.

On Nov. 1, 1901, the day after the Manchester Carriage Company and the Bury, Rochdale, and Oldham Tramway Company ceased to run on the old main routes, about 900 men commenced the work of reconstruction in about seven different places. The winter proved a very unfavourable one, and many weeks were lost owing to severe weather, but whenever it was possible steady progress was made until the end of April last, when the whole of the track

MR. S. A. PICKERING, BOROUGH SURVEYOR.

on the main routes was completed, with the exception of Rochdale-road, which at the present time remains unaltered, and, by agreement with the Bury, Rochdale, and Oldham Tramway Company, is still being used as steam tramways on weekly rental Featherstall-road, which is part of the old tramways constructed in 1884, but which may scarcely be called a main route, is now to be reconstructed, and also Rippondenroad, which is a new route under the 1899 order. About 11¼ miles (route) of electric tramways are now in operation, two miles nearly complete, leaving approximately eight

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miles to construct. The following is a brief summary of the estimate presented at the Board of Trade enquiry :

New routes, including land for car depôt	£91,891
Reconstruction of old routes	91,778
Electrical equipment	37,901
Car depôt at Mumps	27,102
Cars	121,500

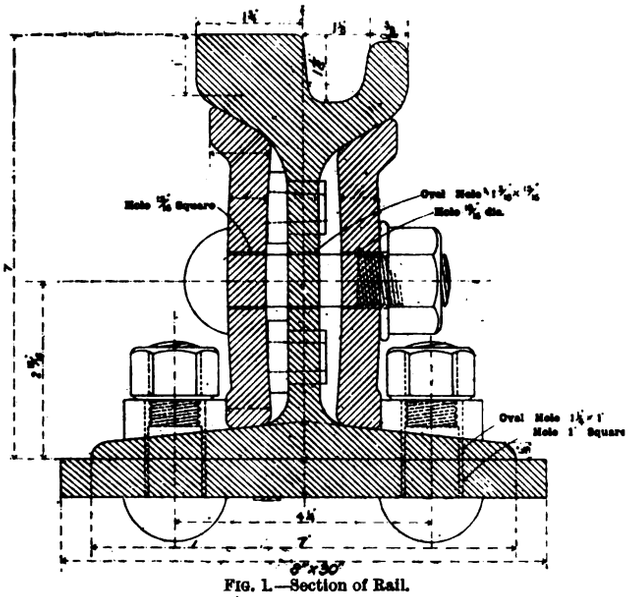

FIG. 1.—Section of Rail.

Supplementary estimate (to be presented to the Board of Trade).

Reconstruction of old routes	17,316
Electrical equipment	11,520
Car depôt at Neville-street	28,026
	£427,034

porary), erection of standards, and overhead equipment and cables, has been designed and carried out by Mr. S. A. Pickering, A.M.I.C.E., borough engineer, with Mr. H. Clegg, A.M.I.C.E., as his assistant. Messrs. Hewitt and Rhodes, of Manchester, have acted as consulting electrical engineers for the overhead equipment.

The whole of the track was constructed by Corporation workmen. The contractors for all other work are as follows: electrical overhead equipment and cables—Messrs. W. T. Glover and Co., Limited, Manchester rails, fishplates, etc.—Messrs. the Barrow Hematite Steel Company, Limited, and Messrs. Dick, Kerr, and Co.,

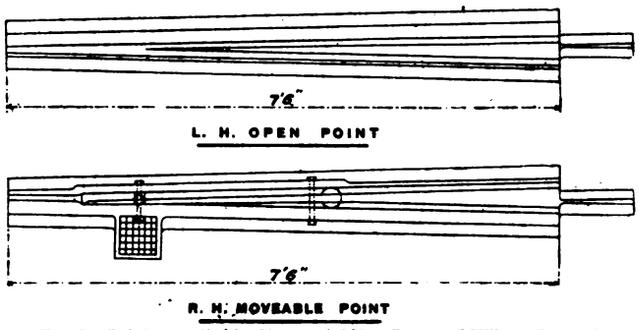

FIG. 2.—Points supplied by Messrs. Askham Bros. and Wilson, Limited, to the Oldham Tramways.

Limited, London; points and crossings—Messrs. Askham Bros. and Wilson, Limited, Sheffield; cars—Messrs. the Electric Railway and Tramway Carriage Company, Limited, Preston; car depôt—Mr. Edward Stephenson, Oldham; car depôt (steelwork)—Mr. Jno. Mundy, Glasgow.

The rails used on all new work and in relaying old tracks are rolled to a special section (Fig. 1), and are 100lb. per yard in weight. The contract for the supply of these has been in the hands of two firms: the first contract was given to the Barrow Hematite Steel Company,

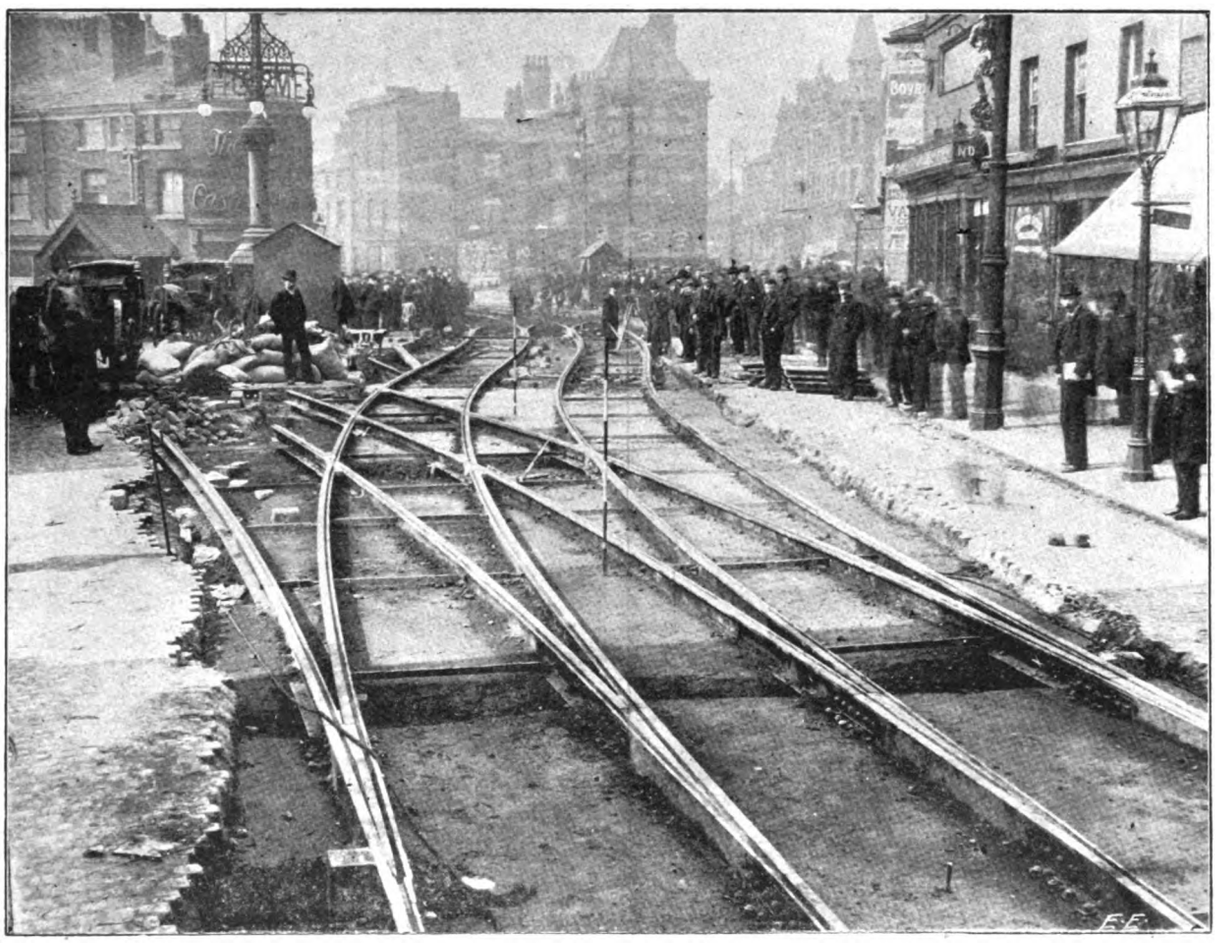

FIG. 3.—Special Work at Oldham, supplied by Messrs. Askham Bros. and Wilson.

The whole of the undertaking, including the construction of the track, building of depôts (permanent and tem-

Limited, and they supplied about 2,000 tons, terminating their contract about March, 1901; the second contract,

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for 3,000 tons, was given to Messrs. Dick, Kerr, and Co., Limited, who have now supplied about 2,000 tons. The two sections of rails differ slightly, the width of the head of the Barrow rail being ½in. less than that supplied by Messrs. Dick, Kerr, and Co. The jointing of the two makes are also different. With the Barrow rail separate sole-plates and fishplates are used, whilst with Messrs. Dick, Kerr, and Co.'s rail the fishplates and sole-plates are rolled in one piece. Fourteen bolts are required to complete the former joint, six for the fishplate and eight for the sole-plate; six bolts only are required for the latter joint, the sole-plate being constructed so as to grip the lower flange of the rail. The weight of the Barrow fishplate is 44lb., as is also the weight of the sole-plate. The weight of Messrs. Dick, Kerr, and Co.'s fishplate and sole-plate is 123lb. Tie-rods have been supplied by Messrs. Askham Bros. and Wilson, Limited. They weigh 16lb. each, and are 5ft. long by 2in. by $\frac{7}{16}$in. They are fixed every 9ft. in the track, and are secured by four bolts, two on each side of the web of the rail. There are 32 double junctions in the system, besides numerous passing-places, turn-outs, and the special work at the Wallshaw car depôt. All points (Fig. 2) and crossings, excepting those at the depôt, have been supplied by Messrs. Askham Bros. and Wilson, Limited. Approximately 183 pairs of points and 279 crossings have been used in the track laid down up to date. Figs. 3 and 5 give some idea of the character of this work as put in at

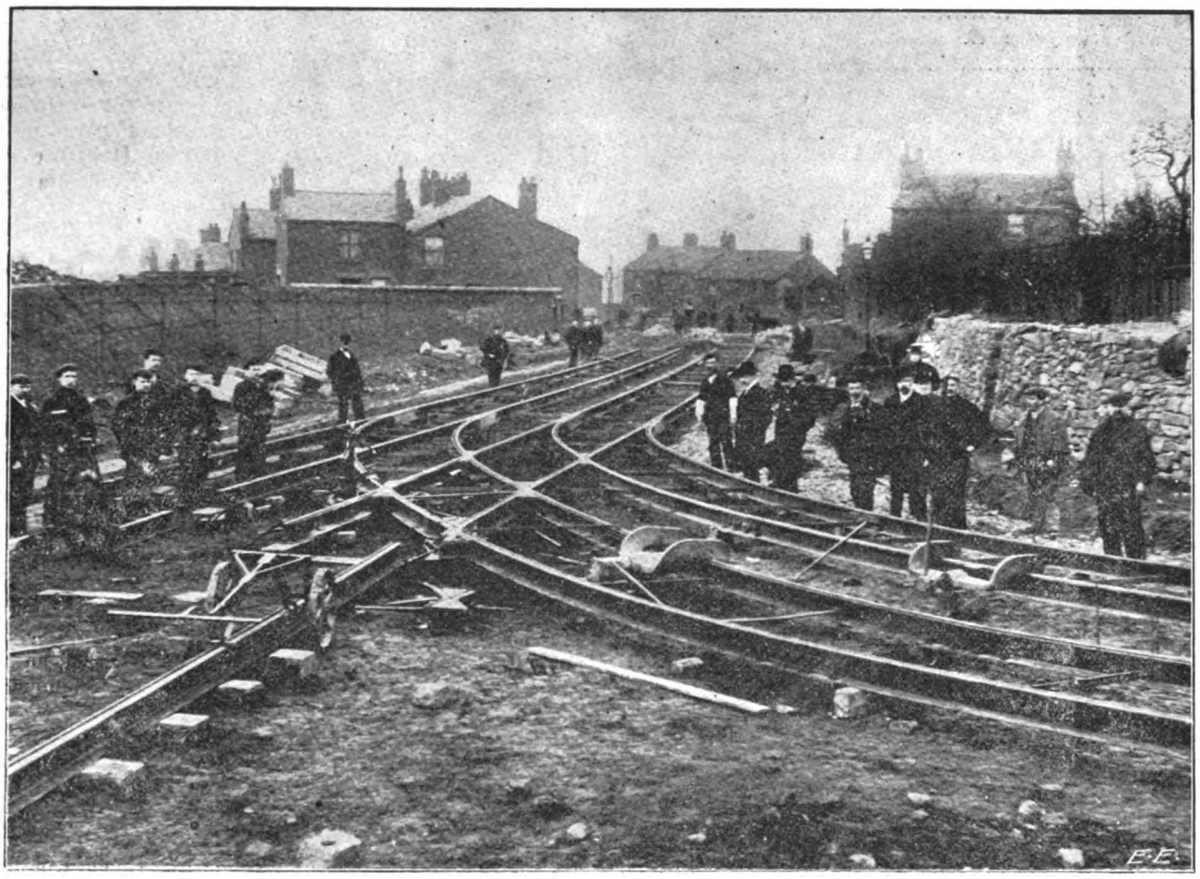

FIG. 4.

FIG. 5.

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the principal crossings of the routes. The bonding of the rail joints is effected by means of stranded copper bonds, two to each joint, each 6¾in. long, and equal in area to 166 square inches. At points and crossings solid bonds of varying lengths are used. These are 4/0 gauge, and of the same sectional area as the stranded bond. Solid cross bonds have been laid every other rail, or at intervals of about 30 yards. Messrs. Glover and Co., of Salford, have been the contractors for the bonds, and up to the present date have supplied about 12,000.

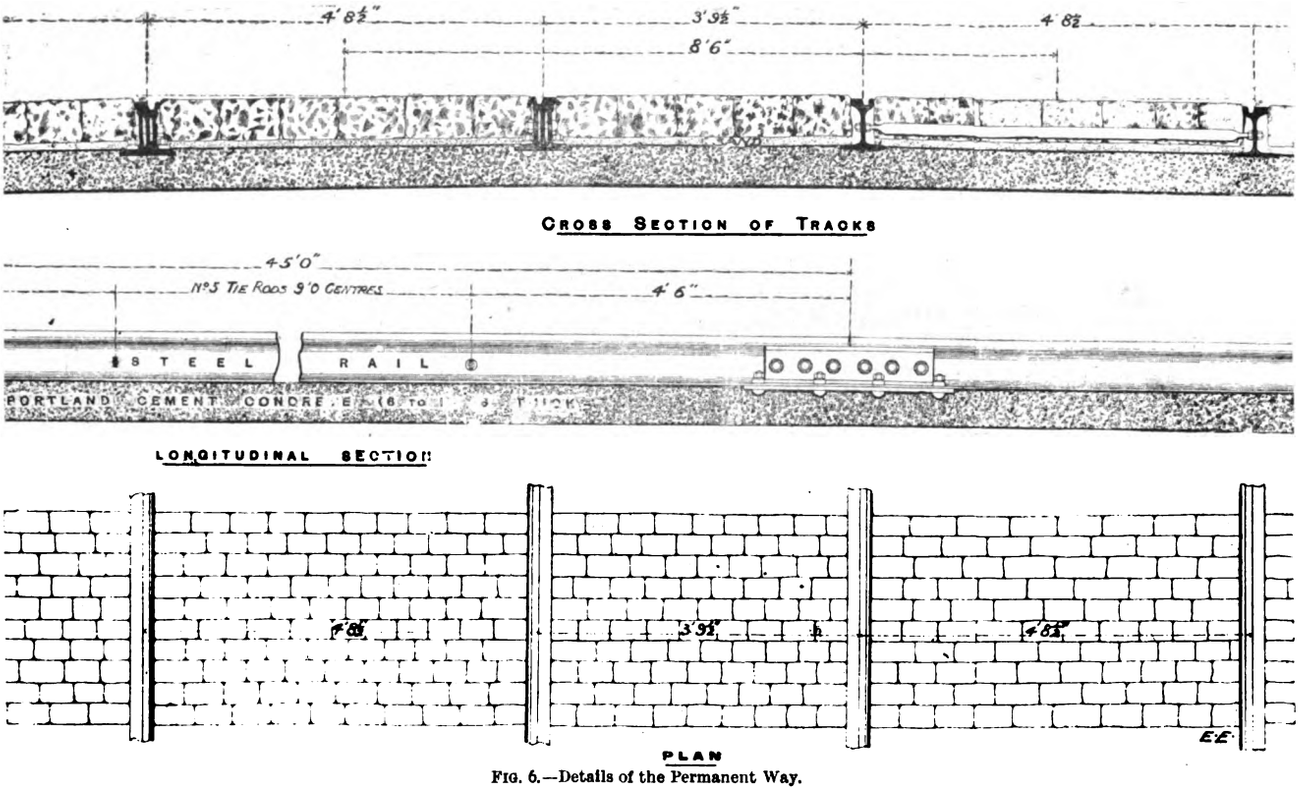

FIG. 6.—Details of the Permanent Way.

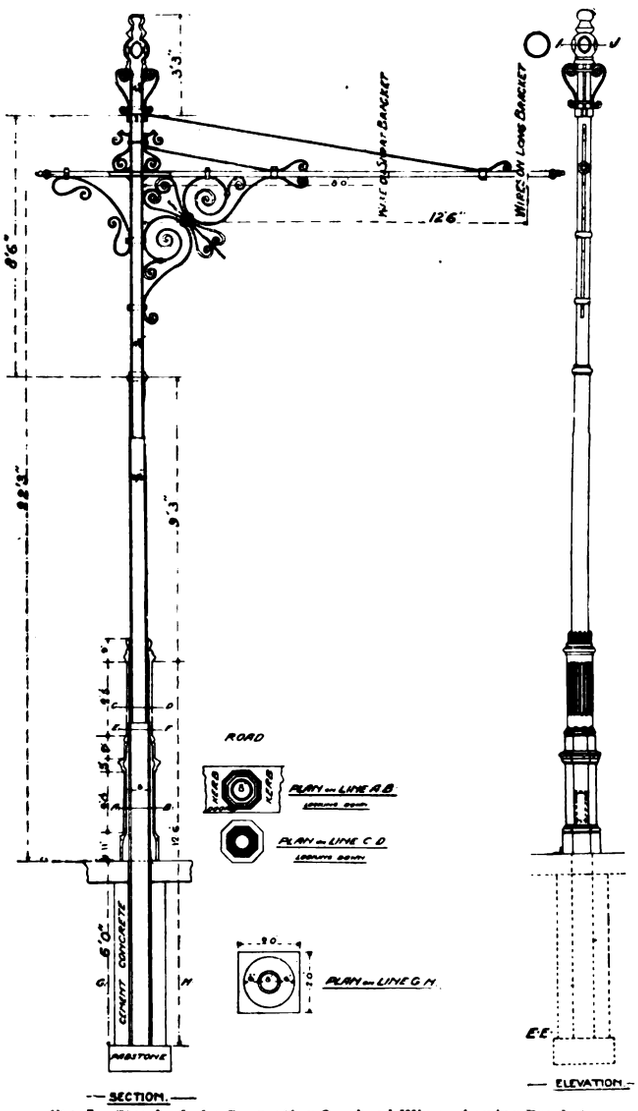

FIG. 7.—Standards for Supporting Overhead Wires, showing Brackets, supplied by Messrs. J. Spencer, Limited.

The following particulars of the track work as carried out by the Corporation workmen will be of interest. The existing carriageway with its foundation—if it be unsuitable—is first taken up and the ground further excavated and prepared to a depth of 13in. below the proposed finished level. In places where, by reason of the removal of unsuitable foundations, a greater depth than 13in. below the proposed finished level has been attained, a bed of ballast, well rammed, is laid to form the proper level. The rails are then laid upon old setts placed at intervals of about 15ft., and with the necessary small packings between sett and rail the proper gradient of the permanent way is arrived at. The rails are laid to a gauge of 4ft. 8½in., and tied in with tie-rods at 9ft. centres. On every curve of whatever radius the outside rail is given the necessary amount of elevation above the inside rail, the calculation being based upon a speed of eight miles per hour. Double tramway tracks (Fig. 6) on the straight are laid at 8ft. 6in. centres, but where they happen to be on the curve a greater centre than 8ft. 6in. is necessary to prevent two cars coming into contact whilst passing each other. When the rails are satisfactorily laid, concrete foundations, of 6 to 1 concrete, are laid to a depth of 6in. Great care is always taken that the concrete is made thoroughly solid and tight between the ground and the bottom flange of the rail; the width of the track concreted is 8ft. for single track and 13ft. 6in. for double track, which leaves 1ft. 6in. on each side of the rails. To complete the formation of the carriageway, 6in. local or granite setts, according to the locality and gradient of the road, are paved on a bed of sand 1½in. thick, the setts being laid about ½in. higher than the tread of the rail, and properly toothed into the existing carriageway between the kerb and the rail. The level of the road and its suitability for a permanent way is always duly considered, and when it is found that an improvement may be made, the full width of the carriageway is taken up. In such cases the carriageway between the kerb and the track limit is provided with a good foundation of rubble and ballast, at least 6in. thick, together with a bedding of sand 1½in. thick. The old setts are used again where possible.

The worst gradient in the whole system of tramways

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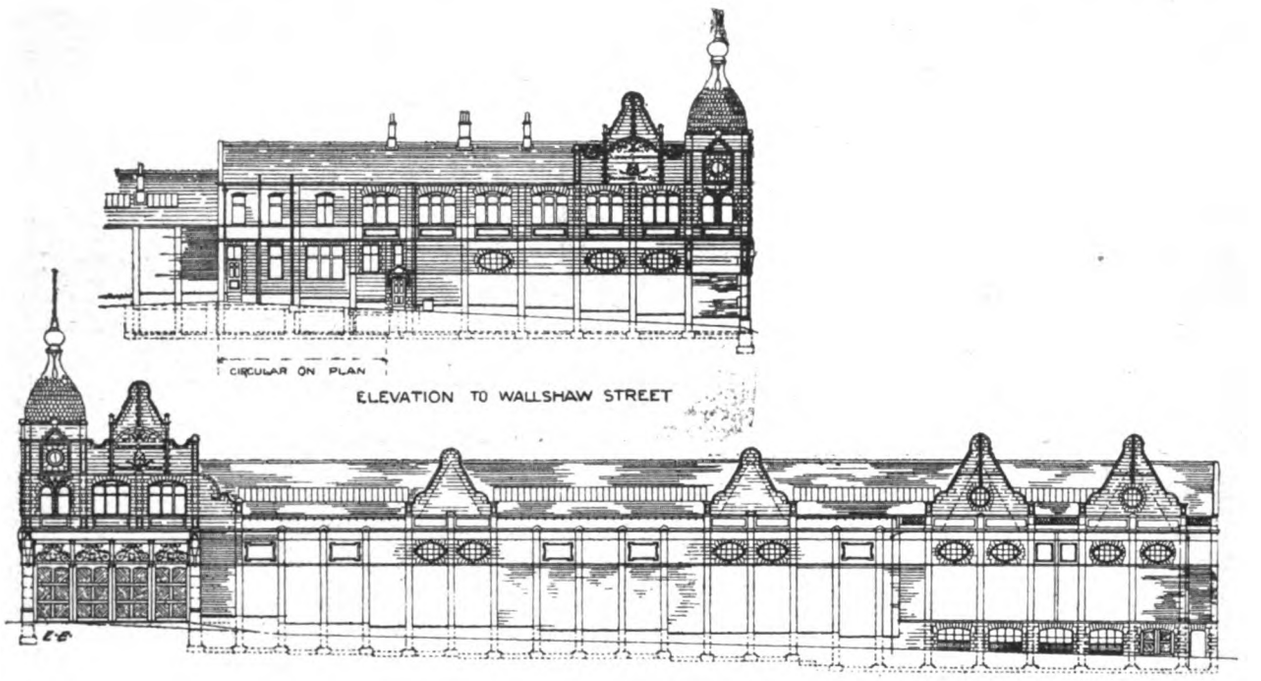
proposed and existing is in Middleton-road, which is 1 in 11·37, which lasts for 133 yards. The following is a list of routes giving quickest and slowest gradients and locality :

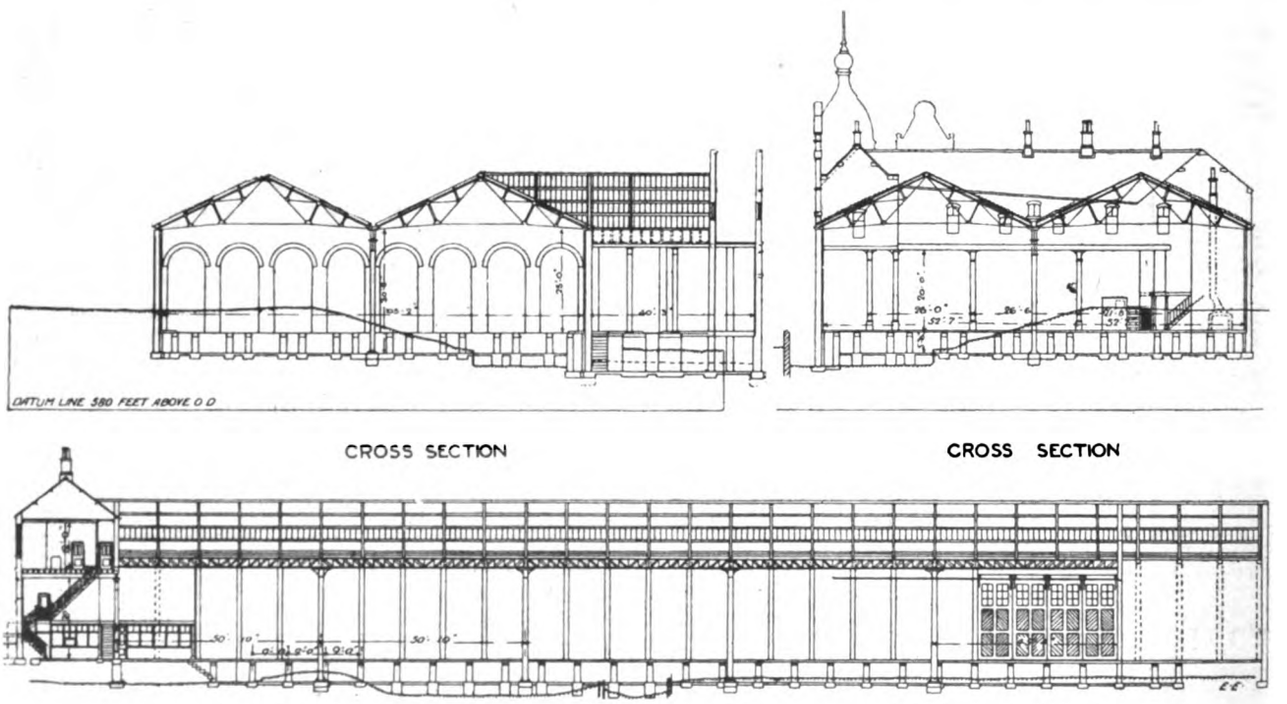
Route.	Gradient.	Length (yards).	Locality, commencing.
Chadderton-road	1 in 12·33	50	Orleans-street.
	1 in 850	30	Frankhill-street.
Egerton-street ...	1 in 13·50	40	St. Mary's-street.
	1 in 370	22	Opposite Edge-lane-road.
Middleton-road..	1 in 11·37	133	At York-street.
	1 in 27·68	80	Bay-street.
Hollins-road.....	1 in 13·45	55	80 yards above Bowley-street.
	1 in 985 and level.	66	Copster-hill-road.
Lee-street	1 in 14·85	33	70 yards past Vernon-street.
	1 in 10·40	35	150 yards past Manley-street.
Park-road and Glodwick-road	1 in 15·83	40	Landseer-street.
	1 in 440	45	Woodstock-street.
Shaw-road	1 in 14·55	27	48 yards from Derker-street.
	1 in 10·40	35	Windsor-street.
Lees-road	1 in 13·60	35	55 yards from New Earth-street.
	1 in 290	20	Frome-street.

Route.	Gradient.	Length.	Locality, commencing.
Ripponden-road	1 in 13·24	47	Collett-street.
	1 in 770	53	200 yards below Lark-street.
Hollins-road (South)	1 in 15·70 level	55	
Rochdale-road and Ashton-road steam tramway.	1 in 21	300	Denbigh-street to Boundary-street.
	1 in 466	66	Morton-street to Portland-street.
Featherstall-road	1 in 22	183	Alfred-street to Porter-street.
	1 in 147	233	Middleton-road to Arkwright-street.
Manchester-road to Waterhead	1 in 18·05	290	Cannon-street to Market-place.
	1 in 960		
Union-street.....	1 in 20	330	Manchester-street to John-street.
	1 in 950	500	Peter-street to Greaves-street.



ELEVATION TO WALLSHAW PLACE

FIG. 8.—Elevations of the Mumps Car Sheds, Oldham.



LONGITUDINAL SECTION

FIG. 9.—Sections of the Mumps Car Shed.

The standards for the overhead work (Fig. 7) were made by Messrs. J. Spencer, Limited, of Wednesbury. The steel used for the poles is the best weldable steel. Each pole consists of three telescoping lengths, with the joints thoroughly rolled and welded solidly. The butt end of the pole is 12ft. 6in. long, the intermediate length 9ft. 3in. long, and the top end or length 8ft. 6in. long.

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There are three types of poles—viz.: (1) a bracket pole; (2) a span-wire pole; and (3) a terminal pole. The first type (bracket pole) is 8in. diameter at the base, tapering to 4⅞in. at the top, with a uniform thickness of metal throughout of ⅜in. The second type (span-wire pole) is 7in. at the base, tapering to 4½in. at the top, with a uniform thickness of metal throughout of ¼in. The third type, or terminal pole, is 10in. diameter at the base, tapering to 6¼in. at the top, the metal throughout being of a uniform thickness of ½in. The poles, without base or scrollwork, are subjected to varying tests, as set forth in the specification. The bases are of cast iron, made in two sections, having ornamental mouldings and coat-of-arms cast thereon in high relief. Each bracket pole (Fig. 7) is fitted with ornamental scrollwork in wrought iron, and fitted so as to act as a support to the bracket arm. At the junction of each section of a pole cast-iron moulds are fixed, which hide the jointing.

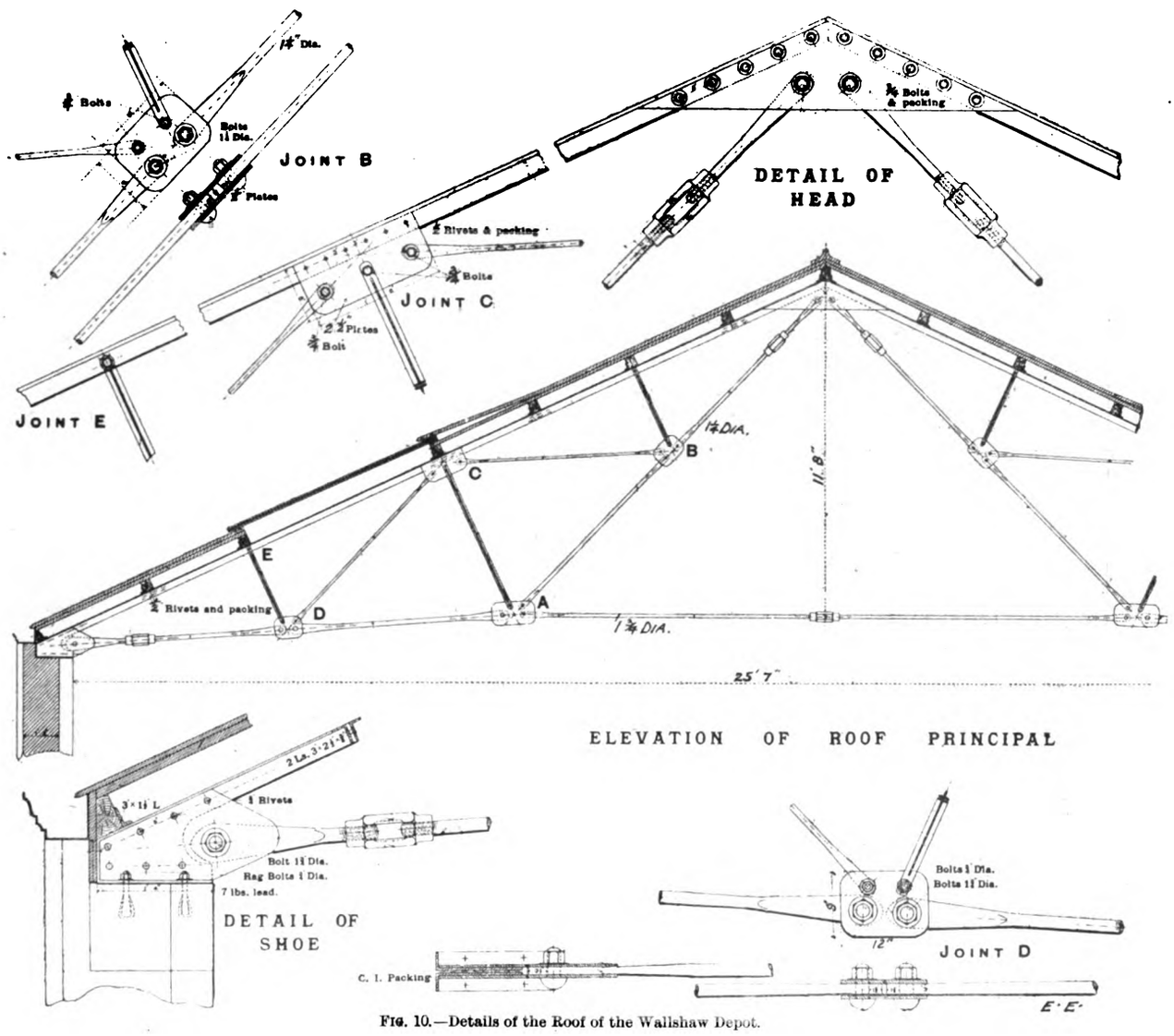

FIG. 10.—Details of the Roof of the Wallshaw Depot.

The electrical equipment has been supplied by Messrs. W. T. Glover and Co., Limited. To convey the current one large feeder cable is taken out from the generating station to each route and gradually diminished in size. There are five feeder cables, varying from ·75 square inch to ·1 square inch in sectional area. All cables are drawn into earthenware conduits through drawing-in boxes placed at intervals along the route. The cables are of Messrs. W. T. Glover and Co., Limited, own make, and the insulation is impregnated paper, lead-covered. There are 25 feeding points on the route, and the number of section

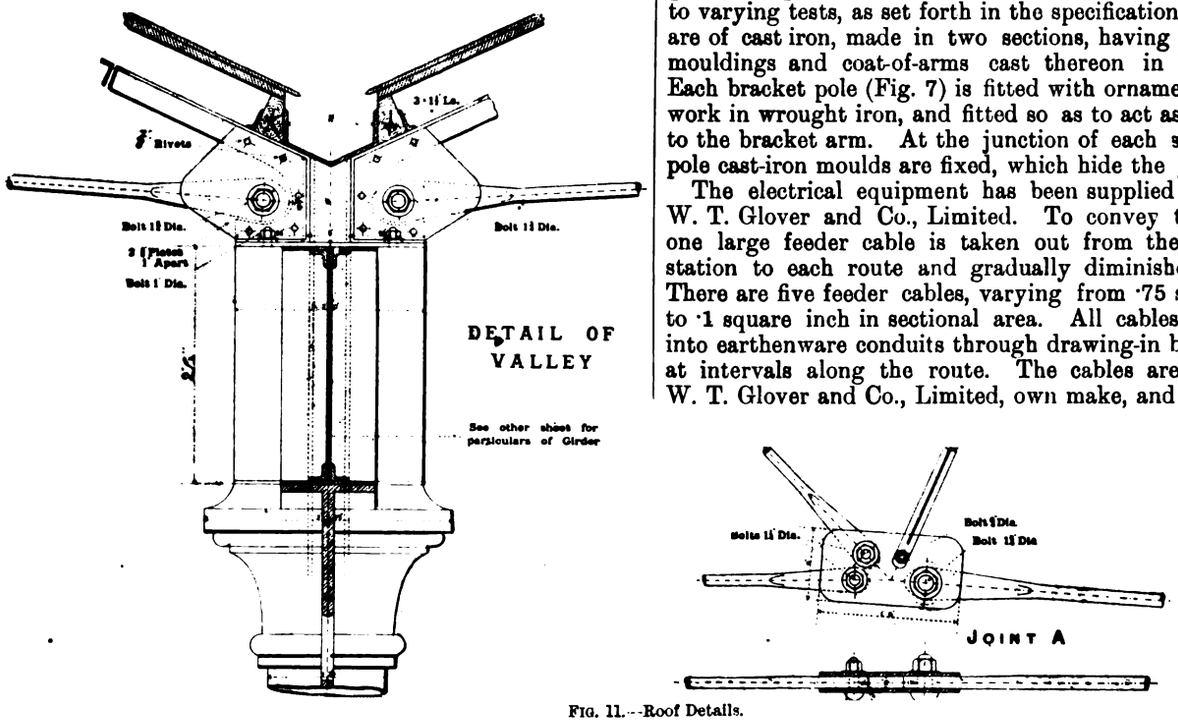

FIG. 11.—Roof Details.

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boxes is 45. The telephone system is not yet installed, but it is proposed to fix a telephone in each section pillar communicating to the car-shed. The overhead trolley wire is 3/0 gauge, and two wires are used throughout the system.

Messrs. Smith and Sons, Anaconda Works, Salford. The overhead fittings were mostly supplied by Messrs. Estler Bros. Guard wires of No. 8 steel are fixed where necessary, in accordance with the Post Office and Board of Trade regulations.

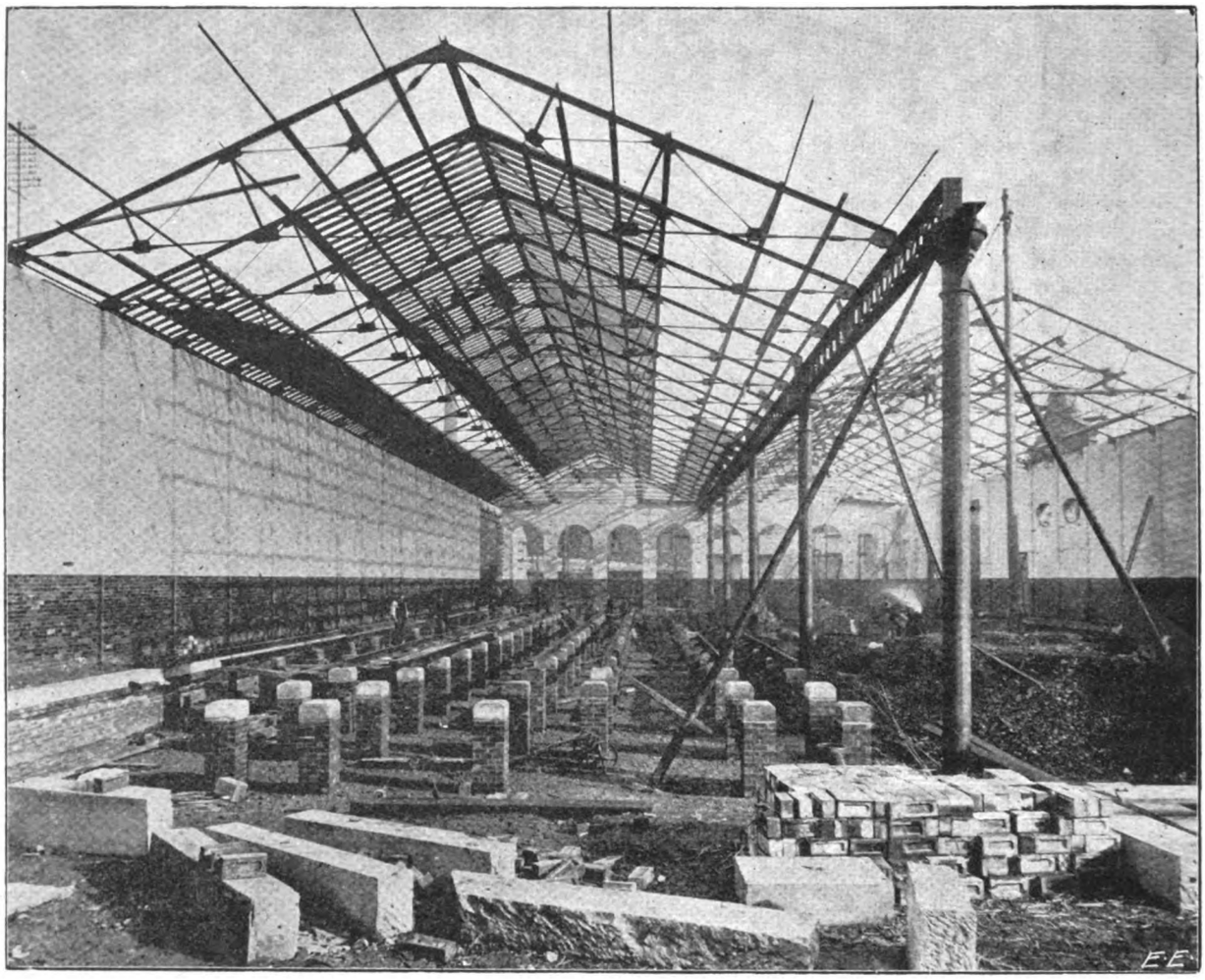
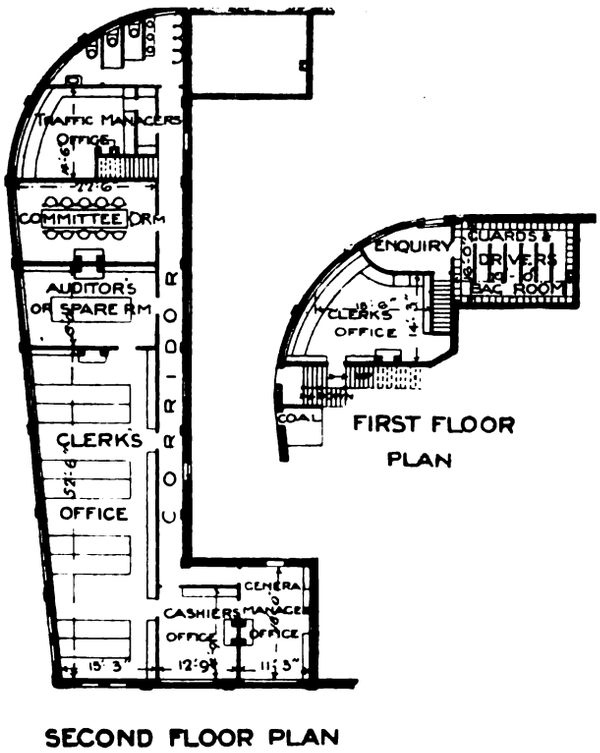


FIG. 12.—Car Shed in course of Erection.



The car depôt at Wallshaw Mumps (Figs. 8 and 9) was originally constructed to accommodate 70 cars. It is approximately 111 yards long by 35 yards broad and 25ft. high from the rail level to the underside of the roof principal (Fig. 10). There are eight tracks into the depôt, converging from one single track at the entrance, necessitating an amount of special work with 44 points and 22 crossings. The car-pit for the examination of car trucks is constructed over the whole width and length of the car-shed, the rails being fixed to brick piers 1ft. 6in. square and 5ft. 6in. high, built at 9ft. centres. Six turntables of varying diameter are constructed at the east end of the building for use in turning the cars out into the new street behind the shed, from whence they may be run into Wallshaw-street and out on to the main line in Yorkshire-street. There are four workshops at the extreme end of the building, which are to be fitted with suitable machinery, such as motors, lathes, circular saws, milling machine, blacksmiths' hearths, etc. The

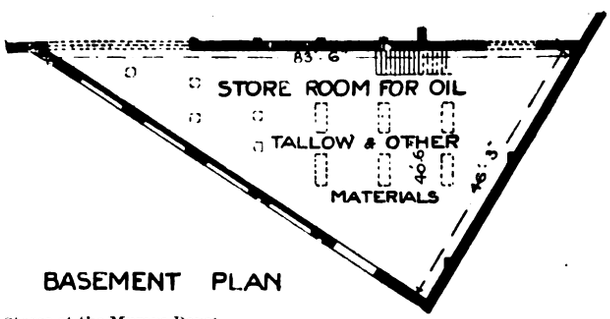


FIG 14.—Details of Offices and Stores at the Mumps Depot.

They are fixed 22ft. 3in. above the level of the carriage way. The material is hard-drawn copper wire with conductivity of 99 per cent. The manufacturers of this were

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main shed is divided into two bays, the roof principals being supported in the middle by a lattice girder 2ft. 6in. deep, and supported on five cast-iron columns 28ft. long (Fig. 13). The offices (Fig. 14) are situated at the west end of the building, and comprise a manager's office, cashier's office, clerks' office, auditors' room and committee room, traffic manager's office, guards' and drivers' room, bag room, enquiry office, lavatories, etc. The construction of the building involved the following materials: 2,000 cubic yards of excavation; 1,200 cubic yards of concrete; 8,257 square yards brickwork, reduced to 9in. work; 200 tons of steelwork in roof principals, etc; and 100 tons of girder rails.

The cars used on the lines were manufactured by the Electric Railway and Tramway Carriage Company, Limited, of Preston. Three different types of car are in use—*i.e.*, a single-deck single-truck car, a single-back bogie, and a double-deck car with a single truck. The seating capacities of these cars are respectively 28, 36, and 58. The trucks are of the Brill type, and the electrical equipments were manufactured by the English Electrical Manufacturing Company, also of Preston. All the motors are of 25 h.p., and the number of motors per car varies from two to four, according to the type and weight of the car. The controllers are of the same firm's make, having the solenoid blow-out. The trolley heads are of the Wilkinson type, and Messrs. Estler Bros. provided the trolley stand. The cars are fitted with three different brakes—*i.e.*, a handwheel brake, an electrical emergency brake, and a pneumatic slipper brake. In the front of the car Tidswell's lifeguards are fixed.

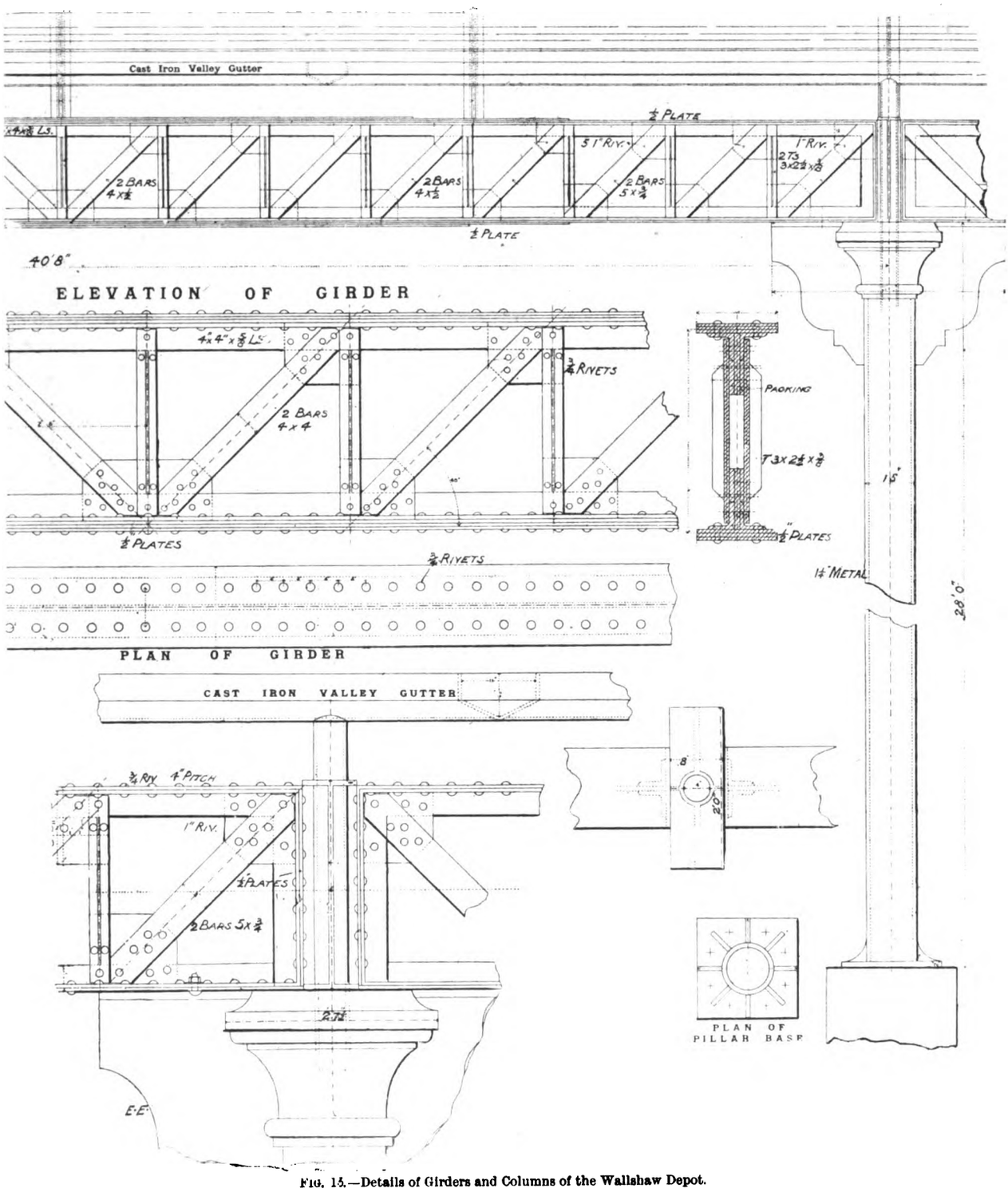

FIG. 15.—Details of Girders and Columns of the Wallshaw Depot.

The tramways service in Oldham commences at 5 a.m. in the morning and is carried on until 11.20 at night. The average frequency at present is 10 minutes, and we understand that this is to be materially reduced as soon as more rolling-stock and more power is available. The average car mileage per day is about 1,200 at present, and it is found that about 0·9 of a Board of Trade unit is the average consumption of energy per car mile. At the present time the power for working these trams is taken from the old electric lighting works, which are equipped

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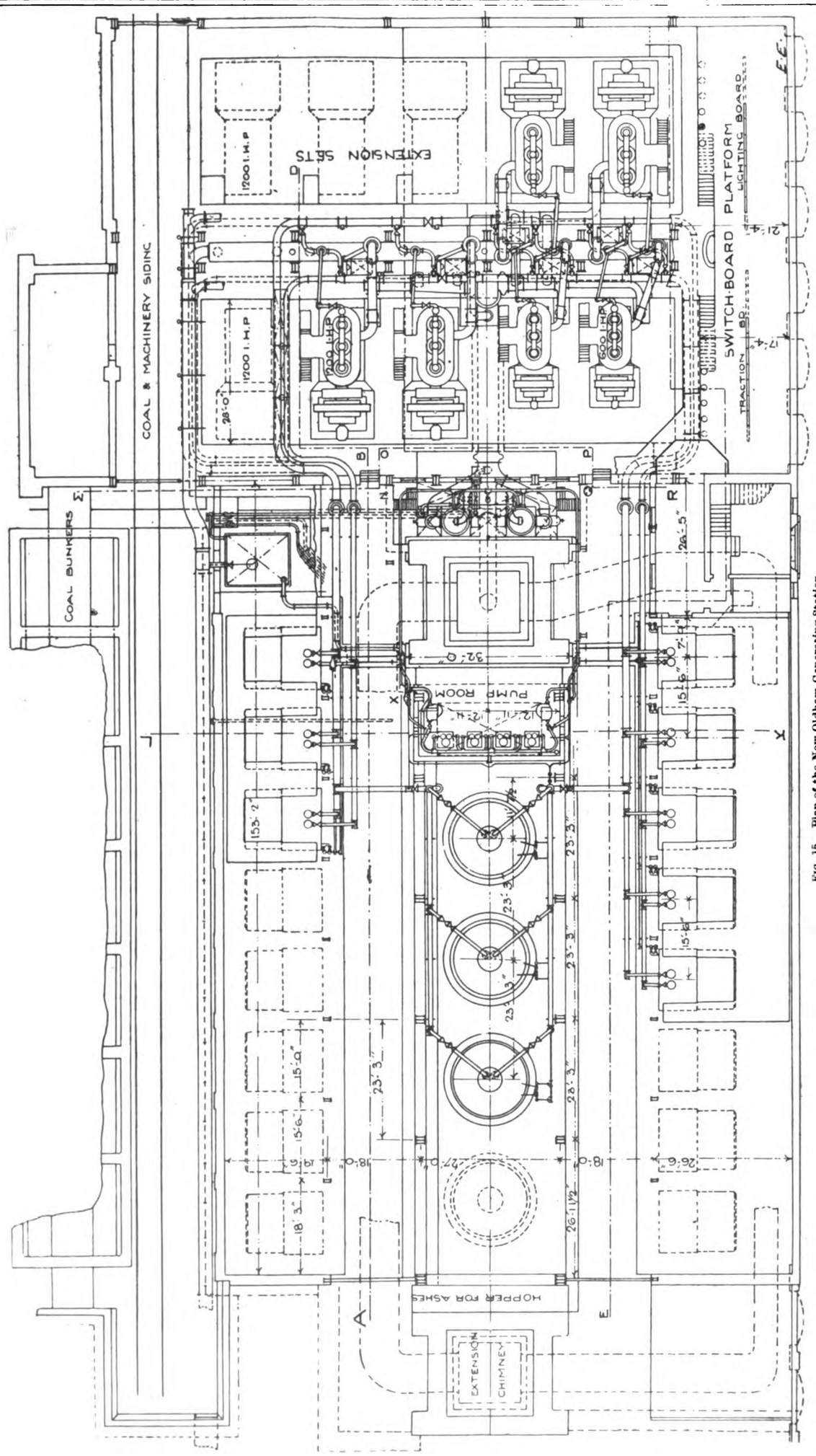

Fig. 15.—Plan of the New Oldham Generating Station.

with direct-current plant available either for traction or lighting. It was recognised, however, that this station, which is already crowded, could not contain the additional new plant required when all the tramways are at work.

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On the advice, therefore, of their consulting engineer, Dr. A. B. W. Kennedy, large new generating works are being erected, but these were not in a sufficiently advanced state to be opened last week. We understand, however, that the building work is progressing favourably, and that the erection of the boilers has been commenced.

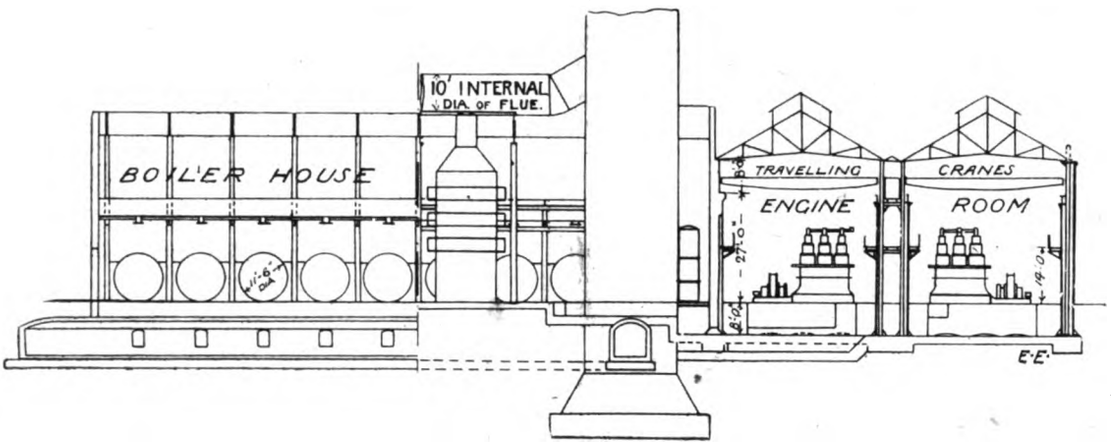

FIG. 16.—Sectional Elevation of the same.

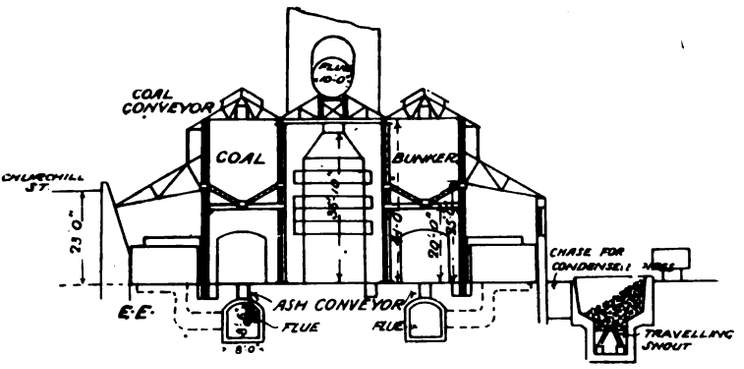

FIG. 17.—Section showing Coaling Arrangement.

Through the kindness of the consulting engineer, we are able to give the following illustration of these large works, which are novel in many respects. From the general plan (Fig. 15) it will be seen that in the boiler-house there are three lines of boilers. The outside lines consist of dry-back marine boilers, but the centre line consists of three Climax boilers, which have not been up to the present used to any great extent in this country. The flues from these boilers has from their construction to be overhead, and the details of the same can be seen in Figs. 16 and 17.

A 10ft. diameter steel flue is carried along the top of the centre bay of the boiler-room, and then into the shaft. The cross-section (Fig. 17) shows well what the coaling arrangements are for feeding both the marine and Climax boilers. The elevation (Fig. 18) gives a good idea of the feed-pipe arrangements. The contractors for the equipment of this new station are the following: marine boilers, Edwin Danks and Co., Oldbury; Climax boilers, B. R. Rowland and Co., Reddish; electric generators, Messrs. Siemens Bros., Woolwich; engines, Messrs. Willans and Robinson, Rugby; pipework, Messrs. Babcock and Wilcox, London; crane, J. Broadbent, Limited. The barometric condensers are to be of the Bulkley type, and are, we believe, the first of the kind to be erected in the kingdom. The switchboard contract has not yet been settled. We hope to give a detailed description of these large and interesting works after they are more nearly completed. The photographs which we have reproduced were taken by Mr. Percy Guttenberg, of Manchester.

At the opening ceremony on the 19th Mrs. Chadwick, wife of Alderman Chadwick chairman of the Tramways Committee, and Mrs. Hanson, wife of Councillor J. A. Hanson, vice-chairman, started the first and second cars respectively. After the procession of decorated cars had gone over the principal lines the guests adjourned to the town hall for luncheon and speech-making.

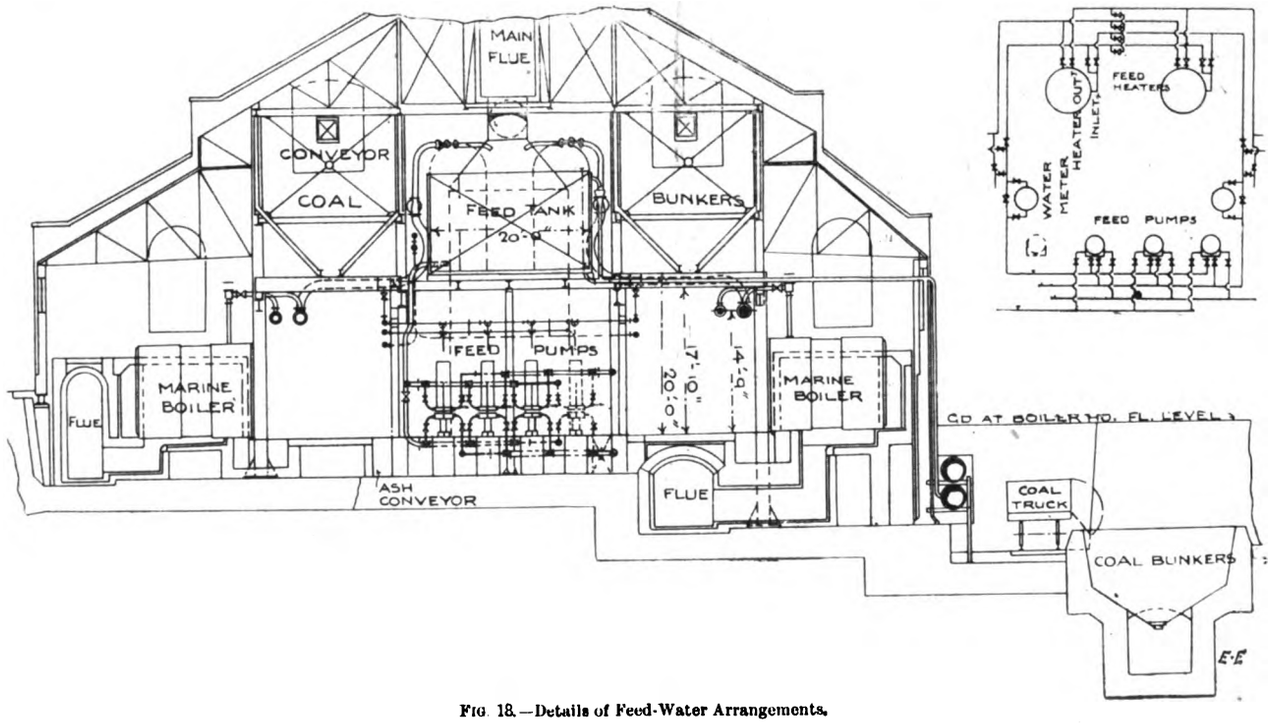

FIG. 18.—Details of Feed-Water Arrangements.

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THE ELECTRIC LIGHTING OF ST. PAUL'S CATHEDRAL.

On Wednesday last we had the opportunity of inspecting the electric lighting of St. Paul's Cathedral under the guidance of Mr. C. J. Scott, who has had charge of the work for the contractors, Messrs. W. A. S. Benson and Co., Limited, of 82 and 83, New Bond-street. We purposely made our visit independent of the Press view of the lighting at 9 p.m. in order to get from Mr. Scott technical information as to the way in which the work had been carried out and the difficulties encountered. The consulting architect to the cathedral, Mr. Somers Clarke, F.S.A., has superintended the work, and Dr. A. B. W. Kennedy has acted as consulting engineer. It will give a good idea of the difficulties involved in wiring the cathedral when we state that the work has been in progress for three years. In that time between 1,100 and 1,200 lights have been wired for and erected at a cost of almost £10,000.

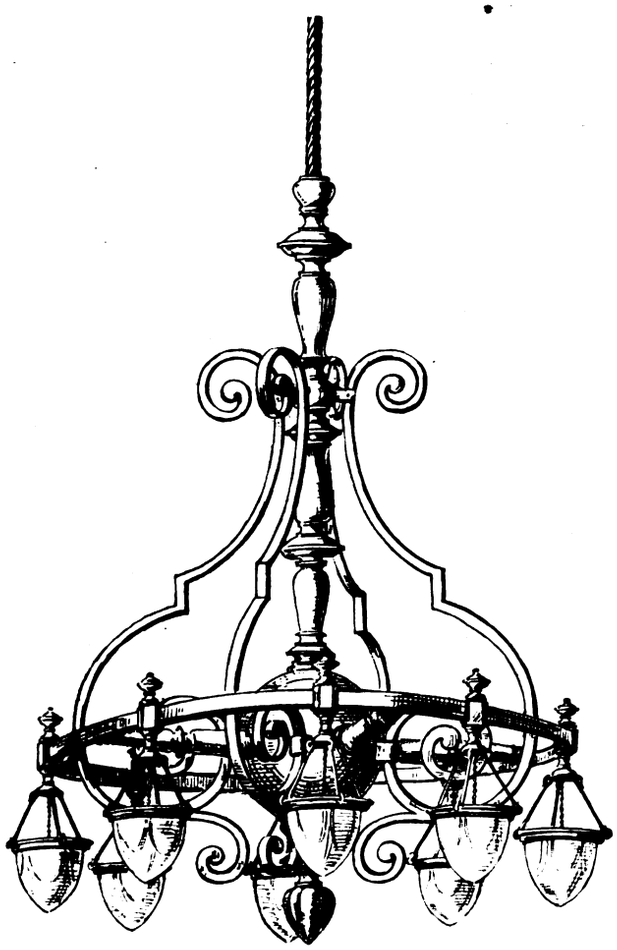

Fig. 1.—Coinage Metal Fittings for the Dome Lighting in St. Paul's Cathedral.

The supply is taken at 200 volts, half from the mains of the City of London Electric Lighting Company, and half from those of the Charing Cross and City Electric Supply Company. In this way a duplicate supply is obtained which prevents a total extinction of light if either company had a breakdown. The two circuits are, of course, kept quite distinct throughout, and alternate lights or groups of lights are connected to each, so that no part of the cathedral would be in total darkness if either supply were to fail. The arrangement of the circuits is briefly as follows: From the main boards, which are fixed near the supply terminals, a number of main circuits are run to distribution boards throughout the building. Each of these main circuits is provided at the main board with double-pole switches and fuses. A large number of these distributing boards, to which the individual circuits are connected up, are grouped together at one point in the crypt, so that the lighting of the chancel, dome, and nave can be conveniently controlled from one point. In each of the smaller circuits supplying the individual electroliers a switch and fuse is provided in each conductor. The wires are all laid in iron barrel, which, so far as we inspected the crypt, is mostly out of sight. The bulk of the mains are carried under the crypt floor, access being obtained to them by means of inspection boxes, having covers filled in with red tile to match the rest of the flooring. The rule was made

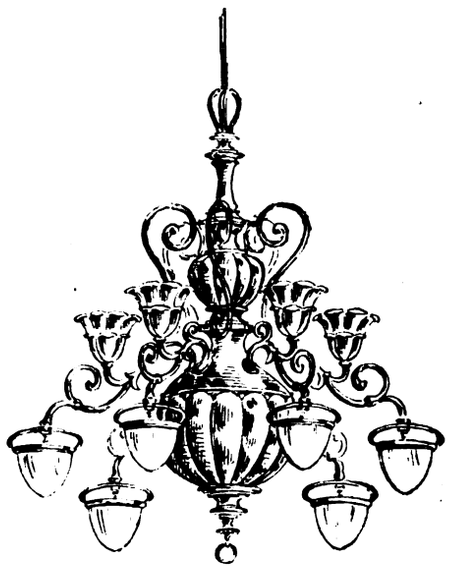

Fig. 2.—Gilded Fittings for the Chancel Lighting

that no tube was to be carried across any tomb, or across any space which might hereafter be required for interment. In consequence, the tubes have as a rule to be carried close to the walls and to follow the contour of the same, which has necessitated a large number of inspection boxes to

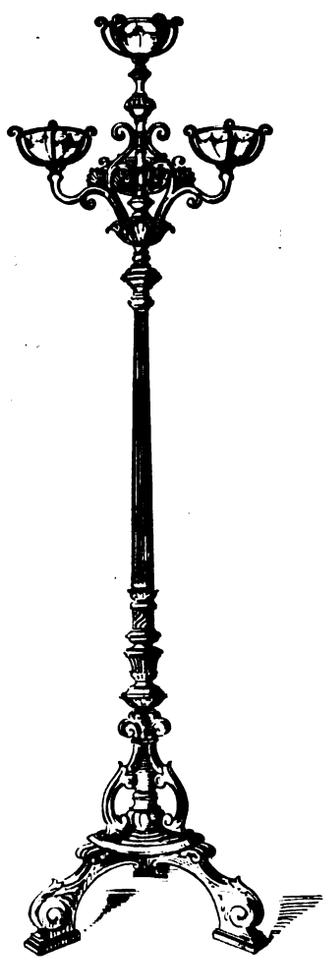

Fig. 3.—Bronze Standards for the Nave Lighting.

enable the wires to be got round the numerous angles. A large number of these iron barrels are 3in. in diameter, so that many wires can be pulled into the same tube. In the construction of the cathedral, Sir Christopher Wren left vertical shafts in a number of the main pillars, and these have been utilised for carrying up the vertical leads into the

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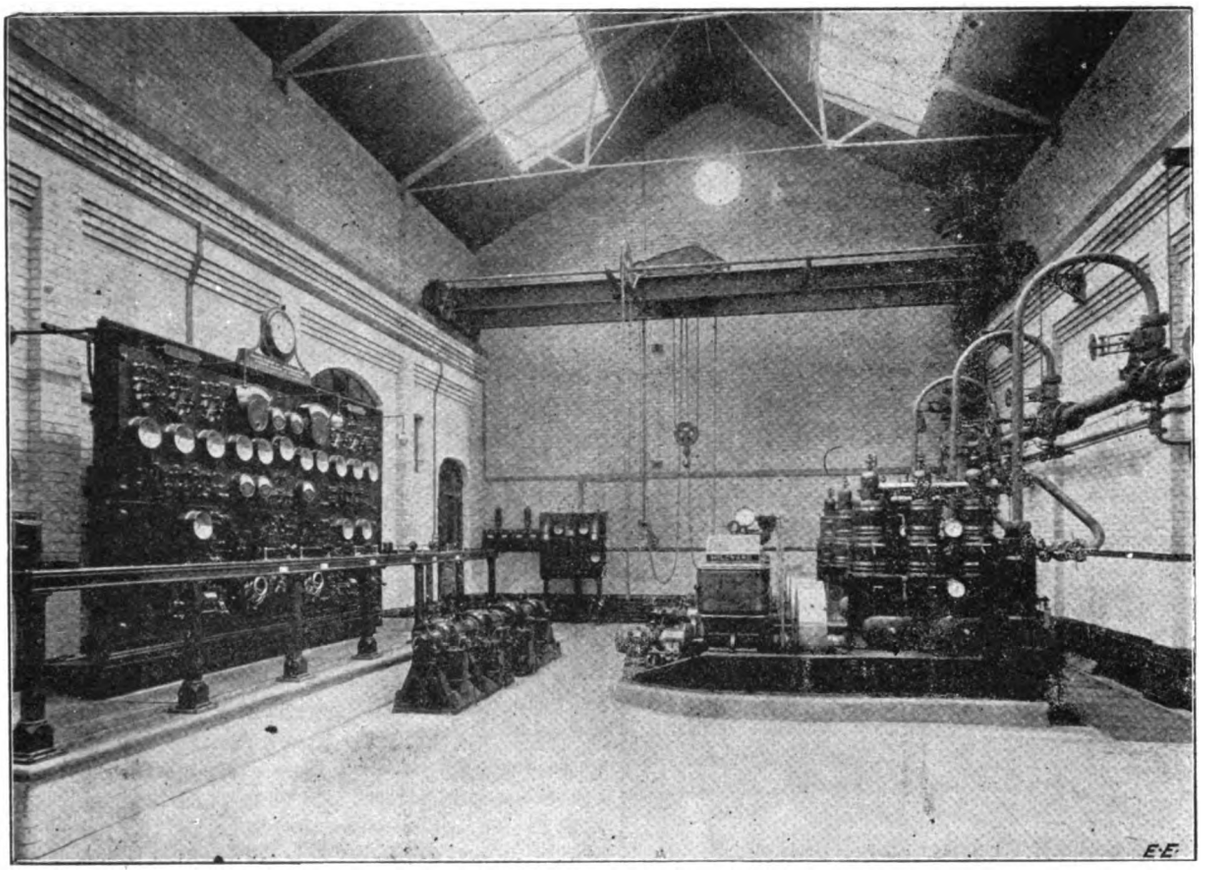
roof. The contractors for the electric lighting think that "the hollow centres of these main piers might almost have been designed for the purpose." While this is not probable, the fact remains that these vertical shafts and holes left in the roof of the chancel have enabled the work to be carried out with a minimum amount of damage to the stonework of the cathedral. Owing to the great length between the distributing boards in the crypt and the lights supplied from them hanging from the roof, the wires have to have very considerable area. We are informed that a current density of 250 amperes per square inch was adopted so as to prevent appreciable drop of voltage.

Of the lighting of the crypt we do not propose to deal in detail, but the three accompanying illustrations will serve to give an idea of the electrical fittings used respectively in the chancel, dome, and nave of the cathedral. The dimensions, however, are not on the illustrations, and in consequence one can hardly appreciate the massive character of the pendants. For instance, the fittings which are suspended from the whispering gallery of the dome in order to light the seats under the dome weigh a quarter of a ton each. These are illustrated in Fig. 1, and are cast in coinage metal and left with a scraped finish. The result is that they harmonise well with the mosaic decorations of the walls round the whispering gallery. The chancel fittings (Fig. 2) are gilded. The great weight of these hanging fittings is borne by a stranded steel armouring round the conducting wires. The outside diameter of this strand is almost 1in., and at intervals up the length of the wire ornaments are attached, which add to the general effect. The fittings are carried from the end of cantilevers inlet into the walls of the dome, and the weight is entirely borne by the steel armouring. These fittings were designed by Mr. Clarke and cast by Messrs. Benson. The nave is lighted by standards from the floor, as illustrated in Fig. 3. These exquisite bronzes are the outcome of three separate designers' labour. For instance, Mr. Penrose and Mr. Pegram were responsible for the pedestal and column, while Mr. Clarke designed the upper portion, which was cast by Mr. Benson. A great feature in the lighting is that the lamps are carried in basin-shaped glasses, which act as diffusers of the light. The glass in question is of a special texture, and is the outcome of researches on the subject by Mr. Benson. Its general appearance is not unlike in finish that of hammered metal work, and the irregular surface serves as an excellent diffuser of light, without, we are informed, unduly absorbing it. It will be remembered that the lighting of St. Paul's Cathedral is the gift of Mr Pierpont Morgan, and this gift will be more appreciated by the London public when it has been enjoyed in the winter. At present the nights are so light that one has to go to the cathedral at nine o'clock in order to judge the effect.

ALDERSHOT ELECTRICITY WORKS.

Through the kindness of Mr. O. F. Francis, the resident electrical engineer of Aldershot, we are now able to give the following photograph of the engine-room equipped under his supervision. It is not often that one photograph can be taken of the whole generating plant and switchboard to show as well as this one does the arrangements of the station. It will be noticed that the first dynamo is named "Hildyard," after Lady Hildyard, who opened the station. A full description of these works will be found in our issue of May 23.



The Engine-Room of the Aldershot Electricity Works.

Correction.—We have to correct an error which has occurred in one of our "Notes" this week, headed "The Factory Act of 1901," which, unfortunately, was not discovered until too late to delete. It seems that the deputation to the President of the Board of Trade next Thursday is not solely concerned with the effect of the Factory and Workshops Act of 1901 on the industry, but that the opportunity will be taken to lay the views of the Institution of Electrical Engineers before the President of the Board of Trade on the general subject of electrical enterprise from the point of view of legislation. We were under the mistaken impression that the deputation would merely urge upon the representative of the Government the great desirability of modifying certain of the provisions of the Factory Act in its application to electrical works.

Edison's Latest Battery.—According to a New York message, Mr. Edison claims to have solved the problem of the storage battery for automobiles. In an experimental run on Friday he is said to have made a speed of 83 miles an hour with his latest battery. For ourselves, we are not inclined to believe this in view of the numberless false rumours which obtain circulation through the daily Press on th subject. It would be well to wait for some authentic information before accepting the above statement.

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ELECTROLYSIS OF MAINS (?)

In these days of specialisation it is exceedingly difficult for engineers to keep themselves fully informed on all matters connected even with their own particular branch of work. The consequence is that few find time to get more than a general idea of work outside of their own practice, and are apt to take the views of their own particular trade journal on such matters. Thus when the great question of electrolysis was discussed at the Glasgow Engineering Congress last year, the majority of the gas engineers speaking displayed a lamentable want of knowledge of the subject. They would learn much from Dr. W. Leybold's able paper which was then read on "The Destruction of Gas-Pipes by Means of Electricity," but they could not forget their preconceived ideas on the subject. This paper clearly showed that ordinary corrosion was due to electrolysis, and occurred in places where there were neither electric lighting nor electric tramways. We remember that one English gas engineer corroborated this to the disgust of the chairman. As we remarked in a leader at the time, it would be most unfair if electric tramway enterprises were called upon to make good damage done to pipes by the ordinary action of the soil. As a further evidence of how gas engineers are being educated in the matter, we give the following extracts from our esteemed contemporary the *Journal of Gas Lighting, Water Supply, etc.*, whose issue for May 27 will form amusing reading to electrical engineers. In this and previous issues our contemporary has "wiped the floor" with the English electrical papers by arguments which we should be the last to attempt to refute. Fresh from these extensive victories, our contemporary takes up the question of electrolysis of mains. The editorial article commences as follows: "The remarkable communication from Mr. Wood, of Bradford, which is noticed in another column, will serve as a further provocation to those who are charged with the responsibility of safeguarding the interests of the gas industry to give heed to the danger of electrolysis." After reading this, we naturally turn to see the communication in question. We find that the communication was a photograph, round which the editor of our contemporary had displayed his intimate knowledge of electrolysis. This photograph, to quote the description in question, "is a remarkable piece of evidence from that city as to the grave danger which is now threatening gas and water mains by the great electrical traction systems which are daily on the increase throughout the country. The gas-main illustrated is a twelve-inch one, and the two ugly, gaping apertures are the result of the fusing of an electric tramway cable on the 18th inst. The cable had been laid close to the gas-main at this point, and when it fused, Mr. Wood says, 'it melted up the earthenware pipes, bricks, and stones, but fortunately did not ignite the gas.' This shows the brilliant chance that gas-mains have in the face of an accident of this kind. The character of the holes in the gas-main are of interest. The one on the right-hand side, it will be observed, is a clean straight cut through the metal, and the aperture on the left-hand side is much of the same kind, but appears to have a good deal of surrounding fitting. The photograph was taken *in situ*. This must have been rather a troublesome job, but our illustration shows that it was very successfully accomplished. In this Mr. Wood has, indeed, done great service to the gas industry, and has supplied a strong lever with which to help forward the claim of gas undertakings to protection in connection with electrolysis. We undertake to say that more will be heard of this Bradford example of the gravity of the growing danger." This quotation shows the danger of using large words like electrolysis without,

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at least, some elementary idea of their meaning. We do not propose to take up the ungrateful task of educating the editor of *Gas Lighting, Water Supply, etc.*, on this subject, but think that he should attend the lectures of the electrical experts retained by the large gas companies to report on such matters as they arise. We would point out, however, that an "electrolysis" which melts up earthenware pipes, bricks, stones, and gas-pipes is of the kind which can be easily located and removed, as at the same time it does damage to the electric cables. We should be extremely surprised to be informed that the damage to the twelve-inch gas-pipe photographed by Mr. Wood was not opened up and discovered in the course of repairing the faulty electric main. This may serve to explain why the gas was not ignited, as the melting "electrolytic" (?) process had ceased before the excavation was made which enabled an explosive mixture of gas and air to form. If this class of article is the usual literature on which gas engineers are expected to form their ideas on the subject of the electrolysis of gas and water pipes, we are not surprised at the tone of the discussion at Glasgow last year.

DUBLIN LOCAL SECTION.

The second annual report of the committee of the above section of the Institution of Electrical Engineers for the year ending this month, states that during the session nine ordinary general meetings have been held, at which various papers were read and several exhibitions of apparatus made. The committee announce that one of the members of the section, Mr. J. W. Towle, has been nominated to the Committee on Traction, Light, and Power Distribution. They have communicated with the Department of Agriculture and Technical Instruction for Ireland with reference to the utilisation of water power, asking that the Board should consider the desirability of taking some steps to secure the collection of data as to available water power at different seasons of the year, also of the sites for water power which are not at present utilised. A sub-committee has been appointed to enquire into the suggestion made in Mr. Ruddle's paper on consumers' installations. During the session 12 new members of various grades have been elected. The total membership has thus been increased from 58 to 66, at which figure it now stands.

FORTHCOMING EVENTS.

FRIDAY, MAY 30.

Royal Institution.—At 9 p.m., Prof. J. A. Fleming on "The Electronic Theory of Electricity," in place of Mr. Marconi's lecture on "The Progress of Electric Space Telegraphy," postponed till June 13.

MONDAY, JUNE 2.

Incorporated Municipal Electrical Association.—Annual convention opens in London. The convention will close on June 5.

Institution of Junior Engineers.—Visit to the new signal cabin of the South-Eastern and Chatham Railway. Meet at Charing Cross Station (under the clock) at 7 p.m.

WEDNESDAY, JUNE 4.

Electro-Harmonic Society.—At 4.30 p.m., at the Institution of Electrical Engineers, annual general meeting.

THURSDAY, JUNE 5.

Institution of Electrical Engineers.—At 12 noon, deputation to President of the Board of Trade on the subject of electrical enterprise.

FRIDAY, JUNE 6.

Royal Institution.—At 9 p.m., Sir Benjamin Baker on "The Nile Reservoir and Dams."

Engineering Standards Committee.—We are informed that the Council of the Institution of Electrical Engineers have appointed Sir Wm. Preece and Colonel Crompton to represent them on the Engineering Standards Committee.

MANCHESTER ELECTRICITY WORKS.

Very significant of the increasing demand in Manchester for electric light and electrical energy was the opening on Tuesday this week of the new electricity station which the Corporation have built on a site in Stuart-street. The new installation will, however, at first be mainly employed in meeting part of the tramway load, which naturally will become heavier and heavier as additional lines and extensions into the suburban districts of Manchester are opened up. The first instalment of 15,000 h.p. had been so far expedited as to make Tuesday's inauguration possible, and when the installation is complete the station will contain engines of an aggregate capacity of 60,000 h.p. This is provided for by Dr. A. B. W. Kennedy's scheme, under which the Electricity Committee are carrying out the work. Ultimately, however, another 12,000 h.p. will be installed under a supplementary scheme of Mr. G. F. Metzger, the borough electrical engineer. The ceremony on Tuesday consisted in starting the first engine of 2,500 h.p., a function which was very prettily carried out by Mrs. Bishop, the wife of the chairman of the Electricity Committee. After an inspection of the building had been made, the company adjourned to the town hall for luncheon, where Dr. Bishop took the chair. The toast-list was kept commendably short, the important speech being that of the Lord Mayor, who proposed success to the electricity undertaking. Speaking of the opinion expressed in some quarters that the Corporation were going beyond their bounds in assuming the responsibilities of an extensive electrical undertaking, he said it was necessary, therefore, that the greatest care should be observed in the prosecution of the work, which was of very great importance to the city, and would continue so, for the city was dependent upon the electricity department for the early use of its electric tramway system—a system that was not only a great municipal experiment, but would also be a paying one. It was only fair to say of their electrical undertaking that while there appeared to be some risks, in view of the changes and advances which were constantly being made in electrical machinery, the Corporation had as fair a chance of finding a profitable investment as had any company that had been established. In some further observations on the question of the borrowings of the Corporation, the Lord Mayor pointed out that the city was to-day indebted to the extent of 18 millions, against which they had property valued at over 23 millions sterling. In acknowledging the toast, Dr. Bishop said his committee would shortly be in a position to erect more machinery, and within six months there would possibly be six or seven engines running at the Stuart-street station. The Electricity Committee had done their utmost to push on the work in order to enable the Tramways Committee to run their cars at the time promised, and in view of the fact that the work at Stuart-street was only commenced on July 1 last, he thought that what had already been done constituted something like a record. Dr. Bishop added that during the progress of the works not a single accident of a serious nature had occurred.

FORMERS AND FORMER-WINDING.

BY F. W. DAVIES.

(Continued from page 733.)

IV. FORMERS FOR DRUM ARMATURE COILS (WIRE-WOUND).

A large variety of formers for wire-wound drum armatures has been devised The windings for them have been classified as the evolute, bastard, and barrel windings. The formers for these windings, it will be remembered, were said to belong to one of two types, the block and the frame. The evolute winding—so called from the ends of the coils being of an evolute form—is well known, though it is not so often used as the barrel winding. A serviceable former for the evolute winding is shown in Fig 7. It is of the block type, and is suitable for coils which are composed of several turns. It is of simple construction; in

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fact, the block may be cut out of a single piece of hard wood. It consists essentially of the base block, A, and the raised portion, B, which is cut in the form of steps—the number of steps being one greater than the required number of turns per coil. The former shown in the figure is for coils composed of three turns. For forming the bends in the end windings, and in order that the wires may be pulled taut, the former is provided with two studs, C and C_1. There is a slight shoulder on each of these studs; and on this shoulder rests a washer, which is kept in place by a wing nut. A peg, D, is provided, so that the beginning of the wire may, by being twisted round it, be secured whilst the coil is being wound In winding a coil, the wire, after being twisted round the peg, D, is taken along the face of the block round the first stop, and then round the stud C_1. Then it is led back again on the top of the first step, round the second step, to the stud C; and thence it is taken along the face of the block round the first step in the same manner as the first turn, returning (*viâ* stud C_1) on the top of the *second* stop, and so on, until the required number of turns are wound. To render the method of winding more clear, the wires are represented in section on the steps in the end view. The coil is removed from the former after winding by removing the wing nuts and washers from the studs, C and C_1, when it can be easily taken off. A disadvantage attending the use of this design of former is that a different one is required for every different winding. Before the coils can be assembled on the armature they must be formed into the evolute shape at the ends. If the coils are but small ones, this may be done by taking the two limbs of a coil in the hands and pulling the coil into the required shape. This method does

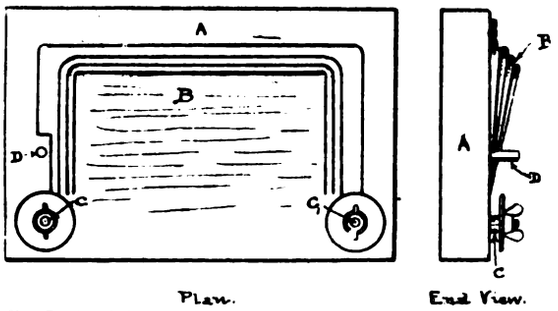

FIG. 7.—Block Former for Evolute Wire Winding. (A, base block; B, winding steps, C and C_1, studs; D, peg.)

not give it a very good shape, but it is suitable for the coils of small armatures. For the larger coils it is advisable to form the evolute spiral on the end windings by means of a second former. A former of somewhat similar construction to that used for forming the end connectors of bar-wound armatures (hereinafter to be described) may conveniently be used for doing this. There are various modifications which may be made in the construction of the block former for evolute winding, shown in Fig. 7, but the construction shown and described may be taken as a typical one

A frame former for evolute wire winding possesses the important advantage over the block former that it is possible to wind and form a coil at one operation, thus avoiding the necessity for using a second one for the purpose of forming the spirals at the end. Such a former is shown in Fig. 8, which possesses, also, the advantage that it can be used for coils having any number of turns. When it is desired to wind the coils with a different winding, the jigs, F and F_1, must be replaced with jigs suited to the new winding. The general construction of the former is made clear by the figure. The frame itself, as will be seen, is made up of two pieces of sheet iron, A and B, bent to the shape shown, and riveted together. Two angle bars of wrought iron, C and D, are screwed or riveted to the frame. In the end of each of these bars a removable peg is fitted. One of the pieces of wrought iron of which the frame is built (that marked B) has a saw-cut at each end; and the tongues of sheet iron so formed are curled up under the main bend, as shown at E and E_1. Immediately facing these tongues of metal, the jigs, F and F_1, are fixed. A detail of one of these jigs, suitable for a coil consisting of three turns, is shown in the figure. To wind a coil on this former, the end of the wire must be twisted temporarily round the fixed peg, G; and then taken over the bend on the frame A, under the peg at the end of the angle bar C, along the angle bar itself, and under the peg at the other end. From thence it is taken over the bend at the other end of the frame; and then around the largest diameter of the jig F_1, and over the bend on the frame B. The wire is then taken along the angle bar D; and, after being taken over the bend at the other end of the frame B, it is led round the largest diameter of the jig F, and over the bend on A, as at the first. This cycle of operations is repeated until the whole coil is wound.

It is not always possible in an evolute winding, especially when there is a large number of coils on the armature, to get all the bends in the end windings in place round the shaft This difficulty may be avoided by winding the armature with two sets of coils, each set consisting of half the total number of coils. Should this not meet the difficulty, the armature may be found with *three* sets of coils, a set consisting in this case of one-third of the total number of coils. Except in very rare cases, however, it will be found that the coils can be assembled in position without difficulty, if they are wound in two sets, and sometimes if wound in one set. When winding an armature in two sets, half of the coils should be wound of the usual length, and the other half of such a length that their end windings

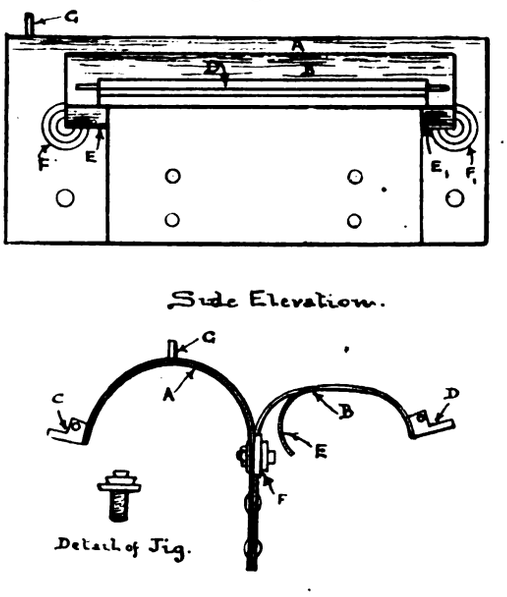

FIG. 8.—Frame Former for Evolute wire winding. (A and B, frames; C and D, bars; E and E_1, tongues of sheet iron on frame B; F and F_1, jigs; G, peg.)

project beyond the end windings of the first set. The short coils should be put on the armature core first, every alternate coil space on the core being left vacant in order to receive the long coils. When the short coils are all in position, the long coils can be placed on the core. The windings of the two sets of coils will then be in different planes at the ends. A little more room is required at the ends when this method is adopted. An armature wound thus is much easier to wind, and the insulation is safer than if wound in the ordinary way; for when the armature is wound in one set it is often necessary to use rectangular wire, or else to have a smaller number of sections in the armature, in order that there may be room for the coils at the ends. A rather serious disadvantage attending the plan of winding an armature in sets is the difficulty there is in repairing or replacing a faulty coil in the first set, if there should be one. When such a fault occurs, it is necessary to entirely remove the second set of coils before it is possible to remedy it. Also, it should be noted, two formers are required for each size of armature if wound in two sets, and three if wound in three sets. Whether or not these disadvantages are compensated for by the greater facilities for winding offered by this method, is a question that the reader must decide for himself.

The principal types of former-winding for wire-wound drum armatures, are the evolute and the barrel windings. That class of winding which belongs to neither of these

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classes, but has some features in common with each, is in these articles, called the bastard winding. A block former for a bastard winding is shown in Fig. 9. The former is especially suitable for small armatures. It is simple in construction, and winding on it is an easy matter. Owing to its simplicity, skilled labour is unnecessary—a not unimportant advantage, by the way. It is made of hard wood, and consists essentially of three pieces—the back block, A (to which is fastened the centre block, B), and two end blocks, C and C_1. Passing through the back block are two bolts, the square shanks of which are recessed into the block and serve to prevent the bolts from turning. There is also a hole in each end block through which the bolts pass. The end blocks are secured to the back block by means of these bolts, on each

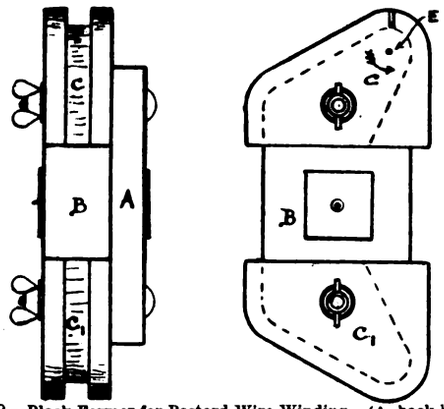

FIG. 9.—Block Former for Bastard Wire Winding. (A, back block; B, centre block; C and C_1, end blocks.)

of which a winged nut is screwed. Two small brass plates, in the middle of each of which a small hole is drilled, are screwed on to the former, so that it may be placed between centres for convenience in winding. The method of winding on this former needs, of course, no description. The method of removing the former from a coil after winding is very simple. First of all, after removing the wing nuts, the back block, A, and centre block, B, are withdrawn from the coil. Then by slightly rotating the end block C about the centre, E, in the direction indicated by the arrow, and moving it towards the middle of the coil, it can easily be removed—the end block C_1 being removed in a similar manner. The coils are mounted on the core in a precisely similar way to barrel-wound coils, the only difference between them being in the appearance of the end windings. No special end plates are required on the armature. The coils may be formed slightly with the fingers when they are being mounted on the core, though this is not really necessary. This winding is cheap, safe, and well ventilated.

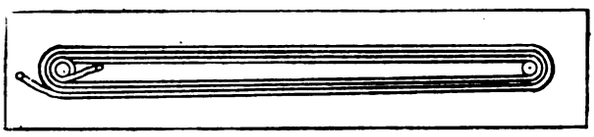

FIG. 10.—Coil for Barrel Winding, wound upon pegs, preparatory to being formed on Block Former.

The most common former-winding of all is the barrel winding. When a block former is used for this winding, it is usual to wind the coils first of all upon pegs of hard wood or metal, which are inserted into a board or into the winding bench. Fig. 10 represents such a coil, wound upon pegs, ready for being removed and formed. The forming process is carried out on a former of the design shown in Fig. 11. This former may be made from a single block of wood, but for the sake of convenience it is usually made up of several pieces. The middle of the former is quite open, as shown, in order to minimise the weight. A trough, just large enough to receive the coil, and of a contour corresponding to the shape which it is desired to give to it, is cut in this block. It facilitates matters to fasten a few clips at regular intervals near to, or over, this trough. By this means the coil may more easily be held in position during the forming process. The process of forming is a simple one. The ends of the coils are first put in place on the former, the pegs, B and B_1, being inserted in the loops at each end of the coil. Afterwards the remainder of the coil is formed by being carefully tapped into the trough with a rawhide mallet. This method of winding and forming coils for the barrel winding, though an excellent one for armatures having a large number of turns per coil, is rather more expensive in most cases than the one in which the frame former (Fig. 12) is used, as it necessitates two operations for every coil.

For medium and large sized armatures of ordinary voltage the frame former depicted in Fig 12 is the more suitable. This, as will be seen from the figure, consists of a frame of sheet iron, A, upon which is permanently fixed the hardwood block, B. The removable block, C, is held in position, whilst a coil is being wound by means of a thumb-screw and steady pins. The method of winding a coil on this former is as follows: The beginning of the coil is twisted round the fixed peg, E, and the wire is then taken around the removable block, C; and thence passes between the two removable pegs, marked

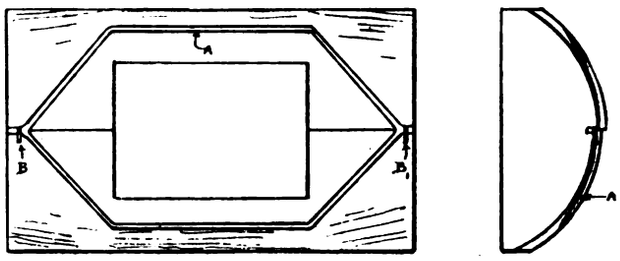

FIG. 11.—Block Former for Barrel Wire Winding. (A, coil trough; B and B_1, pegs.)

D_2 and D_3, over the edge of the iron frame, and then between the same two pegs on the other side of the frame. The wire is then taken around the fixed block, B, and is led out between the two removable pegs at the left-hand side of the former, marked D and D_1. It then passes over the edge of the iron frame, and then between the same two pegs on the other side of the frame. This completes one turn. This cycle of operations must be repeated until the required number of turns have been wound. The coil may be removed from the former by simply taking off

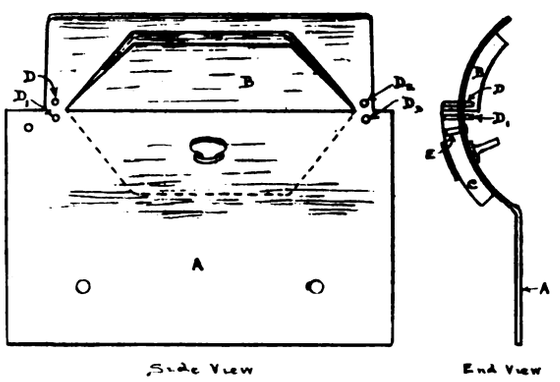

FIG. 12.—Frame Former for Barrel-Type Wire Winding. (A, frame; B, fixed block; C, removable block; D, D_1, D_2, and D_3, removable pegs; E, fixed peg.)

the removable block, C, and withdrawing the two pegs marked D and D_2. This former is a very serviceable one, and coils wound on it are both cheap and neat. Care must be exercised in the use of both this former and the frame former for evolute winding (shown in Fig. 8) not to damage the insulation of the wire where the bends occur at the ends of the coils. In all other respects, the winding of coils on this former is a matter that does not call for any special attention

(To be continued.)

PHYSICAL SOCIETY.

At the meeting of this society on May 23, Prof. S. P. Thompson, president, in the chair,

A paper by **Mr. J. A. Erskine** on **"The Conservation of Entropy"** was read by the Secretary. Heat energy may be expressed as the product of two factors—a quantity factor, entropy; and an intensity factor, temperature. The conservation of entropy holds in thermo-

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dynamics when dealing with reversible processes, and is analogous to the conservation of other quantity factors, such as momentum, moment of momentum, and electric quantity. The author shows the completeness of the analogies by considering Carnot cycles carried out on electrostatic and hydraulic engines. Prof. Wiedeburg has proposed to extend the doctrine of the conservation of entropy to irreversible processes by introducing a new quantity analogous to electric resistance.

The Secretary read a letter from **Mr. Swinburne**, in which he stated that the author had got hold of what was no doubt Clausius's original idea of entropy. The science of thermo-dynamics, as far as it deals with reversible processes, depended upon what the author called the conservation of entropy, but reversible processes did not exist in practice. The author's treatment was quite in accordance with orthodox thermo-dynamics.

A paper by **Signor G. Giorgi** on **"Rational Units of Electro-magnetism"** was read by Mr. Price. Mr. Price prefaced the reading of the paper by saying that both Prof. Fleming and Prof. Fessenden had advocated a partial change of units which would leave the most important ones unchanged, and the method employed by the author was similar to that adopted by Prof. Fessenden. The author starts with a set of three equations, which contain explicitly the four concrete units of E.M.F., M.M.F., electric current, and magnetic current, together with that of activity, and considers them as fundamental in electromagnetism. Two fundamental units are required to express these quantities, and their product must reproduce the mechanical unit of activity. If the watt is assumed as unit of activity, there are two units ready made—the volt and the ampere—which satisfy the condition and may be considered fundamental. All concrete units in electricity and magnetism can be expressed in terms of these and the second as unit of time. In order to complete the system, a unit of length is required. The metre and kilogramme are consistent with the watt, and putting them together with the units enumerated in the paper, the author has built up an absolute metre-kilogramme-second system which comprises electric, magnetic, and mechanical measures in a consistent frame.

The Secretary read a letter from **Mr. Swinburne** stating that most physicists who love simplicity would be glad to get rid of "4π," but schemes for suppressing it generally moved it somewhere else. He asked if the author had really got rid of 4π, or merely chained it up in another place. If a change in units were to be made, it would be an advantage to get rid of the terms "electromotive force" and "magnetomotive force."

Prof. Everett said he had arrived at the following determinations of the author's meaning: when μ and K are taken into account we have the two following identities: (1) the dimensions of current are the same as those of magnetomotive force, or H × length, called f in the paper; (2) the dimensions of E.M.F. are same as those of quantity of magnetism divided by time—called by the author magnetic current, and denoted by g. In connection with (1) the line-integral of H for a path singly linked with a circuit carrying a current of C amperes is to be called C. This gives the unit for H in terms of the ampere and the unit of length (the metre). In connection with (2) we are to use the equation for magneto-electric induction in a circuit $\text{E.M.F.} = \frac{dN}{dt}$, together with the rule that a quantity of the magnetism m gives the total flux $N = m$. The unit quantity of magnetism is thus defined in terms of the volt and the unit of time (the second).

The **Chairman** said he had received a paper from Signor Giorgi, giving a number of illustrations of the application of his theory to calculations. There were also some further explanations, and the dimensions of many physical quantities were tabulated in terms of the volt, ampere, and second. The author claimed to have based an absolute system on the metre, kilogramme, and second, while leaving the practical units unchanged.—The society adjourned until June 13.

BUXTON ELECTRICITY WORKS.

Mr. W. J. Leeming, the borough electrical engineer, embodies in his annual report on the electricity undertaking an analysis sheet of generation and costs for the year ended March 31 last, which we give below, together with a copy of the previous year's analysis, from which the progress of the undertaking can be gauged. The engineer states in his report that the 250-kw. set had been tested, and had turned out very satisfactory. It was now running on the town, and was a very economical set. The extensions to the mains were progressing very favourably. During the last quarter 2,949 8-c.p. lamps had been connected to the mains. The analysis of generation and costs from commencement of supply to March 31, 1901, give the following figures: units generated, 102,134; total sold, 73,286; sold to consumers, 50,886; public lighting, 22,400; used on works, 16,180 (including expenditure on new machinery); per 8-c.p. lamp capacity, 12·2; maximum supply demanded, 126 kw.; number of public lamps, 25 at 10 amperes; connections to mains in 8 c.p., 6,550; capacity of plant in kilowatts, 198; load factor, 6·6; total revenue, £1,728. 12s. 9d. (5·6d. per unit); revenue from supply, £1,246. 12s. 9d. (4·08d.); from meters, £32. 10s. 5d. (0·106d.); from public lighting, £437. 10s. (1·4d.); miscellaneous, £11. 19s. 7d. (0·03d.). From April 1, 1901, to March 31, 1902: units generated, 147,563; total sold, 109,100 (sold to consumers, 86,700; public lighting, 22,400) used on works, 9,298; per 8-c.p. lamp capacity, 6·6; maximum supply demanded, 180 kw.; number of public lamps, 25 at 10 amperes; connections to mains in 8 c.p., 11,971; capacity of plant in kilowatts, 538; load factor, 6·9; total revenue, £2,496. 10s. 3d. (5·49d. per unit); revenue from supply, £1,934. 0s. 8d. (4·25d.); from meters, £50. 6s. 1d. (·1104d.); from public lighting, £500 (1·10d.); miscellaneous, £12. 3s. 6d. (0·026d).

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

485. Why is the iron regulating resistance of a Nernst lamp enclosed in a vacuum tube?—J. C. R.

486. I have two dynamos in separate engine-houses, distant about 60 or 80 yards, both compound-wound, one 200 volts, 100 amperes; the other 250 volts, 200 amperes. I might say that the engine driving the larger machine doesn't govern very accurately, the variation in voltage being as much as 15 or 20. Can I run the two in parallel at 220 volts? If so, I should like all necessary diagrams and particulars; if not, the reasons why. Of course, I mean for each machine to remain where it is. The machines are by different makers.—DOUBTFUL.

ANSWERS.

Question No. 479.—I have seen on a high-tension alternating switch-board an instrument indicating power factor, but can find in no text-book a description of its mechanism, and I should like it explained.

Best Answer to No. 479 (*awarded* 10*s.*).—Although it is not usual to meet with instruments indicating power factor, yet a great many types have been designed, several of which work very well, and are extremely useful on circuits having an induction motor load. These instruments measure the phase angular variation directly or indirectly, or what in many cases is just as good, the "wattless power." Power-factor indicators may be classified under four heads: (1) Phase meters, by which the phase angle is determined directly. (2) Power-factor meters, measuring some function of the phase angle—*i.e.*, cos ϕ, sin ϕ, or tan ϕ. Measurements involving the cosine, etc., however, are unsatisfactory if the cosine approaches unity. (3) Wattless power meters—*i.e.*, meters measuring A V sin ϕ. (4) Wattless current meters measuring A sin ϕ.

1. The best example of this group is Tuma's phase meter. A and B (Fig. 1) are two coils connected in

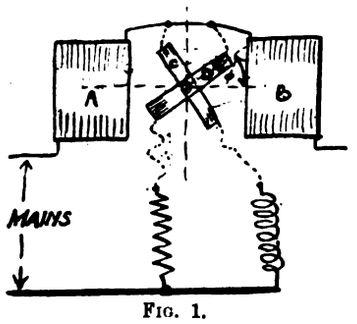

FIG. 1.

series, and carrying the current whose phase angle with reference to the E.M.F. is desired. In the field set up between these two coils, suspended freely, are two coils, C and D, consisting of two independent windings connected together mechanically at right angles. The two coils are connected across the mains separately, so that the phase of the current flowing in them depends on the phase of the voltage wave in the main circuit. One of the coils, C say, is connected in series with an inductive resistance, but the other one has a non-inductive resistance in series with it. This results in a displacement of the phase of the currents flowing in the two coils. When not in use, the axis of the coil D will lie along A B. When current is turned on it will be deflected, as shown in Fig. 1, directly the current gets out of phase with the volts. If the inductances, etc., are correctly proportioned, it

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can be proved mathematically that ϕ is the actual angle of phase displacement. Another example of group No. 1 is the electrolytic phase indicator. This is a very simple device, due to Janet, and consists of a metallic drum upon which rest two styli of iron. One of these is connected so as to have a difference of potential between it and the drum which is in phase with the current. The other one is connected so that its difference of potential is in phase with the E.M.F. On the drum is stretched a sheet of paper which has been soaked in potassium ferro-cyanide and ammonium acetate. When the difference of potential between either stylus and the drum reaches a certain positive value, electrolysis begins, and the paper under the stylus turns blue. Now, if the drum be turned, each stylus traces a broken blue line on the paper, each blue mark representing part of a positive half wave. The angular distance from the centre of one of these short lines and that of the corresponding mark made by the other stylus expressed in electrical degrees is the phase angle. This, however, is only exactly true when the current and E.M.F. waves have the same form.

2. *Power-Factor Meters.*—Instruments giving trigonometrical functions of the phase angle direct are usually too involved for any but laboratory use. A Siemens electrodynamometer may be used, however, to determine them indirectly. The principle of the former is usually as follows: Two harmonic motions acting at right angles, and having the same frequency and amplitude, but a difference in phase of 90deg., will produce, if acting at the same time, a uniform circular motion. If the amplitudes are not the same the result is an ellipse, the major and minor axes of which are the respective paths of the two harmonic motions. If the phase difference is not 90deg., the two axes of the resulting ellipse do not coincide in direction with the two harmonic motions. This principle is made use of in Puluj's power-factor meter. Two electromagnets act upon two armatures, causing them to vibrate in planes normal to each other. Through one of the electro-

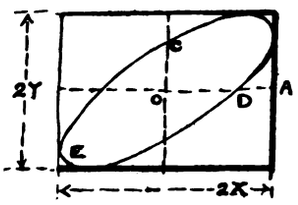

FIG. 2.

magnets is passed a current which is in phase with the current in the main circuit whose power factor we wish to measure. Through the other is passed a current which is in phase with the E.M.F. wave. A ray of light falling upon a mirror attached to one of the armatures is reflected back to a second mirror attached to the other armature, and thence to a screen. The spot of light will describe an ellipse, the shape and position of which is determined by the values of the two currents in the electromagnets and their phase difference, as in Fig. 2. Thus, if O A and O B are the directions of the two harmonic motions and C D E the ellipse described by the spot of light, it can be shown that

$$\sin \phi = \frac{O\,C}{O\,B}.$$

A method of using a modified Siemens dynamometer for phase angle measurements is described in the *Electrical World* for September, 1901. Two fixed coils are used instead of one, and the movable system is replaced by a coil closed upon itself and suspended in the plane of the other two—*i.e.*, all three coils in the same plane. Suppose that with one current flowing in one of the fixed coils, the angle of torsion required to keep the movable coil in its zero position is d_1, and with the other current flowing in the other fixed coil alone it is d_2, and with both currents flowing at the same time it is d_3. Then we have, if $d_3 = d_2 + d_1$ there is no phase displacement between the two currents. If this is not so

$$d_1 + d_2 - 2\sqrt{d_1}\,d_2 \cos\phi = d_3,$$

from which the phase angle can be deduced. In the methods described above the object sought was the determination of the phase angle. In many cases, however, we are more concerned with the magnitude of the wattless component of current than with the power factor. We may have more trouble, due to the poor regulation, caused by inductive loads than by the decrease of output and efficiency. Instruments that will measure the "wattless current," or, rather the "wattless volt-amperes," are easily made in commercial form.

3. *Wattless Power Meters.*—A Siemens dynamometer becomes a wattmeter indicating A V cos ϕ when the main current is passed through one coil, and a current proportional to and in phase with the E.M.F. through the other. If the current in the pressure coil be in quadrature with the E.M.F. the instrument indicates A V sin ϕ, the wattless volt-amperes. This is easily done with a two-phase system by taking the E.M.F. current from the other phase. With a single-phase system it is necessary to place a proper condenser or inductive resistance in series with the E.M.F. coil. The instrument mentioned in the question, however, is probably a Tuma phase meter, or one of that type.—T. SQUARE.

Answer to No. 479 (*awarded* 5*s.*).—Numerous methods and instruments have been devised for measuring the power factor or angle of phase displacement on alternating circuits, but, partly owing to their liability to inaccuracy and partly through want of simplicity in the instruments or in the methods of using them, they have not come into very general use as yet. One of the best instruments for directly measuring power factors, and one which is suitable for fixing on a switchboard, is that made by Messrs. Hartmann and Braun (Tuma's principle). It may be used on single, two, or three phase circuits, and its readings are not rendered inaccurate by small changes in periodicity. It consists (Fig. 1) of a single fixed coil carrying the main

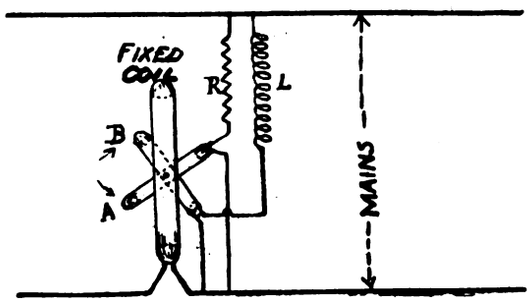

FIG. 1.

current of the circuit (or at least a derived current in phase with the main current), and two swinging coils, A and B, fixed at right angles to each other and on the same suspension. The fixed coil surrounds the swinging one. The two swinging coils are connected in parallel with one another across the mains, with the difference, however, that one is in series with a large non-inductive resistance, R, whilst the other is in series with a highly inductive choking coil, L. In this way both moving coils are made to carry the same amount of current, but that in one coil, B, lags practically 90deg. behind that in the other, A. The two coils consequently act just like the two sets of stator coils in a two-phase induction motor, and produce a rotating magnetic field. Under these circumstances as soon as the main current is passed through the fixed coil, the moving-coil system will take up such a position that the rotating field is exactly parallel to the fixed coil's field at the instant when the latter is a maximum—*i.e.*, when the current in the mains is a maximum. Thus, suppose the circuit voltage and current to be exactly in phase, then, at the instant when the current in the fixed coil is a maximum, the current in the non-inductive coil, A, will also be a maximum, whilst the current in coil B (which lags 90deg. behind that in A) will be zero, and the direction of the rotating field at the instant will, therefore, be parallel to the axis of A. Consequently the swinging coils will set themselves so that the phase of coil A is parallel to the plane of the fixed coil. The corresponding position of the pointer of the instrument would be marked 1 on the scale—*i.e.*, the power factor of the circuit = 1 when the pointer is at this point.

Next, suppose the load on the circuit to be practically

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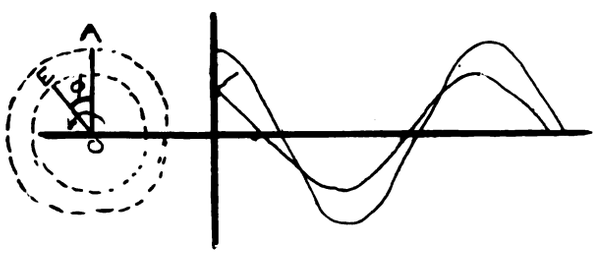
entirely inductive, so that the current lags 90deg. behind the voltage. Then, at the instant of maximum current in the fixed coil, the current in coil A will be zero, whilst that in coil B will be a maximum, and the rotating field will be in the direction of the axis of B. Consequently the position taken up by the swinging coils will be such that the plane of coil B is parallel to that of the fixed coil—*i.e.*, 90deg. from the position occupied in the previous case—and this position of the pointer would be marked O. In the same way, the coils would take up some intermediate position for all intermediate values of the angle of lag, the resultant instantaneous field due to the combined action of A and B being nearer to the direction of the axis of B or to that of A according as the load is more or less inductive. For angles of lead (capacity loads) the coils would move in the opposite direction from the point for non-inductive load (marked 1), so that the complete scale of the instrument would cover an angle of 180deg., with the centre point marked 1 and the two end points marked "O lagging" and "O leading" respectively.

Of other instruments for the same purpose reference may be made to that of the Allgemeine Electricitäts-Gesellschaft, of Berlin, in which the measurements are proportional to volts × amperes × sine of angle of lag or lead, and which is practically a small two-phase induction motor, one phase of which is excited in series with the mains and the other in shunt to them. The two coils are fixed, and surround a suspended short-circuited rotor controlled by a torsion spring. So long as the volts and amperes are in phase the coils only give rise to a stationary alternating field, but as soon as any phase difference occurs a rotating field is produced and a torque is exerted on the rotor. This instrument, however, does not give the value of the power factor directly. The General Electric Company of America have introduced a phase meter, for use on balanced two or three phase circuits, which is based on the fact that the readings on two wattmeters having their shunt coils placed respectively across two of the phases and their series coils placed in series with the line common to these two phases, will bear a ratio to one another proportional to the phase angle between volts and amperes in each phase. Instead of two actual wattmeters a single instrument is used, having one series coil and two shunt coils attached to the same suspension. This instrument, again, only gives the power factor indirectly, but both this and the Allgemeine Electricitäts-Gesellschaft one described above are quite suitable for use with rotary converters and synchronous motors for the purpose of deciding the correct excitation to obtain a power factor of unity, for the instruments deflect one way or the other according to whether the current leads or lags.

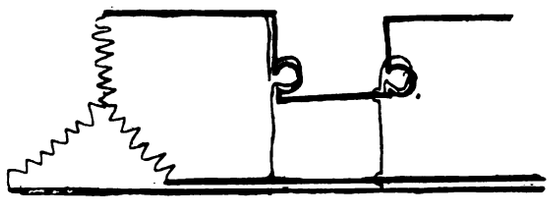
A classification of the different possible instruments for use as phase meters, together with some particulars as to their accuracy, will be found in a paper read by Prof. W. Browne before the American Institute of Electrical Engineers in June, 1901, and abstracted in the *Electrical World* of New York for Sept. 7, 1901 (p. 379).—Q.

Answer to No. 479 (*awarded* 5*s.*).—In the case of a continuous current the power absorbed by a circuit is equal to the product of the volts at its terminals into the current



passing. But in the case of an alternating supply this is only true when the current is in the same phase as the pressure—that is, they have their zeros and maximum values simultaneously. This can best be represented by the accompanying diagram. Let O E represent the voltage, and O A represent the current lagging by an angle ϕ. The power absorbed in the current is equal to the product of the voltage, O E, into the component of O A in phase with it—that is, power = O E . O A cos ϕ—and this factor, cos ϕ, is what is known as the "power factor." Its value is from 1 downwards, and for maximum power from a line whose maximum current is fixed it should be 1, for the smaller it is the greater the current for a given power, and consequently the greater heating loss in the cables. In working synchronous motors it is well to have an indicator of power factor, as by varying the excitation the current can be made to fall into phase with the pressure, and so economy may be effected.

The design of a commercial power-factor indicator is a problem that has occupied some attention for a considerable time, and it can safely be said that the instrument in its most general form has yet to reach perfection—in fact, up till now there is no instrument sold which will directly indicate the phase difference between the pressure and current in one circuit. To measure in the laboratory the lag of a current it is usual to take three independent readings, one from a wattmeter (of the split-dynamometer type), and one each from a voltmeter and ammeter. The product of the latter gives the *apparent watts*, and the former the *true watts*, the ratio between these being the power factor. This is an operation which could scarcely be performed mechanically. There are several laboratory instruments which are made to read off power factor, but as in nearly all some preliminary adjustment has to be made they cannot be called switchboard instruments. Thus there are many depending on the magnetic field set up by the currents flowing in the two coils, one current being in phase with the pressure and the other with the main current. But in all of these it is necessary to adjust the shunt so that there will be equal currents flowing in both coils, or the power-factor reading will be completely masked. Instruments such as the oscillograph, which give the actual relative positions of the curves of pressure and current, will also indicate with considerable accuracy the lag of the current behind the pressure, but these again are not exactly commercial types.



Though for the determination of power factor in one circuit the problem presents such difficulty, yet when we come to three-phase working (such as was probably the case mentioned by your correspondent) it is greatly simplified if a wattmeter be inserted in one of the leads of a three-phase line and one end of the pressure coil being connected to the same lead, the other end of the pressure coil being connected first to one of the other leads and second to the remaining one. If d_1 and d_2 are the deflections of the instrument, then it may be shown that if ϕ be the phase angle of the current behind the pressure (assuming this to be equal in all three circuits)

$$\tan \phi = \sqrt{3}\left(\frac{d_1 - d_2}{d_1 + d_2}\right).$$

This fact is the principle of an instrument which is on the market. It consists of two split-dynamometer wattmeters; the current coils in series with one lead; the pressure coils between this lead and the other two; the connections made so that the torques oppose, and the two movable coils on one spindle, to which is attached the pointer. The instrument will be calibrated by comparison with the three readings method of the laboratory. The pointer marks unity power factor in the middle of its scale, lag and lead being shown by deflections to opposite sides.—T. R. S.

Question No. 480.—Describe, with sketches and diagram of connections a good type of series-parallel controller for electric overhead travelling crane.

Best Answer to No. 480 (*awarded* 10*s.*).—Controllers are now either of the magnetic or solenoid type. They are both largely used, the latter being used on many corporation tramway installations. It is perhaps more effective than the other, having a solenoid at each contact, and so reduces the damage done by flashing. The general

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arrangement of a series-parallel controller and a complete diagram of connections is shown in Fig. 1, the mechanical detail of which needs but little description. It consists of a vertical spindle with rows of metal projections, on which are fixed renewable contact pieces, this spindle being operated by means of the controller handle, and when the latter is revolved these contact pieces make connection with a number of metal strips fixed on the side of, and thoroughly insulated from, the case of the controller. There is also a small power handle which operates the reversing switch for the motors, on the spindle of which is fitted an interlocking arrangement so that the controller handle cannot be moved when this power handle is in the "off" position. There are two other small switches, which in case of one motor being disabled allows that motor to be completely disconnected from the circuit and the crane can be worked *pro tem.* with the single motor. A short description of the electrical arrangements and connections is also interesting. On one side of the controller are a number of terminals (shown on the right-hand side of Fig. 1) from which the motor leads are taken, short leads to the contact strips (shown on the left of the sketch), leads to the resistances, which are usually placed in some convenient place away from the controller, short connecting strips to the reversing switch terminals, and the mains from the trolley wires. In the sketch the return main is shown "earthed," but this is only a detail. The upper five rows of projections are all fixed on to one casting, the next three rows to another casting. These two and the bottom casting, which is shown connected to the controller frame (or some other convenient earth connection), are all

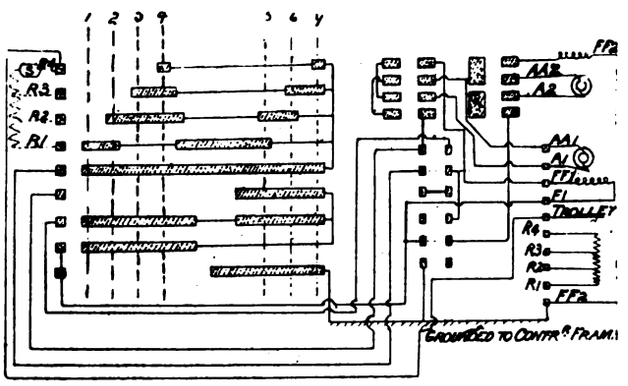


FIG. 1.

thoroughly insulated from one another, and fixed on to the controller spindle. I have for the sake of simplicity shown the electrical contacts supposed to be laid out flat; the lines drawn from one projection to another on the same row are merely to remind one that they are all on one casting. For the same reason have I shown the ends of these rows connected. When the power handle has been put into, say, the position for "hoist" and the controller handle moved over to stop No. 1, the two motors are connected in series with all the resistance in the circuit, and as the handle is moved over the stops 2 and 3, the resistance is gradually cut out of the circuit until it reaches No. 4, when the two motors are connected in series with all resistance "out." When the controller handle reaches No. 5 stop, then the two motors are in parallel with a portion of the resistance in circuit, and, as before, is gradually cut out until finally, when on No. 7, all the resistance is cut out and the motors connected in parallel across the mains. Between the stops 4 and 5 the change from "series" to "parallel" is made. First, a point between the field coil of No. 1 motor and No. 2 armature is earthed (in the case of an earth return). Now No. 1 motor is doing all the work. Then the armature connection of No. 2, which is connected at this point, is then, as the handle is moved round, connected to the armature lead of No. 1, thus putting the two motors in parallel, but at the same instant all the resistance is placed in series with the main circuit. But when the handle reaches No. 5 stop only a portion of the resistance is in circuit. By a little study of the sketch these changes will be easily followed. Fig. 2 shows a simple arrangement of the reversing and motor cut-out switches. The main current after passing through the resistance enters No. 1 motor armature at the terminal marked A A_1, and in No. 2 motor at A_2. When the switch is reversed the current will then enter No. 1 at A_1, and No. 2 at A A_2. The direction of the current in the field coils in each case is the same. When the motor cut-out switch, M S_1, is in the downward position it will be seen that the current will pass straight on by means of the short-circuit strip at the bottom of the switch on to No. 2 motor, and thus cutting out No. 1 from the circuit, and in cutting out No. 2, the switch being in the downward position, the current after passing through No. 1 motor would be earthed direct. For a more detailed description of various other

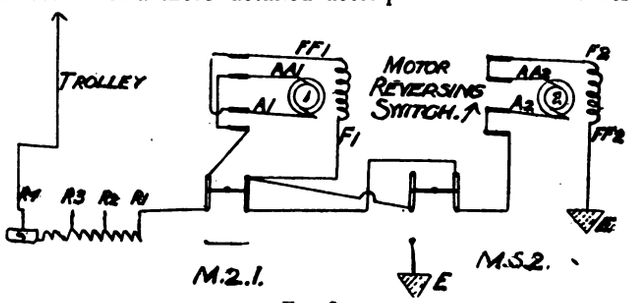
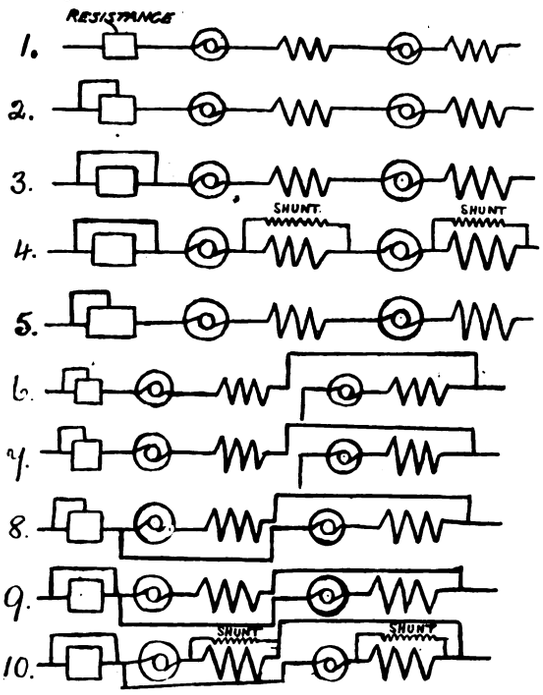


FIG. 2.

types of controllers aud their electrical arrangements I think I can only recommend anyone who may be interested with such electrical equipments to look up the *Electrical Engineer*, vol. xxiii., p. 339; vol. xxvii, p. 117; and vol. xxviii., p. 519.—A. G. SHEARER.

Answer to No. 480 (*awarded* 5*s.*).—The series-parallel system consists in the use of two or more motors, which by means of a special device are thrown into different combinations. The sketches below show the various relative positions through which the motors pass from their first position, when they are in series with a resistance thrown in, to their last position for high speeds, where they are in parallel and part of the field is cut out, this accelerating the motors.



The following are the various positions in what is known as the "K" controller of the General Electric Company: (1) motors in series and all resistance in circuit; (2) motors in series and half resistance in circuit; (3) motors in series and all resistance cut out; (4) motors in series and shunt around the fields; (5) same as position (2); (6) one motor cut out, the other in series with half the resistance; (7) same as (6); (8) motors in parallel with half the resistance in series; (9) motors in parallel with no resistance in series; (10) motors in parallel with shunt round field.

The points (5), (6), and (7) are only graduating. The four economical running speeds are when the controller is in the positions (3), (4), (9), and (10).—H. TAYLOR.

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TUBE BILLS IN PARLIAMENT.

LORD WINDSOR'S COMMITTEE.

MONDAY, MAY 26.

The Select Committee of the House of Lords presided over by Lord Windsor reassembled in the Grand Committee-room, Westminster Hall, after the Whitsuntide recess, and proceeded with their consideration of the schemes of the combined Piccadilly and City, London United, and North-East London Railways for an underground railway from Hammersmith to the City.

Mr. Fitzgerald, K.C., for the Central London Railway Company, whose proposal for the construction of a new tube from Hammersmith to the Bank was, with the exception of a small loop at the City end, rejected by the committee at the last sitting, said all it was proposed to proceed with in their Bill was the provision for the acquisition of land for the enlargement of their station at Marble Arch. This land was the property of the Duke of Portland, and its acquisition was not opposed. They also asked for power to raise the sum of £150,000 new capital for the acquisition of land and the construction of rolling-stock.

The committee passed the preamble of the Bill so far as it related to these matters.

Mr. Balfour Browne, K.C., said that since his withdrawal of the Bill of the City and North-East Suburban Company for the construction of a line from Whitechapel to Waltham Abbey the local authorities had approached them with a request that they should proceed with their railway, believing that some means would be found hereafter of getting from Whitechapel into the City by an unobjectionable route. Messrs. J. S. Morgan and Co. had agreed to give financial support to the line. He desired to ask the committee whether, if he succeeded in getting the order of the House of Lords for the withdrawal of the Bill discharged, they would hear him in support of their proposal.

Mr. Littler, K.C., for the North London Railway, protested against this "extraordinary application."

The **Chairman** said the committee could not give any support to the application.

Mr. Balfour Browne said he believed the only opposition remaining to be heard against the combined line from Hammersmith to the City and to Palmer's Green was that of the frontagers, and the promoters had framed a clause expressing their view as to how the frontagers ought to be dealt with. The clause was drawn on the lines suggested by Viscount Knutsford so as to place for a limited period after the opening of the railway the owners of lands and houses which were not taken on the same footing as the owners of lands and houses which were taken for the purposes of the railway. The words "injuriously affected" had been incorporated in the clause in accordance with the suggestion of Viscount Knutsford, and he believed that by its terms the views of the committee would be carried out.

The **Chairman** expressed a hope that the clause would be considered by all the parties interested, so that on Friday, when they would take it into discussion, it might be possible to arrive at a settlement.

In reply to a question by Mr. Pember, K.C., with regard to the North-East London Railway, the Chairman said they would not give their decision on the preamble until the whole of the opposition to the combined scheme had been heard, but if there were nothing else but the railway opposition the committee would pass the preamble.

Mr. Reader Harris, K.C., addressed the committee on behalf of the frontagers along Kensington-gore and in Prince's-gate in opposition to the railway.

Lord R. Cecil, K.C., stated the opposition of the rectors and churchwardens of St. Martin's-in-the-Fields and St. Clement Danes, Strand, to the railway, which passed close to both those churches.

The committee having consulted in private,

The **Chairman** said the committee had decided to pass the preamble of the Bill for the construction of a railway from Hammersmith to Palmer's Green. The committee would next proceed with the Clapham Junction to Marble Arch Railway.

Mr. Balfour Browne said there was no opposition to this railway, Earl Cadogan, the Duke of Westminster, and the Battersea Borough Council having been settled with.

The committee then declared the preamble to be proved, and also made the same declaration with regard to the extension of the Brompton and Piccadilly-circus line to Holborn, to which there was no opposition.

Mr. Littler applied for an extension of time for the construction of the authorised Brompton and Piccadilly-circus Railway, which was granted, and the committee adjourned.

TUESDAY, MAY 27.

The committee proceeded with the opposition to the proposal of the Brompton and Piccadilly-circus Railway Company for the construction of a spur line from South Kensington to Parson's-green *vid* Fulham-road. The general scheme was explained to the committee a week or two ago.

Mr. Freeman, K.C., now addressed the committee in opposition to the proposed spur line on behalf of the Brompton Consumption Hospital and other institutions on the line of route. He explained that it was proposed to construct the railway with a station in the immediate neighbourhood of the consumption hospital. These buildings were of a very special character, and he submitted that there was no public necessity shown for this railway. Another scheme was also before their lordships' committee for the construction of a railway under the King's-road, Fulham, which was not open to the objections, from the point of view of the hospitals, of the railway now under consideration.

Evidence having been given in support of counsel's statement,

Mr. Coward, K.C., on behalf of the London County Council, asked the committee to reject the proposal, which they regarded as unsatisfactory from the point of view both of finance and of convenience to the public. But the real fear of the County Council was that, if sanctioned, the railway would never be made, but would remain as a "block" line against any other railway down either the Fulham-road or the King's-road.

The **Chairman** said the committee had decided that this portion of the preamble of the Brompton and Piccadilly-circus Railway Bill had not been proved.

The committee next proceeded with the King's-road Railway Bill.

Mr. Balfour Browne, K.C., explained that the Bill was before the Joint Committee last year, and that their report was that it might be referred in the ordinary course "if interchange stations are provided at Victoria; an extension to Putney would be desirable." Last year, the proposal was to proceed only as far as Eel Brook Common, but in accordance with the recommendation of the Joint Committee the present scheme was to construct a line from Putney, starting close to the station of the London and South-Western Railway there, coming under the river on to Eel Brook Common, and so on to Victoria. There it was proposed to make an exchange station which would enable passengers to get into the City in conjunction with the Deep-Level District Railway. The line was four miles one furlong in length, and was supported by all the local authorities through whose district it passed except that of the city of Westminster. The capital proposed by the Bill was £2,598,773, and the promoters believed there would be no difficulty whatever in raising the money.

Mr. J. MacAllister, one of the promoters, gave evidence in support of the Bill. He said the estimates provided for a sum of £123,000 for financial purposes. In cross-examination, the witness stated that the other promoters were Sir Owen Slacke, Sir Richard Sankey, and Lord Teynham.

Mr. Shepherd, of Messrs. Shepherd, Perry, and Scott, financiers, Old Broad-street, thought there were fair prospects of raising the capital in the City.

The **Chairman**, on receiving an intimation that this was all the direct evidence as to finance, said the committee did not think that the preamble of the Bill was proved.

Mr. Pember said his clients, the governors of St. George's Hospital, had been informed that the West and South London Junction Railway Bill, which stood next on their lordships' list, was to be withdrawn. They thought it was a gross abuse that a Bill should be kept in the list until the last moment, and that then, when all the expense had been incurred by the opponents, it should be withdrawn. He asked the committee to keep a grip on the Bill until Friday, when he should ask their lordships to award his clients cost against the promoters.

The **Chairman** said the committee would take care that the Bill was not withdrawn behind the backs of those interested in it as opponents.

The committee adjourned till to-day (Friday).

NEW COMPANIES REGISTERED.

Anglo-French Motor Syndicate.—Capital £10,000. Object: to acquire and work a motorcar business as now carried on at Suresnes, France, and elsewhere.

Electro Voelker Syndicate, Limited.—Capital, £5,000. Objects: to adopt an agreement with E. Manning and William Barker, and to carry on business as sanitary and electrical engineers, etc.

Anglo-Belgian Construction Syndicate, Limited. — Capital, £50,000. Objects: to construct, equip, and work rail and tram roads, light railways; as producers and suppliers of electricity for the purposes of light, heat, or power; establish and maintain telegraph and telephone systems, etc.

Dunlop Marine Course Signal Syndicate, Limited.—Capital, £5,000. Object: to acquire any inventions relating to marine signalling and apparatus therefor; in particular, to acquire an existing invention from J. D. Dunlop, and to carry on the business of electrical and general engineers, etc.

Bohm Syndicate, Limited.—Capital, £35,000. Objects: to acquire any patents relating to improvements in the manufacture of electric incandescent lamps or any other patents; in particular, to acquire from M. Boyd, of 147, Fenchurch-street, the benefit of certain existing inventions in relation to the above, etc.

City and Surrey Electric Railway Company, Limited.—Capital, £150,000. Objects: to carry on the business of an electric railway company, to undertake the construction, maintenance and working of electric and other railways and tramways and motors therefor, and their accessories and appurtenances, etc.

Erimus Automatic Safety Guard Company.—Capital £2,000. Objects: to acquire the benefit of a certain existing invention in relation to an improved form of safety guard for tramcars, motorcars, and the like; and to adopt an agreement with Middlesbrough Investments, Limited, and others generally to acquire any other inventions relating to safety guards or other machinery, accessories, or fittings to electric tramcars, trolley and motor cars, vans, carriages, and other road vehicles, etc.

APPOINTMENTS VACANT.

Draughtsman for electrical measuring instrument department. Ferranti Limited, Hollinwood, Lancashire. See advertisement.

Borough Electrical Engineer and Tramways Manager, Newport (Mon.) Corporation, May 31. Full particulars may be obtained from the town clerk.

Commission Agents, to travel in Manchester, London, Midlands, North and South of England, Scotland. A. Royle and Co., Sutton Oak, St. Helens. See advertisement.

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COMPANIES' MEETINGS AND REPORTS

WOKING ELECTRIC SUPPLY.

The annual general meeting of this Company was held at Woking on Saturday, Mr. John Ashby presiding.

The directors' report stated that the revenue earned from sale of current and rent of meters amounts to £4,466. 15s., as compared with £4,002. 5s. 11d. in 1900. Taking into consideration the fact that the Company ceased to supply current for the public lamps in May of year under review, and that the Inkerman Barracks were unoccupied for the latter half of the year, and consequently consumed very little current, the directors consider the increase in revenue very satisfactory. Further, taking into consideration the fact that the full benefit now being derived from the new plant did not obtain until late in the year, on account of the delay in delivery by the makers, they feel that the present year will show a very much better result. At the beginning of 1901 the total number of lamps on circuit was 11,400 ; this figure had increased at the end of the year to 15,090, and had further increased at the end of March to 15,889, while the number of customers increased during the year from 294 to 417. The directors consider that this steady increase is very encouraging, and augurs well for the future of the Company. It may be mentioned that the present plant is sufficient to supply 21,500 lamps without any further additions. During the year 43,875ft. of additional new cable have been laid, and 6,926ft. of new cable have been laid to replace old, and it is believed that these new cables have tapped districts which will ere long give an adequate return on the capital expenditure involved. It will be seen from the balance-sheet that during the year £3,400 4½ per cent. debentures and £8,790 6 per cent. cumulative preference shares have been issued to provide funds to meet the expenditure upon new machinery, boilers, and new cables, and generally for the increased requirements of the Company. The directors have pleasure in recording the excellent work done by Mr. J. G. McLean, the Company's engineer and manager, and they consider that the success achieved during the year is largely due to his energy and tact.

The **Chairman**, in moving the adoption of the above report, said that when the present directors took over the management of the Company it was not in a satisfactory condition, most of the mains being rotten, and the dynamos and boilers out of date. Last year they called for fresh capital in order to buy new plant, which they anticipated would be delivered early in the year. There was, however, great delay with the makers, and they did not get the new boilers until Nov. 1 and about a fortnight before Christmas. Hence they were working under a serious disadvantage, and at heavier cost than would have been the case had the plant been delivered sooner. They had now got quite an up-to-date plant, and the majority of the mains were new and in good order, so that the Company were in a position to supply light to the inhabitants of Woking in a thoroughly satisfactory manner. The present number of lamps was 16,252, and 800 more were waiting connection, so that by that day fortnight they would probably have 17,000 lamps on circuit. The number of customers at present was 460.

The report and accounts were adopted.

CORK ELECTRIC TRAMWAYS AND LIGHTING.

The following is the balance-sheet of the above Company for the year ended Dec. 31 last :

To nominal capital : 11,500 5 per cent. cumulative preference shares of £10 each, £115,000 ; 11,500 ordinary shares of £10 each, £115,000—£230,000. Issued capital : 11,000 5 per cent. cumulative preference shares, £110,000 ; 11,000 ordinary shares, £110,000—£220,000 ; less calls unpaid, £435—£219,565. Reserve account : premium on shares issued, £2,000 ; 4 per cent. mortgage debentures, £70,000 ; interest accrued on mortgage debentures, £1,318. 6s. 8d. ; loans, £20,484. 8s. ; sundry creditors, £9,792. 7s. 11d. ; reserve for depreciation, £2,000. Profit and loss account : balance Dec. 31, 1900, £6,916. 6s. 10d. ; less dividends and other appropriations thereout, £6,665. 16s.—£1,250. 10s. 10d. ; and profit for year as per annexed account, £9,426. 12s. 2d.—£10,677. 3s. ; less interim dividend on preference shares to June 30, 1901, £2,500—£8,177. 3s.—£333,337. 5s. 7d. By capital expenditure as allocated by the engineer : land, £2,877 ; purchase and cost of Order in Council, £13,526. 0s. 6d. ; buildings, offices, and plant in power house, £71,584. 1s. 5d. ; permanent way, rolling-stock, overhead line, etc., £129,114. 11s. 9d. ; house services and lamps on consumers' premises, £12,550. 5s. ; cables, £57,433. 0s. 6d. ; public lamps and cables, £5,682. 19s. 10d. ; Queenstown lighting undertaking, £21,950. 12s. 9d.—£314,718. 11s. 9d. Stores on Company's premises, £5,548. 19s. 7d. ; work in progress—installation of motors, £707. 1s. 6d. ; plant on loan, £502. 9s. 8d. ; office furniture and fixtures, £429. 0s. 10d. ; sundry debtors, £10,487. 12s. 9d. ; cash at bankers and in hand, £243. 9s. 6d. ; preliminary and establishment expenses—amount as per last balance sheet £750 ; expenditure during year, £176. 0s. 9d.—£926. 0s. 9d. ; less written off, £226. 0s. 9d.—£700—£333,337. 5s. 7d.

BARCELONA TRAMWAYS.

The directors' report for the year ended Dec. 31 last states that the traffic receipts from electric traction amounted to £105,641, and sundry receipts £773, making the total receipts £106,235. The working expenses were £70,035, leaving a gross profit of £36,200. Deducting loss on exchange, and adding amount carried forward from 1900, there is a balance of £25,973. The receipts show an increase over those of 1900 of £6,714, and the expenses only £306. The number of passengers carried was 33,787,925, against 27,959,547 in 1900 and 21,736,264 in 1899. The balance at credit of net revenue account is £25,973 ; of this amount the service of the debentures and debenture stock has absorbed £10,264, and the dividend on the preference shares £5,000. The directors now recommend the payment of a dividend on the ordinary share capital at the rate of 3 per cent. per annum, free of income tax, and that the sum of £4,709 be carried forward. The Board's reason for carrying forward so large an amount is that a sum of £3,316, paid to the Spanish authorities in respect of arrears of taxes for 1899-1900, has been temporarily carried to a suspense account. A considerable portion of this amount is in dispute, and has been appealed against ; pending a final settlement, the directors thought it prudent to make provision for the entire sum, in case the Company's appeal is unsuccessful. The conversion of the Ensanche line, and the construction of the Josepets-Bonanova extension, together with the supply of 40 addditional motorcars (26 new and 14 converted), will, when completed, entail an expenditure of about £65,000, of which the sale of certain sites of stables and car-sheds no longer required will produce about £10,000, and it is proposed, towards providing for the remainder, to issue the hitherto reserved balance of the 4½ per cent. redeemable debenture stock, amounting to £51,900.

INSTITUTION OF ELECTRICAL ENGINEERS.

At an extraordinary general meeting of the Institution on May 15 the following were the candidates balloted for :

Associate Members.—G. Aldridge, 7, West Marlands, Southampton ; W. Hudson, 9, The Drive, West Brighton ; W. F. Long, 2, Albany-road, Chorlton-cum-Hardy, Manchester ; J. D. Pember, 99, Bridge-street, Farnworth.

Associates.—A. D. Manlove, Little Dene, Ventnor, I.W. ; A. Ruiz, Los Andes, Chili ; B. Sankey, 306, Markhouse-road, Leyton ; E. Thornton, 86, Charing Cross-road, W.C. ; C. J. Vaughan, General Post Office, Durban.

Students.—D. C. H. Bell, 9, Powis-gardens, W. ; C. Petersen, 3, Aynhoe-road, Brook Green, W. ; P. Richards, Dunkeld, The Avenue, Beckenham.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Falkirk.—The Town Council will shortly advertise for tenders for piping and cables.

Shanghai.—The last day for receiving tenders for the proposed municipal tramway and motor 'bus service is June 30.

Beckenham.—The Electric Lighting Committee invite tenders for the supply of incandescent lamps. Tenders by June 6.

Dudley.—The Electric Lighting Committee invite tenders for the supply of incandescent lamps and oil. Tenders by June 6.

Sophia (Bulgaria).—The General Post Office require tenders for £2,000 worth of telephone and telegraph material. Tenders by June 9.

Glamorgan.—Tenders are invited for wiring and fittings at Parc Gwyllt and Angelton Asylums, near Bridgend, Glamorgan. Tenders by May 31.

Calarashi-Stirbein (Roumania).—The Municipality invite tenders for the installation and working of electric lighting for 35 years. Tenders by June 13.

Dunston. — For relighting the Primitive Methodist Church. Applications to be made personally to Mr. A. Scott, Winship-street, Dunston, by May 31.

Fulham.—The Board of Guardians invite tenders for the supply, delivery, and erection on their premises of pipework. Tenders by June 5. See advertisement.

Glasgow.—The Corporation invite tenders for the supply of electricity meters required for the year from June 4, 1902, to May 31, 1903. Tenders by June 7. See advertisement.

Greenock.—The Corporation invite tenders for the supply and erection of one 300-kw. steam dynamo, with steam and exhaust piping. Tenders by June 2. See advertisement.

Rome.—The Minister of Marine and the Director of the Arsenal at Spezzia invite tenders for about £5,000 worth of electrical material for installations on men-of-war. Tenders by June 4.

Valparaiso.—The Municipality are inviting tenders for electric lighting and tramways. We understand that particulars may be obtained from the Chilian Consul. Tenders by Sept. 1.

Bury.—The Tramways Committee invite tenders for the supply and delivery of rails and fishplates, fishbolts and nuts, tiebars, points and crossings, and sole or anchor plates. Tenders by June 24.

Barking.—The Urban District Council invite tenders for motors, pipework, chequer plating, etc. Full particulars may be obtained from the Engineer, Electricity Works, East Barking. Tenders by June 6.

Brighton.—The Town Council invite tenders for the supply of 300 tons of steel girder tramrails. Specifications, etc., may be obtained from Mr. Thos. B. Holliday, tramways engineer, Lewes-road, Brighton. Tenders by June 9.

Lisbon.—The Portuguese Government Railway require 34,300 kilos of 1, 2, 3, and 4 mm. galvanised wire. Tenders by June 9 noon. Further particulars may be obtained from the Company's office, 28, Rue de Châteaudun, Paris.

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Glasgow.—The Corporation invite tenders for one economiser, with induced-draught fan, and condensing plant. Particulars may be obtained from Mr. W. A. Chamen, the engineer, 75, Waterloo-street, Glasgow. Tenders by June 7.

West Ham.—The Corporation invite tenders for the construction of about eight miles of route length of tramways. Specifications, etc., may be obtained from the offices of Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster. Tenders by June 10.

Brighton.—The Town Council invite tenders for the supply of points, crossings, tiebars, bolts, and other fittings. Specifications, etc., may be obtained on application at the office of Mr. Thos. B. Holliday, tramways engineer, Lewes-road, Brighton. Tenders by June 9.

Warrington. — The Coronation Committee invite tenders for illuminating the town hall and Bank-Park with electric light. Specifications, etc., can be obtained from the Borough Electrical Engineer, Electricity Works, Howley, Warrington. Tenders by June 2.

Launceston (Tasmania).—The Corporation invite tenders for polyphase generating, transmitting, and distributing plant and apparatus, transforming apparatus, reconstruction of existing plant, and enclosed arc lamps and accessories. Tenders by Sept. 15. See advertisement.

Dundee.—The Gas Commissioners invite tenders for the supply and delivery at the electric station of steel and iron steam-piping and fittings, cast-iron piping, and cast-iron manhole frames and covers. Specifications, etc., may be obtained from the Electrical Engineer. Tenders by June 3.

Stretford.—The District Council invite tenders for the following in connection with its scheme for supply of electrical energy: Steam-raising plant, comprising boilers, superheaters, economisers, etc.; generators, comprising engines, dynamos, condensers, pumps, etc.; and mains. Tenders by June 18. See advertisement.

Tonbridge (Kent).—The Urban District Council invite tenders for the fitting up of an electric light installation in their electricity works. Specification, etc., may be obtained at the offices of Mr. Robert Hammond, M.I.C.E., consulting engineer to the Council, 64, Victoria-street, Westminster, London, S.W. Tenders by June 9.

Astrachan.—Erection of electric generating station and installation of public and private lighting, commencing with 150 arc and 6,000 incandescent lamps. Manufacturers who will undertake to finish the work within two years can obtain particulars from the Municipality. Agents will not be able to tender. Tenders by June 7-20.

Stockton-on-Tees.—The Corporation invite tenders for the supply, delivery, and erection of one 300-kw. steam generator, two Lancashire type boilers, one switchboard panel and instruments, surface condenser and cooling plant, pipework and valves, extension feeders, and mechanical stokers, economiser, and feed pump. Tenders by June 10. See advertisement.

Bury.—The Tramways Committee invite tenders for the work required in the construction of the permanent way in several parts of the borough—viz.: Fairfield section, Bolton-road section, Heywood-street and Knowsley-street sections. Specifications, etc., can be obtained on application at the office of Mr. Arthur W. Bradley, borough engineer and surveyor. Tenders by June 24.

York.—The North-Eastern Railway Company invite tenders for the following articles in such quantities as they may require during six months ending Dec. 31, 1902, delivered (carriage paid) at the telegraph stores at York: telegraph apparatus and telegraph wire and line stores. Particulars may be obtained on application to Mr. Graves, Telegraph Department, York. Tenders by noon on June 9.

Worthing.—The Corporation invite tenders for the erection of a circular brick chimney shaft for their electric generating station, High-street, Worthing, 140ft. high from the ground level and 7ft. 6in. inside diameter at the top (the Corporation will construct the foundations and other brickwork to the ground level). Full particulars can be obtained on application to the Borough Surveyor, Municipal Offices, Liverpool-road, Worthing. Tenders by June 16.

Belfast.—The Harbour Commissioners invite tenders and designs for the decoration and illumination by electricity or otherwise of the harbour office and the south end of the Glasgow shed, Donegall Quay, in connection with the celebration of the coronation of King Edward VII. A detailed specification of the work proposed to be carried out must accompany each tender. Any further information required may be obtained from the harbour engineer, Mr. G. F. L. Giles. Tender by June 2.

RESULTS OF TENDERS.

Barnsley.—The Corporation have accepted the tender of the Electrical Power Storage Company for the supply of a storage battery.

Broughty Ferry.—The Town Council have placed the contract for the supply of a storage battery with the Electrical Power Storage Company, 4, Great Winchester-street, E.C.

Hamilton (Scotland).—The Town Council have accepted the tender of Edmundson and Co., London, at £32,302, for erecting new electricity generating station at Almeda Hill.

West Stanley (Durham).—The tender of W. B. Garrick and Co., Gateshead, Newcastle-on-Tyne, has been accepted for the electric lighting of the new Catholic church, West Stanley.

Swansea.—The Council have accepted the tender of Mr. D. Jenkins, Lower Oxford-street, at £996, for the foundation work in connection with the proposed extension to the station.

Limerick.—The contractors for the electric lighting of Limerick (the Allgemeine Elektricitats-Gesellschaft, of Berlin and London) have entrusted R. Carr and Co. with the order for the arc lamp columns required.

Mansfield.—The Town Council have accepted the tender of Crompton and Co., at £2,486, for (Section L) pipework, valves, and tanks.

Blackburn.—The Guardians have accepted the tender of G. H. Woods and Co., Northgate, Blackburn, at £169. 1s. 3d., for certain alterations and additions to the electrical fire-alarm installation at the workhouse.

Insulating Compound.—The National Telephone Company have accepted the tender of R. Carr and Co., Lime-street-square, London, E.C., for the supply of insulating compound for the six months ending Dec. 31, 1902.

Willesden.—The District Council have accepted the tender of the British Insulated Wire Company, Prescot, Lancs., for the supply and erection of arc lamp columns to be of the design and manufacture of R. Carr and Co., 6 and 8, Lime-street-square, London, E.C.

Bexleyheath (Kent).—The Electric Lighting and Traction Committee have accepted the following tenders: A. Penney and Co., 107, Fenchurch-street, E.C., tramway rails and fishplates; W. Scott and Co., Leeds Steelworks, Leeds, anchor plates; Dick, Kerr, and Co., 110, Cannon-street, E.C., bolts and nuts, tie-bars, etc.

West Ham.—The Corporation have received the following tenders for the construction of eight transformer chambers:

G. Wise, works manager, West Ham (accepted)	£675	0	0
Whitehead and Co., Portland-place, Clapham-road	710	0	0
Windsor and Co., 61, Strathblane-road, Clapham Junction	721	12	4
Foster Bros., 148, Birchanger-road, Norwood Junction	757	0	0
J. Jackson, Broadway, Plaistow	845	4	8
F. G. Minter, Ferry Works, Page-street, Westminster	907	0	0
Gregar and Son, Jupp-road, Stratford	984	0	0
C. Ford, 11, Nicoll-road, Harlesden, N.W.	995	0	0

Falkirk.—The following tenders have been accepted by the Electric Light Committee: Falkirk Iron Company, manhole covers, £124. 12s. 6d.; W. D. Hamilton, brickwork of pavement boxes; Buchanan and M'Donald, plaster work of pavement boxes and repair of pavement. Also tenders for work at the electric station buildings: O. M'Kearney, mason work; J. and P. Dewar, joiner work; J. Happer, slater work; R. Brown, plumber work; J. Marshall, painter work; Buchanan and M'Donald, plaster work; T. Laurie and Co., lightning conductor. No decision has yet been made regarding the cast-iron and steel work, for which the following firms tendered: Cameron and Co., J. Munday, P. B. Johnston, Watt and Co., W. Jones and Sons, W. Turner and Son, P. B. Smith and Co.

Fulham.—The following tenders have been received for the supply of a switchboard (Contract No. VI.):

Electrical Company, Limited	£316	15	0
Crompton and Co., Limited	338	0	0
Williamson and Joseph, Limited (accepted)	344	9	0
Geipel and Lange	373	14	0
Johnson and Phillips	377	0	0
Johnson and Phillips	379	10	0
Johnson and Phillips	385	0	0
General Electric Company (1900), Limited	401	0	0
General Electric Company (1900), Limited	424	0	0
Bertram Thomas	442	15	0
Siemens Bros. and Co., Limited	455	0	0
Siemens Bros. and Co., Limited	459	0	0
Kelvin and J. White, Limited	499	12	6
Electric Construction Company, Limited	511	0	0
Kelvin and J. White, Limited	525	0	0
R. Dawson and Co., Limited	529	0	0
Mechan and Sons	605	0	0

BUSINESS NOTES.

TRACTION.

Ipswich.—Tenders will very soon be invited for the construction of the proposed tramways in the town.

Chiswick.—The agreement between the District Council and the London United Tramways Company has been sealed.

Dornoch Light Railway.—This railway was inspected by Major Druitt, of the Board of Trade, yesterday, and will be opened for traffic on Monday.

Tipton.—The British Electric Traction Company have promised to consider the request of the District Council for a tramway from Ockerhill to Great Bridge.

Swansea.—A fractured trolley wire on the tramway system at this place fell to the ground on Monday afternoon, and a horse coming in contact with it was killed.

Ayr.—The municipal tramways have now been completed to Burns Monument, the total length being about 5¾ miles, of which over two miles through Ayr is double.

Mornington (N.Z.).—Negotiations are proceeding between the Town Council and the tramways company for the purchase of their undertaking by the Corporation.

Merthyr.—The Local Government Board have made an order extending the period for the completion of the Merthyr Electric Railway Company's lines from the 16th inst.

Dunedin (N.Z.).—The engineers' estimate for the construction of the Dunedin electric tram system is £160,891, the maximum being £170,000. Eighty-one pound rails are to be used.

Huddersfield.—A temporary stoppage of the electric cars occurred one day last week owing to the breaking of a guard wire, which fell on to the trolley wire and interrupted the electric current.

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Northumberland.—The North-Eastern Railway Company have notified their intention of opposing the Northumberland Electric Tramways Bill in Committee of the House of Commons.

Chatham.—Several trial trips on the new electric tramways in the town have been made within the last two or three days, and it is expected that some of the routes will be opened for traffic on Tuesday next.

Speed of Motors.—The Cheshire Chamber of Agriculture at their last meeting discussed the speed of motorcars, and after a long debate a resolution was passed asking the authorities to fix a reasonable limit of speed.

Margate.—A fine of £5 and 9s. costs was imposed on the driver of an electric tramcar at Margate on Wednesday for driving down Forthill at the rate of 3¾ miles an hour, the Board of Trade limit being two miles an hour.

Appointment.—Mr. O. A. Pilcher, chief assistant electrical engineer to the Blackburn Corporation, has been appointed electrical engineer and tramways manager to the borough of Ilkeston. There were 35 applicants for the post.

Birkenhead.—Two of the municipal electric cars were in collision last week, but the incident was not attended by injury to any of the passengers. The impact, however, was so great as to smash in the front of one of the cars and break the lamp.

Bradford.—The work of converting the Otley-road section of the city tramways for electric traction has begun, and for the time being vehicular traffic over a portion of Otley-road will be diverted. A double set of rails will be put down, and from Harrogate-street to the end of Idle-road the road will be widened to the extent of 2½ yards.

Halifax.—Notwithstanding the cold wet weather experienced during the Whitsun holidays, the Corporation electric tramway receipts reached a higher total than last year. Five miles of new track have, however, been opened since last Whitsuntide. The total receipts for the four days from Saturday to Tuesday were £1,193, against £1,170 last year.

Rawmarsh.—The Urban District Council have sealed their agreement with the representatives of the company proposed to be incorporated by the Mexborough and Swinton Tramways Bill now pending in Parliament, under which the powers obtained by the Council under the Rawmarsh Urban District Tramways Act, 1900, have been transferred to the company.

Walthamstow.—A special meeting of the Urban District Council has decided to support the promoters of the City and North-East Suburban Electric Railway Bills in their endeavour to bring such Bills before the Joint Committee for further consideration. These proposals embrace a line from Cannon-street to Waltham Abbey, through Leyton and Walthamstow.

Lewisham.—With reference to the application to Parliament by the British Electric Traction Company for powers to construct tramways, to be known as the Croydon and district electric tramways, the Works Committee reported at the last Borough Council meeting that the portion of the line proposed to be constructed in the borough of Lewisham had been struck out of the Bill.

Doncaster.—The Board of Trade inspection of the completed sections of the new municipal tramways took place on Tuesday. The overhead trolley system has been adopted, and the estimated total cost of the undertaking is put at £77,500. The lines, so far as Balby and Hexthorpe and Frenchgate are concerned, will, it is expected, be ready for public traffic in about a week's time.

Gloucester.—The City Council have confirmed their resolution to purchase the tramways and lay down a system of light railways in the borough. The Gloucestershire County Council have also a light railway scheme on hand, they having given official notice of intention to apply for powers to construct two railways in Wotton St. Mary (Without), Barnwood, Hucclecote, and Brockworth.

Wycombe—This place has decided that it is not yet ripe for electric tramways. The whole question was discussed at great length at the last meeting of the Town Council, when a large majority passed a resolution to postpone the subject until 1904, the date when the first option for purchase of the electric light undertaking comes into effect. It is noteworthy that only five voted in favour of tramways.

Tramway Extensions.—The London United Tramways Company have given official notice at Slough that they intend to apply to the Light Railway Commissioners for power to extend their system of electric tramways to Colnbrook, Slough, Taplow, and Maidenhead, with branches connecting the Great Bath-road with the Great Western Railway at Langley and the South-Western Railway at Datchet-on-Thames.

Heywood.—The examiners of Standing Orders in the House of Lords have had before them a Bill concerning a number of tramway orders granted to local authorities, including one granted to the Heywood Corporation authorising the construction of about five miles of tramway lines within the borough. The Standing Orders of the House were found to have been complied with, and the Bill was ordered to be reported for second reading.

Oldham.—The electrification of the whole of the tramways in the borough has now practically been accomplished. The first sections of the reconstructed lines running through the town were formally opened last week. When the whole scheme is completed there will be a total length of tramway route of 21 miles, the aggregate length of single track being 30 miles. The estimate presented at the Board of Trade enquiry amounted to £427,034.

South Lancashire Tramways.—Good progress is being made by the contractors for considerable lengths of the South Lancashire tramways. The Tyldesley lines have been completed, and at Leigh the track has been laid from the Lowton boundary to near the junction of the borough with Atherton, and will shortly join up with the length from Hulton. Considerable headway has also been made with the erection of a large generating station at Howe Bridge.

Armley.—A somewhat singular tramcar accident at Armley, one of the suburbs of Leeds, was on Monday the subject of an official enquiry. An electric car laden with passengers was on the previous afternoon proceeding from Stanningley to Leeds when, on taking a curve near Castleton Bridge, it travelled 70ft. on the stone setts, rushed over the causeway, crashed into the bridge, and 17 passengers were injured or shaken. It appears that the brakes did not act, and they are to be subjected to exhaustive tests.

Middlesex.—The County Council have resolved to apply to the Light Railways Commissioners for authority to construct certain further light railways within the county. The county engineer's approximate estimate of the cost of the new railways included in the recommendations is £654,612, which covers the purchase of lands, widenings, and construction of the tracks, and the cost of the purchase of additional land for widenings and works incidental thereto, £228,772—making a total of £883,384.

Wolverhampton.—Another accident, arising, it is said, out of the use of the Lorain surface-contact system of traction, is reported from here. On Monday a horse was drawing a cart along Bilston-street when it was supposed to have stepped on to a live contact box, as it was immediately brought to the ground. The carter in charge, who was walking alongside, at once went to the assistance of the animal, and he also received a shock. Neither the man nor the horse, however, suffered anything but a temporary sensation.

Rochdale.—As announced in our last issue, the Bury-road section of the Corporation tramways was opened for traffic on the 22nd inst. When completed, the system will connect up Rochdale with Summit (beyond Littleborough), Heywood, Norden, Royton, Healey, etc. The section open is only about a mile long, and extends from the southerly end of the Esplanade (near the town hall) to a point where the borough of Rochdale joins the urban district of Norden, on the Bury old road. The next section to be completed will be the line to Norden.

Northfleet.—At their last meeting the District Council decided to adhere to the conditions which they have already attached to their permission to the tramway company to lay their cables underneath the footpaths. Subject to the execution of such agreement, the company's amended plans showing the proposed route of their electric cables have been approved. An amended plan showing the proposed sites for the feeder pillars has also been approved, subject to the exact position of every pillar being settled by the surveyor prior to the ground being disturbed for its erection.

Dudley.—On Saturday one of the guard wires connected with the tramway in High-street suddenly snapped and fell across the trolley wire, a considerable length of the broken strand being extended along the street. The contact with the trolley wire caused the broken guard wire to become "alive," and wherever it touched the rails sparks were emitted. Ladders, gloves, pliers, etc., were at once obtained from the police station, but before the wire could be removed there had been a complete block in the tram service, and a partial block in the street traffic, lasting about three-quarters of an hour.

Asylum Light Railway.—We understand that a light railway is to be put down between Hellingley Station and the East Sussex County Asylum, a distance of 1,900 yards, on the overhead trolley system. Power for working the line will be obtained from the generating plant which is being laid down at the asylum. A locomotive capable of hauling two trucks containing about 10 tons each at six miles per hour on an up grade of 1 in 50 is to be supplied, also a tramcar for passenger service capable of running at a speed of eight miles an hour. A suitable main traction switchboard is also included in the contract.

Greenock.—On an application to the general licensing court for the renewal of tramcar licenses last week, the Provost, referring to the height of car steps, reminded Mr. Braidwood that 12 months ago the magistrates recommended that these steps should be lowered, and they regretted that the company had not seen their way to do so. Mr. Braidwood, in support of the application, said that the steps had in the course of usage gone down about 1½in. Further he could not promise, simply because the engineers could not see how it could be done. In granting renewals, the Provost said that the magistrates would make personal enquiry into the subject.

Bournemouth.—The Town Council have received a memorial from tradesmen residing in the central ward calling attention to the serious inconvenience and loss of business that must necessarily arise through the disturbed state of the road for the laying of tram railways in the main business thoroughfares of this town, and suggest that this can be diminished by the contractors being directed to work day and night. A letter was read at the last meeting of the Town Council from the Light Railway Commissioners stating that a draft of the provisional order of the Poole and district light railway extension would be forwarded for the observations of the Corporation.

Heath.—At the last meeting of the District Council letters were read from the County Council, Wolverhampton Town Council, and the British Electric Traction Company with reference to the delay in laying the tramways along the Willenhall-road to connect the district with the borough. The County Council stated that for some reason the British Electric Company did not at present propose to complete the tramways, while the Town Council said the matter was before their committee, and the tramway company could not at present give any definite information. This Council were very anxious for the tramway to be finished through their district to the borough boundary.

Carshalton.—A scheme is being promoted by the British Electric Traction Company to run a tramway through this place to link Sutton with Croydon, and the inhabitants are very much opposed to the

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proposal. To run an electric tramway through the quaint old High-street on the overhead trolley system would, it is said, destroy its primitive character, as many of the old buildings would have to be removed to give sufficient width. The only alternative route is by the Wandel, and the church where Anne Boleyn's well is sacredly preserved. The adoption of this route would be scarcely less objectionable than the other, and the Carshaltonians protest against either being adopted.

Hastings.—A special meeting of the Town Council has, after a lengthy discussion, adopted a resolution that the Council accede to the application for their consent to the Hastings Tramways Bill, 1902, on condition that the promoters give an undertaking to insert certain clauses and provisions therein, one of which provides that the company shall not, without the consent of the Corporation, open the proposed extension tramway between the west end of Grosvenor-crescent and the Albert Memorial, along the sea-front, and through Robertson-street, for traffic until the line through Clive-vale to the top of High-street, already authorised, shall have been completed and opened for traffic.

Pontypridd.—At a meeting of the Pontypridd District Council on Tuesday it was reported that a joint meeting of the Pontypridd and Rhondda Councils had been held with regard to the proposed purchase of the British Electric Traction Company's tramway between Pontypridd and Porth. The meeting had been convened to consider the advisability of the Councils jointly entering into negotiations with the company with the object of immediately purchasing their undertaking instead of doing so next year, having regard to the present stoppage of the tramway. It was decided to ask the company to name a sum for which they would be prepared to sell. The clerk was instructed to take the necessary steps to obtain the sanction of the Local Government Board to borrow money required in connection with the tramways and electric lighting schemes.

Newcastle.—It is expected that during June the double tramway over Byker Bridge will be opened for traffic. The tramway along Clayton-street is now nearly ready for opening, and the Board of Trade inspectors have been asked to examine the lines. Lieut.-Colonel Von Donop has already made an official inspection of the Dunston tramways extension. This extension, which is about three-quarters of a mile in length, commences at Pine-street, Teams, and terminates at the railway bridge, near the Cross Keys Inn, Dunston. Colonel Von Donop expressed his satisfaction with the line, and will grant the customary order in due course. The Tramways Committee have decided to provide the manager with a motorcar, to be kept in readiness at the power station, to reach any given point requiring his attention with the least possible delay.

Liverpool Overhead Railway.—Another outbreak of fire at the Dingle Station of the Liverpool Overhead Electric Railway occurred on Monday night, but, fortunately, it was unattended by any serious result. A train, consisting of three carriages, was standing at the platform when a flame was seen to issue from the motor box, and the woodwork around caught fire. An alarm was given, and the station officials were quickly on the scene with a hose and hydrants, the flames being extinguished before much damage was done. The official explanation of the fire as given by Mr. S. B. Cottrell, the general manager of the railway, is as follows: one of the magnets fused; the electric current was at once cut off, and the ignition of the cable extinguished by the station staff with little or no damage. The whole occurrence only occupied a very few minutes, and caused practically no dislocation of the service.

Burton and Ashby Light Railway.—It is stated that the Midland Railway Company, who successfully opposed the scheme for the Ashby, Swadlincote, and Burton light railway, when the matter came before the Commissioners at Swadlincote a few months ago, are about to apply for an order authorising them to construct the Burton and Ashby light railway. The scheme is practically on the lines of that which was originally promoted by private gentlemen in South Derbyshire, but which fell through owing to the company's opposition. The railway, which will have a gauge of 3ft. 6in., is to begin where the Burton Corporation tramway system ceases at the east end of the Trent Bridge, and will terminate in the company's station yard at Ashby. Church Gresley and Castle Gresley will be served by a loop-line. Electrical traction will be used, and for this purpose a generating station is to be erected on ground adjoining the company's branch railway at Swadlincote.

Colombo Electric Tramways.—The Anglo-American Debenture Corporation, Limited, having purchased £120,000 5 per cent. first mortgage debenture stock of the Colombo Electric Tramways and Lighting Company, Limited, are offering for sale, on their own behalf, £100,000 of that stock at par. The debenture stock, in accordance with the trust deed, will be secured by a first mortgage upon the central station, car-houses, works, stores, and offices of the tramways company at Colombo, and by a floating charge on the residue of the company's undertaking in favour of the trustees for the debenture stockholders. The Colombo tramways consist of 14 miles of single line, and were constructed in 1898 on the overhead system under an exclusive concession granted by the Municipal Council of Colombo. The net profits for the three years ending Dec. 31, 1901, after paying all renewals and repairs, were: 1899, £10,706. 17s.; 1900, £12,808. 10s. 4d.; 1901, £12,230. 6s. 2d.

Tramways in London.—In a letter on the subject of tramway extension in London, Mr. R. M. Beachcroft, L.C.C., acting on a proposal made by Sir J. Dickson-Poynder, suggests that a tribunal should be constituted, somewhat on the lines of the Light Railway Commission, to hear and decide all matters affecting the promotion of schemes for locomotion, whether under or above ground, in our cities, and to control and supervise the undertakings when sanctioned. "Among the subsidiary matters which such a tribunal might deal with may be mentioned," he adds, "the fixing of the quota of contribution towards the cost of street widenings required primarily for tramway purposes and the settlement of terms for interchange of traffic and running powers between different tramway authorities, as, for example, the London County Council and the tramway authorities outside London. The pressing needs of population in London demand the expansion and quickening of all means of locomotion; and if Acts of Parliament and Standing Orders, reasonable as they may have been so comparatively recent as 1870, are now found to be antiquated, fresh machinery should be devised to suit the wants of the day."

Cardiff.—The Corporation have received a sum of £30,000 on account of the new tramway loan. The Tramways Committee have adopted the suggestion of a sub-committee that 2½ per cent. of the gross revenue be set aside for the formation of a fund to indemnify anyone injured by accident on the cars, instead of insuring through a company. It is estimated that the sum available for this purpose at the end of the year of work would be £1,600. Mr. Ellis, the electrical engineer, has reported with regard to Sunday work that, in reply to printed circulars issued to the electric car employés, 161 had expressed their willingness to undertake it and 12 objected on conscientious grounds. The electrical engineer, through the columns of the daily Press, has issued a warning to cyclists calling attention generally to the great risks they run in continually persisting in riding in front of the electric cars. It is quite a common occurrence, he says, for cyclists to persist in riding immediately in front of the cars—which, as will be recognised, travel at a much greater speed than the horse cars—and trying to see how close they can keep ahead of the same. In doing this they do not recognise the risks they run, especially on wet days, by the wheels of their bicycles skidding and throwing them to the ground, and should this happen it would be impossible for them to save themselves or for the drivers to pull up a car in sufficient time to avoid accident.

Aberdeen.—Mr. M'Elroy, of the firm of Messrs. M'Elroy and Grunow, Bridgeport, Conn., U.S.A., is at present carrying out experiments here in connection with the twin-rail system of electric traction. The firm received permission from the Town Council to lay down rails for the working of the new system from the foot of Constitution-street, across the Queen's Links, to the Corporation bathing station, but when the work came to be tested early last summer, it was found that the system was not working so satisfactorily as was anticipated. As the bathing season was coming on, and it was necessary that the electric cars should be running to the beach, the Town Council agreed to complete the section across the links on the overhead system of contact, but granted an extension of time to the firm to carry out their experiments at some future time if they deemed that desirable. It is in accordance with this permission that Mr. M'Elroy and an engineer are now carrying out the work. A car is being fitted up in the Corporation tramway depôt at Woodside to be run on the new system, which is said to have been greatly improved since last year, now resembling more the stud or Lorain system which is at work at Wolverhampton. At a meeting of the Tramways Committee on Monday, the question of running the tramcars on Sundays was under consideration. The treasurer intimated his intention of moving in this direction at the ensuing meeting of the Town Council.

Preston.—On Tuesday the Earl of Jersey, Colonel Boughey, C.S.I., and Mr. H. A. Steward, Light Railway Commissioners, heard an application by the promoters of the Preston and Lytham light railway for an order empowering them to construct a light railway by way of Freckleton, Worton, and Lytham. A somewhat similar application made in September last year was refused. A good deal of discussion took place as to the financial position of the promoters, and Mr. H. J. Lawson, consulting engineer to the Electric Tramways Maintenance and Construction Company, gave evidence on this point. Mr. Page, K.C., who appeared to oppose the scheme on behalf of the Lancashire and Yorkshire and London and North-Western Railway Companies, submitted that the proposal came within Section 9 of the Light Railways Act, or the competitive clause, and said the effect in that direction on the Lancashire and Yorkshire Railway Company would be serious. Mr. Warton, general goods manager of the Lancashire and Yorkshire Railway Company, said the competition of the proposed line would to some extent affect the dividends of that company. The Earl of Jersey, after consideration with his colleagues, said that, looking at the large expenditure which it was proposed to employ upon the line, and seeing the large population at both ends, which must come within the consideration of the promoters, the Commissioners were limited to apply the Light Railways Act, and they were of opinion that this line did come within the purview of Clause 9, the competitive clause, and upon that ground alone they felt it would be no use their attempting to recommend an order.

Christchurch (N.Z.).—The Borough Council of Christchurch, New Zealand have received an offer of two tramway schemes from the British Electric Traction Company through the local agent of the company, Mr. P. M. Hansen. In the first the company would form a subsidiary company in London with a nominal capital of £250,000, having a local board of three ratepayers to be appointed jointly by the local bodies interested. The company to have a 30 years' concession, paying £200 a year to the Christchurch City Council by way of repairs to the street and a further £400 a year to be divided among the other local bodies. Ten per cent. of the actual net profits would be divisible between the Corporation and the other local bodies interested. At the end of 10 years the boroughs interested to have the right to purchase the tramway concession at valuation plus 10 per cent. in lieu of commission, for conversion, construction, equipment, and supervision. A similar offer is made at the end of 20 years, except that commission is reduced to 5 per cent., and a similar offer is made at the end of the term upon a basis of no commission being payable. The other proposal provides for municipal ownership, the City Council and local bodies providing the necessary capital and giving the British Electric Traction Company a lease for a term of 21 years at least. The local bodies interested are

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to raise by loan the necessary money to take over the tramway lines from the existing company, the British Company guaranteeing the payment of the interest on such loan during their lease with a sinking fund to extinguish loan at its termination. The company would receive as remuneration for preparation of plans and specifications, for supervision and construction and equipment of the trams a commission of 10 per cent. (per annum?) on the actual cost of the whole of the works connected with the conversion and construction of the lines. The company would also pay £50 a year for each mile of line in lieu of keeping it in repair. In the event of either of these two offers being accepted Mr. Hansen would examine and report upon the Waimakariri water-power scheme.

Leeds.—On Monday the Corporation Tramways Committee approved accounts which reveal a profit (after payment of interest and sinking fund charges) of £48,241. 5s. 11d. The accounts showed that while expenditure has increased by £21,747, the revenue has increased by £41,094. The total revenue amounts to £224,294, of which sum £221,308 comes under the head of car receipts, as much as £195,882 being in respect of electric traction. Running expenses and administrative charges furnish a total of £143,150, leaving a gross profit of £81,144. From the latter figure interest has to be deducted, amounting to £19,829; thus there is a net profit of £61,314. And when sinking fund charges, amounting to £13,073, are deducted, there is a clear surplus of £48,241, an increase of £17,183. 3s. 5d. on the previous year's profit, and of £42,000 on the balance of 1899-1900. In the course of the year the cars have run 4,726,043 miles, or 965,758 miles more than in the preceding 12 months, and have carried 48,273,300 passengers, an increase of 8,938,825. Where the electric cars ran 2½ million miles in 1900-1901, they have covered four million miles in the financial year just closed. The earnings per electric car mile have dropped 1½d., and the expenses (exclusive of interest and sinking fund charges) have risen from 6·49d. to 6·63d. Yet an addition of more than £62,000 has been made to the total electric earnings of 1900-1, which is attributed to the improved quicker and extended service that has been put on in the past 12 months. One or two other points are noteworthy, the reduced cost of generating electricity especially so. While in 1900-1 this item was at the rate of ·60d. per mile, it amounted in 1901-2 to only ·39d. per mile, owing partly to the purchase of coal on more favourable terms, but mainly to the fact that an increased output of electricity has kept the power station employed in a uniform degree and on a more economical basis. In almost every branch of expenditure except that of wages considerable economies have been effected. The year's wage bill amounts to over £70,000, which is nearly 50 per cent. of the total outlay of £143,150, and this is exclusive of the wages paid indirectly in the form of repairs and renewals. The capital expenditure on the Leeds tramway system has now reached £895,000.

LIGHTING AND GENERAL.

Ipswich.—Amended plans for the electric lighting installation have been approved.

New Zealand.—The town of Gore is about to expend £5,000 on electric lighting plant.

Barnes.—The Urban District Council are obtaining a loan of £3,000 for electric street-lighting.

Eton.—The District Council have given their formal sanction to the electric lighting scheme at Datchet.

Hampstead.—Mains for the supply of electric current to private consumers are to be laid in portions of Cressy and Redington roads.

Buxton.—The Electricity Committee have agreed to allow a discount of 10 per cent. for prompt payment on current supplied from Lady Day last.

Berwick.—The Sanitary Authority are urging the company who had arranged to put the electric light into Berwick, to take steps to carry out their promises.

Brownhills.—The Urban District Council have granted permission to the Walsall Wood Colliery Company to carry an electric cable from the colliery to the institute at a height of 24ft. above the road.

Agency.—The Klein Engineering Company, Limited, 94, Market-street, Manchester, have appointed Messrs. Harvey and Co., of 25, Victoria-street, Westminster, S.W., definitely as their London representatives.

Hythe.—The Town Council at their last meeting decided to ask the Folkestone Electricity Supply Company whether they will undertake to give the value of their provisional order before the expiration of next month (June).

Stock Exchange.—The Stock Exchange Committee have appointed June 11 a special settling day for Marconi's Wireless Telegraph Company's further issue of 7,264 shares of £1 each, fully paid, Nos. 149,820 to 157,083.

Electrocuting Rats.—It is reported that in order to assist in ridding Sydney, New South Wales, of plague-stricken rats, a local scientist has invented a trap in which as soon as the animal touches the bait it is electrocuted.

Colchester.—The electric service cable broke in St. John's-street, Colchester, on Monday, and, owing to the sewer recently put in, electrified the road for some yards. The electricity affected passers-by, but there was no personal accident.

Londonderry.—We understand that in consequence of a private company having the intention of applying for a lighting order the Corporation have decided to carry out the scheme proposed by Sir W. Preece, which is estimated at £35,000.

Ormskirk.—The Urban District Council have decided to circularise the ratepayers over £10 ratable value as to whether they would take the electric light. As an installation would cost £15,000, the Council propose to take current from the Southport Corporation at 6d. per unit.

Huddersfield.—Sanction has been received from the Local Government Board to the borrowing of £99,483 for the purposes of electric lighting. Electricity and gas for outside illuminations and decorations during the Coronation festivities on three days are to be supplied free to ratepayers.

Personal.—Mr. William M. Furniss, formerly with Messrs. Handley and Shanks, of Birmingham, has been appointed the representative of the Electric Construction Company, Limited, in South Wales and district. Mr. Furniss's address, *pro tem.*, will be 70, Beauchamp-street, River Side, Cardiff.

Stafford.—From the Town Council's budget it appears that there is in the electricity department a deficiency in the accounts of £1,100, but this is not so great as was expected. One of the causes for the large amount being thrown on the rates is the fact that the department had no reserve fund and no depreciation fund.

Catalogues Received.—The Electrical Company, Limited, of 122, Charing Cross-road, W.C., have just issued their price list No. 4, which deals with generators for single and multiphase alternate-current working. It will be remembered that this firm is the agent for the Allgemeine Elektricitäts-Gesellschaft, of Berlin.

Scarborough.—The town clerk has been instructed to apply to the Postmaster-General, under the Telegraph Act, 1899, for a license to construct and work a system of municipal telephones in the telephone area of Scarborough up to the year 1920, and if such license is obtained tenders for carrying out the work are to be advertised for.

Faversham.—Estimates of the cost of establishing the supply of electric light were before the General Purposes Committee at their meeting on Tuesday. The total estimated cost, including site, is £24,109. After discussion and explanation by the engineer, Mr. H. Talbot, it was decided to apply for sanction to borrow the sum named.

Dumfries.—Prof. Capper visited Dumfries on Monday with a view to advising the Town Council on the subject of a proposed electric light installation. He was also taken over the ground between Dumfries and the seaside village of Glencaple, it having been suggested that an electric car line might be laid along the five miles of road.

Explosion.—An explosion of gas which had accumulated in one of the electric cable manholes in Union-street, Aberdeen, occurred on Saturday. The concrete slab covering the aperture was blown into the air, and a volume of smoke and flame issued from the hole. Though a good many pedestrians were on the pavement at the time, no one was hurt.

Wycombe.—Mr. Cecil F. Love, of the Halifax Corporation electricity works, has been appointed to fill the post of chief assistant engineer at the Wycombe (Borough) Electric Light and Power Company, Limited, works. There were 84 applicants. Mr. Love gained his experience at the electricity works at Reading, Shoreditch, West Ham, and Halifax.

Bath.—The Electric Light Committee's accounts for the last year show a profit of £850. The advance in the charge for the public arc lamps to £31 is responsible for this; the charge for the public lamps has now been reduced by £7 per lamp, and this will reduce the receipts by £1,200. The Mayor has been elected chairman of the Joint Committee.

Roentgen Rays – Mr. T. R. Ferens, J.P., has presented to the medical staff at the Hull Royal Infirmary a valuable apparatus for the light treatment, ultra-violet rays, which is being worked in conjunction with the X-rays. The apparatus will be used in the treatment of certain skin diseases, and is considered to be of invaluable assistance to the medical profession.

Belfast.—Messrs. Harland and Wolff, Limited, are to be supplied with current for their pumping station at the Alexandra Graving Dock at the ordinary price charged to other customers, and a guarantee to take a certain quantity of current for five years will be asked for. The firm's application for 200 lamps for illuminating purposes has been referred to the engineer.

Aberdeen.—At the last meeting of the Municipal Telephone Committee a report by Mr. Bennett recommending that the municipal system should be adopted in Aberdeen was submitted. It was stated that the proposed system involved an expenditure of £58,000, and it was proposed that the committee should inspect the Glasgow system, but no definite action was taken.

Ark Lamps.—A further number of "Ark" lamps have just been supplied by Messrs. Johnson and Phillips for the lighting of the Boer prisoners' camps, as a result of the previous lamps giving satisfaction. Quick delivery was again a condition of importance, and this, we are informed, Messrs. Johnson and Phillips were able to comply with, owing to the large stock of all sizes kept by them.

Carlisle.—The Electricity Committee have agreed to supply the Caledonian Railway Company with 15,000 units per annum, for the purpose of lighting the company's yard, at the price of 2½d. per Board of Trade unit. It has also been agreed to extend, at a cost of £200, the electric cable along the streets forming the Botchergate-arcade which the Carlisle Estate Company propose to erect.

Bridlington.—The Town Council propose to ask Mr. Medhurst to prepare, in conjunction with the borough surveyor, plans and specifications and estimates, with a view to tenders being obtained for carrying out the works authorised by the electric lighting order of two years ago. The Council will possibly also be induced to consider the construction of electric trams to be run by the same plant.

Londonderry.—The Corporation have already adopted the report of Sir William Preece, and have decided to proceed with the carrying out of the scheme advised by him for the supply of electric light and power

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to the whole city, and to apply for a loan of £35,000. At their last meeting they decided that the specification of Mr. Macrory, the electrical engineer, be printed and circulated, and that the meeting be adjourned for a month.

Edinburgh.—The last report of the Electric Lighting Committee states that the number of lamps applied for from May 1 to 15 were: lighting, 5,061 8-c.p. lamps; motors, 1,416 8-c.p. lamps; heating, 560 8-c.p. lamps—total, 7,037 8-c.p. lamps. The following shows the gradual increase of the number of 8-c.p. lamps connected since 1897: 1897-1898, 58,949; 1898-1899, 67,821; 1899-1900, 69,848; 1900-1901, 81,995; 1901-1902, 85,545.

New Addresses.—Messrs. Heathman and Co., the ladder makers, inform us they have opened a South Kensington depôt at 351, Fulham-road, where they will keep a stock of ladders, step-trestles, and scaffolds for the use of electricians in the West-end of London.—The registered address and general offices of the Charing Cross and Strand Electricity Supply Corporation, Limited, are to be removed to 60, St. Martin's-lane, W.C., from the 31st inst.

The General Electric Company's Catalogue.—We are asked to correct a statement in our notice of this large catalogue, which appeared in last week's issue, to the effect that it was the third edition. The company in question informs us that the present is the sixth edition, the first having been issued in 1893. We need hardly say that each succeeding issue has contained an increased number of pages and more information than the preceding one.

Presentation.—Mr. J. W. Kempster, on leaving Messrs. W. H. Allen, Son, and Co., Limited, of the Queen's Engineering Works, Bedford, where he has been chief electrician for 14 years, to take up a similar position with Messrs. Harland and Wolff, of Belfast, has been presented by the members of the firm with a collection of Sheffield plate over 100 years old, while from the staff he received two etchings by Rowe. During his connection with Messrs. Allen, Son, and Co. Mr. Kempster has had 280 vessels in his hands for installing electric light, including the "Oceanic" and the "Celtic."

Liverpool.—A discussion took place at the last meeting of the Mersey Docks and Harbour Board on a proposal of the Marine Committee to enter into an arrangement with the postal authorities for the extension of the telegraph system at the docks and as far as the South Stack Lighthouse. A member said he thought the Board had established as far as was necessary the system of telephones, but the Chairman said their engineer had reported that to give orders by telephone was a very unsafe and undesirable method, and he strongly recommended telegraphs. After further discussion, the proposal was referred back.

Sunderland.—The Electricity and Lighting Committee are considering a scheme for the supply of current for motor purposes to various shipyards, large engineering works, and graving docks in the port and river. It is proposed to supply electrical energy at such a price as will satisfy the consumers, and in 12 months this, it is estimated, will double the output of the electricity works, which is now about 2,250,000 units per annum. The net profit upon last year's working of the electricity generating stations was £1,938, and the aggregate profits of £4,015 for the last four years have enabled the committee to repay the money taken from the rates in the preceding three years, leaving a credit balance of £1,346.

Battersea.—From the report of the Lighting Committee we note that Mr. S. Hale has been appointed chairman of the committee for the ensuing three months, and that Mr. A. Whitie, who has been acting as shift engineer at the central electric generating station during the past six months, has been appointed on the staff as shift engineer. Electric mains are to be extended from Church-road to the premises of the Bridge Cycle Company in Battersea Bridge-road, at an estimated cost of £55. 2s. The Council have refused an application for the use of a portion of the central electric generating station, etc., in connection with the King's dinner and Coronation celebrations, deeming it inadvisable having regard to the close proximity of machinery, etc.

Northern Counties Electricity Supply Co.—Mr. John D. Milburn, presiding at the first annual meeting of the Company in Newcastle on Tuesday, spoke favourably of their Blyth works, which would gradually extend, and the same, he said, applied to Spennymoor. Their early success at these two places had been largely due to the adoption of the penny-in-the-slot meter, and free wiring, which enabled small consumers to take advantage of the electric light. They had secured the whole of the public street-lighting in Hebburn and Felling, and they had obtained, or expected shortly to obtain, powers for Consett, Shotley Bridge, Annfield Plain, Stanley, and Leadgate, or a population of 100,000, for which they were waiting the erection of a large power station.

Maidenhead.—The Corporation are busy with the installation of electric lighting plant. Messrs. Burstall and Monkhouse are the consulting engineers and Mr. C. O. Milton the resident engineer. The plant will consist of two Babcock and Wilcox water-tube boilers of 1,619 square feet per boiler, and three Clayton Engineering and Electrical Construction Company's engines of 95 i.h.p. and 500 revolutions, each direct coupled to three dynamos, by the same makers, of a total capacity of 180 kw., and two 128-cell accumulator batteries. The three-wire system has been adopted, and the street-lighting will comprise 35 British Schuckert arc lamps of 10 amperes and 70 16-c.p. incandescent lamps. Private consumers are to be charged 6d. per unit for lighting and 3d. for motors.

Uxbridge.—The Uxbridge and District Electric Supply Company's electric lighting station is to be opened in June. Messrs. Kincaid, Waller, and Manville are the consulting engineers. A capital of £20,000 is authorised. The plant will consist of two semi-marine Davey-Paxman boilers of 160lb. pressure and 1,780 square feet internal surface, and two 150-h.p. and one 50-h.p. Belliss and Morcom engines of 500 and 600 revolutions respectively, direct coupled to four General Electric Company's dynamos with a total capacity of 180 kw., and three multipolar 7·25-kw. tail-shaft-driven exciters. There is no street-lighting at present. In the town 7d. and 3d. per unit will be charged for lighting and outside a flat rate of 8d. Mr. A. Randall Bell, A.M.I.E.E., is the resident engineer.

Oban.—The Corporation's electric lighting station is progressing. Messrs. Burstall and Monkhouse are the consulting engineers, and Mr. M. P. Plunkett is the resident engineer. A loan of £20,000 is authorised. The plant will consist of two Babcock and Wilcox water-tube boilers of 2,010 square feet super each, and three James Howden and Co.'s 95-h.p. engines, direct coupled to three International Electrical Engineering Company's shunt-wound dynamos, of a total capacity of 180 kw., and two 128-cell accumulator batteries. The three-wire system has been adopted, and the street-lighting will comprise 30 Oliver 10-ampere arcs and 60 16-c.p. incandescent lamps. Private consumers are to be charged 6d. per unit for lighting and 3d. for motors. The yearly charge for street-lighting will equal about 2d. per unit.

Telephone Call Offices.—A correspondent recently suggested to the Postmaster-General that the public should be allowed to hand to attendants at telephone call offices written messages to be telephoned when the lines became free, so that the senders might be saved the necessity of waiting for indefinite periods at the call offices. The Postmaster-General has now replied regretting he is unable to adopt the suggestion, because "owing to the uncertainty of being able to communicate with any particular subscriber in a distant town, and also to the fact that no guarantee could be given to senders as to the time or accuracy of transmission, the proposed arrangement would probably offer no advantage to the public over the transmission of ordinary telegrams, while at the same time it would give rise to difficulties in the internal arrangements of the Post Office."

Blaenau Festiniog.—Lord Newborough on the 22nd inst. formally opened the electric supply of the quarry town of Blaenau Festiniog provided by the Yale Electric Power Company, which was formed two years ago for the purpose of developing to some extent the immense amount of water power running to waste in the district, and thereby cheapening the production of slate by supplying power to the quarries during the ordinary working hours for hauling, pumping, mill-driving, and like purposes; also for lighting the streets and for private consumers. The company are enabled to supply electric light to the latter at 4d. per unit, and to supply power to the quarry companies at 1d. per unit. The company have entered into an agreement with the District Council to light the streets and supply private consumers at 4d. per unit for 15 years. A banquet was held at night in further celebration, when Lord Newborough presided.

Morecambe.—The accounts of the electricity department for the last 12 months show a fairly successful year. At the commencement of the year the committee estimated they would require a 6d. rate, which was equivalent to £2,175. They have actually spent £1,632, leaving a balance to the good of £543. 18s. 3d. The revenue increased by £177. 1s., and the gross profit by £120. 17s. 5d. The amount paid in principal and interest during the year was £3,355. 14s. 7d. as compared with £2,281. 2s. 9d., or an excess of £1,075. 11s. 10d. over last year. Current is charged at 5d. (and gas at 3s. 9d.), and it is anticipated that by the end of another year a 4½d. or 5d. rate only will be required, notwithstanding the increased payment to be made on account of capital. We note that in response to a customer who did not wish to pay the meter deposit a shilling prepayment meter has been procured, showing a businesslike desire on the part of the committee to meet the requirements of their customers.

Coronation.—The directors of the Electrical Power Storage Company, Limited, have decided, in commemoration of the Coronation of King Edward VII., to pay their workmen a full day's pay for the Coronation Day holiday, and to illuminate their premises at 4, Great Winchester-street. The construction has begun in Whitehall of Canada's wheat arch for the Coronation, about 150 yards south of the Horse Guards. It will be lighted with electricity after dark during the Coronation week, and will form one of the most attractive decorations in London. Stoke Newington Borough Council will expend £330 in connection with the Coronation. A large scheme for decorating and illuminating Marlborough House is in the hands of Messrs. J. Defries and Sons, Limited, of Houndsditch, the firm who have the contract for the Temple Bar and Ludgate-circus. Messrs. James Pain and Son, of Walworth-road, will ornament the Mansion House, the Royal Exchange, the Monument, and the Peel statue in Cheapside, while Messrs. Piggott Bros. and Co., of Bishopsgate-street Without, will deal with London Bridge. The Eastbourne Town Hall is to be illuminated with 700 electric lamps.

New Issue.—The British Insulated Wire Company, Limited, announces the issue, at par, of £250,000 4½ per cent. first mortgage debenture stock, being the balance of an issue of £500,000. The company has an authorised share capital of £1,000,000, half in 6 per cent. cumulative preference shares and half in ordinary shares of £5 each, all of which have been issued and fully paid. The company has, with a view to a complete amalgamation of the two businesses, acquired the assets and undertaking of the Telegraph Manufacturing Company, Limited, Helsby, near Warrington, and the constantly growing business of the two companies necessitates the provision of further capital. With the view of providing such capital, the company is making the present issue of £250,000 first mortgage debenture stock. The prospectus states that the whole of the stock now being issued has been underwritten. The Charing Cross and Strand Electricity Supply Corporation, Limited, offers for subscription, at par, 40,000 "City Undertaking" 4½ per cent. cumulative preference shares of £5 each. The dividend on these preference shares will be payable exclusively out of the net profits of the corporation's City undertaking and of any present or future investments by the corporation in the share capital of the Charing Cross and City Electric Company, Limited.

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Horsham.—The Urban District Council have adopted a report of the Electric Lighting Committee, in which they state that they had considered the advisability of extending the supply of electric current in various parts of the district, and had instructed the electrical engineer to prepare estimates of the cost of laying the cables, also an estimate for remedying the humming noise at the generating station, for an additional boiler and steam set, and also for an extension of the switchboard. Mr. Proctor (the electrical engineer) in his last report states that there had been three new connections in the last fortnight, and a total of 41 customers.

New Zealand Cable Rates.—The tentative arrangement come to between the Eastern Extension, Australasia, and China Telegraph Company, Limited, and the Federal Government of Australia for applying to Victoria and Queensland the reduced rate now in force in the four contracting States will be extended to New Zealand, New Caledonia, Norfolk Island, and Fiji. Consequently the tariffs to those places on and after June 1 prox. will be as follows: for New Zealand, ordinary telegram 3s. 4d. per word, press telegram 1s. 2d. per word; for New Caledonia, ordinary, 3s. 8d. per word; for Norfolk Island, 3s. 2d. per word; for Fiji, 3s. 7d. per word.

Bournemouth.—The town clerk reported at the last Town Council meeting that the Board of Trade had declined to make an order in favour of the Corporation *re* Pokesdown lighting, and had granted an order to the company. The following resolution was passed: "(1) That in the judgment of the Council of the county borough of Bournemouth, being the governing body of the said county borough, it is expedient for such governing body to oppose a Bill to confirm, *inter alia*, a provisional order made by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, and called the Pokesdown Electric Lighting Order, 1902, so far as the said order is concerned; (2) that the costs and expenses attending such opposition be paid out of the borough fund and borough rate of the said county borough."

Erith.—The Urban District Council's electric lighting station is to be opened next autumn. Mr. W. C. C. Hawtayne is the consulting engineer. A loan of £23,506 is authorised, being £4,527 for buildings, £7,696 for generating plant, £1,000 for meters and instruments, £8,965 for mains and sub-stations, and £1,318 other capital charges. The plant will consist of two Lancashire boilers by Spurr, Inman, and Co. of 160lb. pressure, and two W. H. Allen and Co.'s engines of 460 and 380 revolutions respectively, engines direct coupled to two International Electric Company's three-phase open-coil inductor type dynamos, with a frequency of 50, 2,800 to 3,000 voltage, and 50 kw. and 150 kw. respectively, and a two-pole shunt-wound direct-driven exciter. The street-lighting is on the three-phase alternate-current system at 200 volts, and will comprise nine arc lamps of 15 amperes and 440 16-c.p. or 32-c.p. incandescent lamps. Eight sub-stations will be placed in the streets. The charge for lighting will be 7d. per unit for the first hour and 3d. after.

Mexborough.—The Urban District Council's electric lighting station was opened on May 10. Mr. N. Waring is the resident engineer. A loan of £13,500 was authorised, distributed as follows: £1,500 for buildings, £3,500 generating plant, £750 meters and instruments, £5,500 mains and sub-stations, and £2,250 other capital charges. The plant consists of two Lancashire boilers by Tinkers, Limited, and Davy Bros., of Sheffield, respectively, and two Alley and Maclellan 90-i.h.p., engines direct coupled to two direct-current Mavor and Coulson's six-pole dynamos of 440 to 480 volts, with a total capacity of 100 kw., and Ashmore, Benson, Pease, and Co.'s accumulators, with a normal output of 270 kilowatt-hours and a maximum discharge rate of 100 amperes. The three-wire continuous system has been adopted, and the street-lighting will comprise 15 enclosed arc lamps and 215 32-c.p. incandescent lamps. One thousand yards of mains have been laid for public lamps.

Hull.—With regard to the annual statement of accounts of the Corporation electric lighting department, which appears in another column, Mr. A. S. Barnard, the city electrical engineer, states that owing to a reduction of ½d. per unit made March 31, 1901, coupled with general slackness of trade, the gross revenue is actually less than the previous year. The increase in the use of current is less than half the increase of the previous year, and the local rates have been increased 1s. 6d. in the pound, making an increased charge on the undertaking of nearly £200. The year's revenue has been charged with three years' payment to sinking fund in respect of one item—viz., £8,717 difference of expenses in issue of stock—this being a net charge for the year of £701. When the loan was floated a full quarter's dividend of 15s. was paid when only 6s. 9d. had been earned. This means another net charge of £516 on the year's working. Furthermore, during August a phenomenal storm, when nearly 3in. of rain fell in the space of one hour, deluged the engine-room and did damage to the buildings, machinery, and mains to the extent of over £500.

Swansea.—The engineer's last report states that the number of consumers on the books is 213, with the equivalent of 24,775 8-c.p. lamps. Mains are to be extended to the following districts—viz.: Plymouth-street, etc., estimated cost £90; Little Wind-street, estimated cost £48; Fisher-street, estimated cost £93; Ffynone and St. James's gardens; and an estimate of the cost of laying a distributor along St. Helen's-road to the hospital is being prepared. The Corporation will make an offer to supply electric power to the Hafod Isha Works upon the following terms—viz.: 15,000 units at 1½d. per unit, or a minimum of 200,000 units per annum at 1¼d. per unit, delivered through a meter at two terminals on the property of the Anglo-French Nickel Company, the company to agree to take a supply for at least three years. The Telephones Committee have received 398 agreements, exclusive of 117 written promises, to support the municipal telephone scheme. The Postmaster-General being unwilling to meet the desire of the Council with regard to the rates for telephones, the committee have resolved to interview the Post Office solicitor, and urge upon him the desirability of retaining the rates originally proposed. The Corporation desire the minimum charge for the telephone service to be £5, but the Post Office suggested that the rate should be £4.

Bolton.—The details of the revenue and costs of the electricity department for the year ending March 31, 1902, work out as follows, according to a statement prepared by the electrical engineer, Mr. Arthur A. Day: Board of Trade units sold—private lighting, 905,928 units at 3·80d., £14,460. 15s. 8d.; public lighting, 17,467 units at 3·10d., £225. 17s. 7d.; power, 197,674 units at 1·45d., £1,199. 6s. 3d.; tramways, 1,999,640 units at 1·50d., £12,497. 15s.; meter rents, £501. 15s. 3d.; motor rents, £107. 16s. 11d.; profit of fittings department, £806. 10s. 7d.—total revenue, £29,799. 17s. 3d. The expenditure was as follows: coal, £5,686. 2s. 9d. (·436d.); oil, waste, and water, £803. 3s. 2d. (·062d.); wages, £2,413. 4s. 2d. (·186d.); repairs, £1,563. 19s. 2d. (·120d)—works cost, £10,466. 9s. 3d. (·804d.); rents, rates, and taxes, £906. 9s. 9d. (·070d.); management expenses, £1,107. 14s. 6d. (·085d.)—total cost, £12,480. 13s. 6d. (·959d.); interest, £4,912. 8s. 5d. (·378d.); depreciation, £7,655 (·589d.)—inclusive cost, £25,048. 1s. 11d. (1·926d.). The total revenue was £29,799. 17s. 3d., and the inclusive cost £25,048. 1s. 11d. The balance (net profit) amounted to £4,751. 15s. 4d. The sum of £3,850 was voted in relief of rates, and £901. 15s. 4d. carried forward.

Dudley.—Mr. E. A. Sandford Fawcett has held an enquiry into the application of the Corporation for sanction to borrow £22,000 for electric lighting purposes. Mr. H. C. Brettell (town clerk) explained that the loan was to enable the Corporation to meet their statutory obligations with reference to electric lighting in the borough, and was the third in connection with the electrical undertaking, the previous loans being £8,500 and £33,000 respectively, the former of which was required to enable the Town Council to fulfil their contract with the tramway company, and the latter for the provision of the power station. The first year's operations resulted in a loss of £80 6s. 10d., and last year there was a net profit, in excess of repayment of principal and interest, of £92. Mr. R. Wilson (consulting electrical engineer) said the tramways belonged to a company, but the Corporation were under a contract to purchase them at the expiration of the lease. The company would continue to work them under a lease from the Corporation, and were under a perpetual arrangement to take the current from the Corporation at a price to be determined every five years. The power station had now a capacity equal to 700 kw., and in order to meet the increasing demand it was proposed to lay down a 500-kw. machine and dynamo, the remainder of the money being required for the provision of street cables.

East Sussex County Asylum.—Mr. Albion T. Snell is the consulting engineer for a compact plant which is being laid down by Messrs. J. E. Spagnoletti and Co., of Goldhawk-road, W. The plant will consist of one steam balancing set of engines and dynamos, direct coupled, each dynamo capable of giving 30 kw. at 200 to 205 volts; also two sets of engines and dynamos each capable of giving 60 kw. at 400 to 410 volts for lighting and 400 to 450 volts for traction. The dynamos will be of the multipolar type, and the engines of Belliss and Morcom's make. Two batteries of 226 cells of Chloride accumulators, capable of giving 70 amperes for seven hours and 120 amperes for four hours, will also be provided. The wiring is for 1,500 16-c.p. lamps and 800 8-c.p. lamps. Nine motors are to be supplied for power purposes. Power will also be supplied to a light railway between the asylum and Hellingley Station, a distance of 1,900 yards, on the overhead trolley system. Brackets from side poles 40 yards apart will be used. A suitable main traction switchboard is supplied. The principal switchboard is to be of Spagnoletti's central-station, low-tension, three-wire design, the general arrangement being such that one or more of the steam dynamos can be used for supplying the lights and motors, aided at the same time by the steam or motor balancer and booster for charging accumulators at full rates. The latter are to be in circuit at all times.

Australian Power Transmission.—Another large power transmission scheme projected in Victoria is that of working the extensive mines in the large and well-paying Walhalla district by a plant to be erected on a central site—at Mormon Town, on the Thomson River. This river has an excellent fall and a good permanent water supply, and is, therefore, especially well adapted for the working of power plant. Those interested could not do better than consult a report which has recently been issued by the Department of Mines of that State. The report is the outcome of a special survey planned by the Government geologist, Mr. James Stirling, at present representing the department in London, and signed by Mr. H. Herman, B.C.E., F.G.S., acting Government geologist. The report abounds in plans, sections, and plates, and is far above the usual Blue-book in details of stratifications and general underground work. The field work has been carried out by Messrs. V. R. Stirling and O. A. L. Whitelaw. Mr. V. R. Stirling was a most able officer, whose sudden death a few days ago—cutting short a most promising career—is much deplored by all who knew him, and earnest sympathy is felt for his father. All the photographs in the report are Mr. Stirling's work, and they are remarkable specimens of underground work. Most interesting amongst the plans and sections is a sheet, 6ft. by 2ft., showing the general geological structure of the field where it is proposed to instal the power plant.

Leeds.—The generating engines at the Corporation electric lighting works in Whitehall-road will shortly be laid down. In building extensions and additional plant the Corporation are spending about £160,000, and it is anticipated that by this expenditure they will be able to meet the demand for electricity for some time to come. The extensions include a large engine-house, capable of holding 10 generating sets of 2,500 h.p. each, with the necessary boilers, condensing plant, etc. Messrs. J. and M. McLaren, of Hunslet, secured the contract for one of the two engines at first required to be placed in the new station. The engine is now finished, and has been inspected by members of the Corporation Lighting Committee and engineers in the

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city. It is a triple-expansion, high-speed, enclosed engine, capable of developing a normal power of 2,500 i.h.p., with a maximum for an emergency of 3,000 i.h.p. It is the most powerful electric lighting engine ever built in Leeds. Weighing 150 tons, without flywheel, the engine makes 200 revolutions per minute. The boiler pressure is 180lb. on the square inch, but all is strong enough to admit of a pressure of 200lb. The structure is distinguished by the comparatively small number of working parts and the simplicity of its construction, and the makers assert that economy and steadiness at all loads will characterise its operations. So far, a steam consumption of 11·8lb. per indicated horse-power per hour, equal to a coal consumption of less than 1¼lb. per indicated horse-power per hour, has been obtained.

Leatherhead.—The buildings of the Leatherhead and District Electricity Company are progressing. The boiler-house is equipped with two Davey-Paxman's high-pressure boilers, with superheaters, thus securing the maximum economy. In the engine-house are two vertical 50-h.p. engines coupled direct to the dynamos. The accumulator batteries are said to be of exceptional capacity, so that in the event of unforeseen accidents to any part of the machinery, the lighting of the town and of residences will be in no way affected. It is proposed to commence the laying of the mains at once. For lighting, 7d. per unit will be charged to ordinary consumers, and 4d. per unit for motive power. The company propose at the outset to wire for a limited number of consumers free of charge up to four lights, and to put in penny-in-the-slot meters. The company have offered to light the streets electrically, and to carry out the same scheme for public lighting which Messrs. Handcock and Dykes, the engineers to the present company, recommended the Council to adopt some time ago when they were discussing whether they should themselves carry out the undertaking. They offer to supply the current for public lighting as it was then calculated the Council could generate it for. The company have already secured a contract to light the new blind school with the equivalent of 1,200 8-c.p. lamps, the supply to commence on July 1 next. By this date the company will also be in a position to supply other intending consumers. The building is being carried out from designs prepared by Mr. J. R. Harding, C.E., of Epsom, by Mr. H. Skilton, of Leatherhead. Messrs. Geipel and Lange are responsible for the engineering part of the undertaking, and Messrs. Glover and Co., of Salford, are the contractors for the laying of the mains, the consulting engineers being Messrs. Handcock and Dykes.

Presentations.—Mr. W. F. Stamp, A.M.I.E.E., late assistant electrical engineer to Wimbledon Council, having been appointed to the post of chief assistant electrical engineer to the Devonport Corporation, was entertained by his professional friends at Frascati's Restaurant on Thursday last week. Mr. J. W. A. Binner, chief assistant engineer to the Bermondsey Borough Council, in presenting Mr. Stamp with a dressing case on behalf of the company present, congratulated him on his appointment and wished him every success. A silver cigarette case was also presented to him from the working staff of the Wimbledon electricity works, as a mark of their great appreciation of his courteous treatment, and fair dealing received at his hand. An address from the men, wishing him every success, accompanied the gift. Mr. Stamp left Paddington on Saturday, when he was accorded a most hearty send off; Mr. A. E. Young making a further presentation of a silver match box on behalf of a few personal friends. At Rotherham last week the borough electrical engineer, Mr. Edward Cross, was the recipient of a handsome present, consisting of a silver afternoon tea set and silver-mounted oak tray, suitably inscribed, from the staff and employés on the occasion of his marriage. His Worship the Mayor (Alderman D. L. Winter), who made the presentation on behalf of the employés, congratulated Mr. Cross on the excellent feeling that existed between himself and the staff. He was sure his colleagues in the Council had the utmost confidence in their electrical engineer. The majority of the Council anticipated a loss in the working of the department, and he thought it augured well for the future of the undertaking that in the comparatively short period of 10 months during which their works had been in operation they had not only paid their expenses, but actually made a small profit.

PROVISIONAL PATENTS, 1902.

MAY 14.

11018. Improvements in lampholders or sockets as used in lamps for electric lighting and the like. John Westwood Lea and John Hall Perrins, Midland Works, Bracebridge-street, Birmingham.

11021. Improvements in electricity supply meters. Rankin Kennedy, 42, Markham-avenue, Leeds.

11044. Improvements in and connected with electric arc lamps. John Owen Girdlestone and Carl Frederik Grimur Thorkelin, 16, Davies-street, Berkeley-square, London. (Complete specification.)

11067. Improvements in electrical instruments for signalling on railways. Edward Tyer, Frederick Thomas Hollins, and Frederick William Leake, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

11068. Improvements in apparatus for actuating the electrical controlling appliances of the motors of electric railway motorcars. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktiengesellschaft, Germany.)

11072. Improvements in switches for electric circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (James J. Wood, United States.) (Complete specification.)

11073. Improvements in means for controlling electric circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (James J. Wood, United States.) (Complete specification.)

11074. Improvements in winding forms. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. Julius W. Sundskog, United States.) (Complete specification.)

11075. Improvements in electric switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

11076. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edwin W. Rice, jun., United States.) (Complete specification.)

11077. Improvements in supports for high-tension electric conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Asa F. Batchelder, United States.) (Complete specification.)

11078. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Walter C. Fish, United States.) (Complete specification.)

11079. Improvements in cut-outs for electric conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Pendleton G. Watmough, United States.) (Complete specification.)

11080. Improvements in multipolar electric switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Howard R. Sargent, United States.) (Complete specification.)

11081. Improvements in electric starting rheostats. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frederick Mackintosh, United States.) (Complete specification.)

11082. Improvements in third-rail insulators for electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Samuel B. Stewart, United States.) (Complete specification.)

11085. Improvements in electric cranes. Stothert and Pitt, Limited, and Ebenezer Evans, 24, Southampton-buildings, Chancery-lane, London.

11086. Improvements in and relating to electric switches. Denis Ripley Broadbent, 322, High Holborn, London.

11095. Improvements in or relating to coupling devices particularly applicable for coupling a dynamo to a centrifugal pump. Maurice Auguste Eudelin, 111, Hatton-garden, London.

11101. Improvements in electric clocks. Otto Romanze, 37, Essex-street, Strand, London.

11102. Improvements relating to electric heaters and rheostats. Max Carl Krueger, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MAY 15.

11127. Improved apparatus or means to be employed in conjunction with trolley arms in applying roofs or covers over the tops of electric tramcars and the like. John Thomas Trainer, 32, John William-street, Huddersfield.

11134. Improvements in electric arc lamps. August Eckstein and Arthur Ernest Angold, Peel Works, Adelphi, Salford, Manchester.

11139. Improvements in or relating to the electrical igniters of gas and similar explosive vapour motors. Alfred Rowe Bellamy, 5, John Dalton-street, Manchester.

11159. Spring roller for regulating the height of electric light pendants. Wilfrid Emerson, 45, Earl-street, Grimsby.

11160. Improvements in electric arc lamps. Arthur Kirby and Alfred James Kirby, 226, High Holborn, London.

11165. Improvements in switch-box apparatus used for testing, standardising, or calibrating electrostatic instruments, and in measuring electric currents thereby. George Leonard Addenbrooke, 37, Essex-street, Strand, London. (Complete specification.)

11177. Improvements in apparatus for opening and closing electric circuits. Hugo Hirst and Charles Frederick Trippe, 71, Queen Victoria-street, London.

11188. Improvements in continuous-current dynamos. Paul Néty, 65, Chancery-lane, London.

11197. Extracting electricity from the atmosphere and storing it. James Fenton, Albert du Lac, and Arthur Jonckheere, 70, Oak Hill-road, Wandsworth, London.

11206. Improvements in or relating to arc lamps. Friedrich Engelhardt, 18, Buckingham-street, Strand, London.

11209. Improvements relating to electrical conduit systems for tramways. Frank Boulton Aspinall and James Douglas Dallas, 6, Breams-buildings, Chancery-lane, London.

MAY 16.

11240. Improved electric switch. John Crawford Macalester, Box 23, Athenæum, Glasgow.

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11249. Improved sliding pendant for electric lighting. James Milne, Milton House Works, Edinburgh.

11269. Improvements in wireless signalling. John Munro, St. John's-grove, Croydon.

11286. A new or improved galvanic cell. Gerhard Bodo Puchmuller and George Pearson, 70, Chancery-lane, London. (Complete specification.)

11290. Improvements in electric switches and regulating sockets, chiefly designed for use in connection with incandescent electric lamps. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (William Peyton Pinckard, United States.) (Complete specification.)

11313. Improvements in and relating to the transmission of electrical impulses. Ludwig Walter and Peter Walter, 322, High Holborn, London.

11323. Improvements in electricity meters. Leonard James Eron and John William Flower, 47, Lincoln's-inn-fields, London.

11324. Improvements in electricity meters of the kind known as two-rate meters. Leonard James Aron and John William Flower, 47, Lincoln's-inn-fields, London.

MAY 17.

11339. Improvements in portable telephonic apparatus for the use of persons with impaired hearing. William Edwin Heys, 70, Market-street, Manchester. (The Hutchison Acoustic Company, United States.) (Complete specification.)

11340. Improvements in dry or semi-dry cells of primary or secondary electric batteries. William Edwin Heys, 70, Market-street, Manchester. (The Hutchison Acoustic Company, United States.) (Complete specification.)

11342. Improvements in charging switches for secondary electric batteries. William Edwin Heys, 70, Market-street, Manchester. (The Hutchison Acoustic Company, United States.) (Complete specification.)

11357. Improvements in electricity meters. Knowles Anderson, 65, Albion-street, Leeds.

11369. Improvements in electric governing devices. John Joseph O'Connor and William Oliver Septimus Hilditch, 55, Market-street, Manchester.

11374. A new system of electric traction. Baptistin Cruvellier, Commercial-street, Halifax. (Complete specification.)

11377. Improvements in fittings for metallic conduit systems of electric wiring. Lawrence Maxwell Waterhouse and the Simplex Steel Conduit Company, Limited, 34, Castle-street, Liverpool. (Complete specification.)

11393. Improvements in automatic apparatus for controlling and operating the points of electric railways and tramways. Thomas Bell Stewart, William Herbert Turner, and Rowland Edward Dixon, 8, Quality-court, Chancery-lane, London.

11395. Improvements in or applicable to rheostat switches for controlling electric currents. William Royston Laidlaw and George Hamer Scholes, 70, Deansgate, Manchester.

11404. Improvements in electric fuses. Oliver Leopold Peard, 24, Southampton-buildings, Chancery-lane, London.

11416. Improvements in overhead conductors for electric tram and railways. Edouard Dussek, 39, Hillcrest-road, Acton, London.

11423. Improvements in electric clam dredges. Ephraim Chaquette, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

11427. A new or improved endless electric conveyor for conveying tin plates from the bath of molten metal to a suitable or desirable place. John Baxter, Oliver Clark, and Charles Hillman, 9, Regent-street, London. (Complete specification.)

MAY 20.

11454. Improvements in register dials for gas, water, and electricity meters. Claud Carew-Gibson, 15, Claremont-road, Surbiton.

11460. Improvements in and relating to the electrical propulsion of tramway cars, railway carriages, and the like. Robert Cleghorn Thomson, 96, Buchanan-street, Glasgow. (Donald Kempt, Argentine Republic.)

11487. Improvements in electric cables. George Harrison, of D. Young and Co., 11, Southampton-buildings, Chancery-lane, London. (Kabelfabrik Actien-Gesellschaft, Austria.) (Complete specification.)

11489. Improvements in starting devices for alternating-current induction motors. British Thomson-Houston Company, Limited, and Hans Sigismund Meyer, 83, Cannon-street, London.

11499. Improvements in and relating to electric low-water alarms for steam-boilers. George Croydon Marks, 18, Southampton-buildings, Chancery-lane, London. (George Fuller, United States.) (Complete specification.)

11500. Improvements in multiple switches. George Croydon Marks, 18, Southampton-buildings, Chancery-lane, London. (The Cutler-Hammer Manufacturing Company, United States.) (Complete specification).

11510. Improvements in electric incandescent lamps with rare earth filaments. William Alfred Crook and Edward Mines, 6, Lord-street, Liverpool.

11508. Improved process for the preparation of electrodes or secondary batteries. William Phillips Thompson, 322, High Holborn, London. (Akkumulatoren und Elektricitäts-Werke Aktiengesellschaft vormals W. A. Boese und Co., Germany.) (Complete specification.)

11509. Process for the production of electrodes for secondary batteries. (Akkumulatoren und Elektricitäts-Werke Actiengesellschaft vormals W. A. Boese und Co., Germany.) (Complete specification.)

11516. Improvements in apparatus for electrically operating tools. Herbert John Haddan, 18, Buckingham-street, Strand, London. (James Stewart Andrews and William Matthew Simpson, United States.)

11523. Method of and means for transmitting electrical energy in works for traction purposes. Max Deri, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MAY 21.

11567. A new and improved receiver for wireless telegraphy. Louis Heathcote Walter, 83, Holland Park-avenue, London.

MAY 22.

11640. Improvements in elastic cushions or buffers for electric light shades and the like. Alexander Marr, 18, Cawdor-road, Fallowfield, Manchester.

11668. Improved manufacture of electric accumulators. Albert Schmidt-Predari, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

11683. Apparatus for generating and utilising electric energy. William Speirs Simpson, 173, Fleet-street, London.

11692. Improvements in wireless telegraphy. Edward Pruden Thompson, 322, High Holborn, London.

MAY 23.

11722. An improved trolley head and arm for overhead electric wires and a safety appliance for rendering broken electric wires harmless. Jasper James Carter, 4, Vergemont Hall, Clonskeagh, co. Dublin.

11725. Improvements in or relating to metallic conduits and fittings for electric cables and the like. Laurence Maxwell Waterhouse and the Simplex Steel Conduit Company, Limited, 34, Castle-street, Liverpool.

11728. An improved electrical switch. Oliver Pearson, 2, Akenside-hill, Newcastle-on-Tyne.

11765. A method of measuring temperature at a distance by electrical means. Charles William Scott Crawley and Alexander Pelham Trotter, 44, Castletown-road, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published June 12

1901.

3935. Laying of underground conductors for distribution of electrical energy. Jones and Davis.

10166. Printing telegraph receivers. Boult. (Joy Printing Telegraph Company.)

10766. Electromagnetic selectors for loom jacquards or other apparatus. Macquisten.

11931. Regulating and controlling the speed or power of electric motors. Allcroft.

13010. Telephone and bell set. Byng and Bell.

13078. Electric accumulators. Gibbs.

13402. Self-exciting alternating-current dynamos. Latour. (Rights under Sec. 103 not granted.)

13666. Lamp-holders for electrolytic lamps. Drake and Nernst Electric Light, Limited.

14165. Manufacture of carbon electrodes and of coke. Pohl.

14486. Process and apparatus for the manufacture of wrought iron, steel, and cast iron by electric heating. Imray. (Soc. Electro-Metallurgique Française.)

14643. Electric furnace arranged for being oscillated or tipped. Imray. (Soc. Electro-Metallurgique Française.)

14822. Electrolytic apparatus. Rhodin.

16460. Electric alternating-current transformers and accessories thereto. Wilkinson.

18597. Electric regulating apparatus. William Jared Clark. (James B. Foote.)

20497. Cable terminal boxes for electricity supply purposes. Wilkinson.

26484. Third railway conductors for electric railways. Lake. (Central Electric Construction Company.)

26485. Third-rail conductors for electric railways. Lake (Central Electric Construction Company.)

1902.

1984. Electric transformer. Stutchbury and Gorick.

2701. Telephone line jacks. Lambert.

7447. Electric transmission of power. Otis Elevator Company, Limited. (Otis Elevator Company.)

8009. Submarine and other war vessels, and especially those carrying torpedoes. Hardingham. (Electric Boat Company.)

8487. Transmitting devices for electric telegraphic and like apparatus. Justice. (Rowland Telegraphic Company.)

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TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	May 17	626	672	− 46	35,350	33,242
Birmingham Tramways	,, 24	5,314	4,883	+ 431	38,196	88,652
Blackburn Corporation	,, 24	993	691	+ 302	13,803	12,005
Blackpool Corporation	Apr. 19	278	269	+ 9	3,601	2,242
Blackpool-Fleetwood Tramways	May 24	1,357	432	+ 925	6,227	5,131
Bolton Corporation	,, 25	2,086	1,440	+ 646	29,244	26,739
Bradford Corporation	,, 18	2,828	995	+ 1,833	44,468	16,276
Bristol Tramways Company	,, 23	5,779	4,680	+ 1,099	—	—
Carlisle Tramways Company	Mar. 15	122	123	− 1	1,282	1,192
Central London Railway	May 24	6,899	6,166	+ 733	140,668	130,103
City and South London Railway	,, 25	2,884	1,845	+ 1,039	62,470	41,612
Cork E. T. and L. Company	,, 22	584	621	− 36	2,425	8,215
Darwen Corporation	Mar. 22	169	154	+ 15	1,961	1,814
Darwen-Hoddlesden	,, 14	26	—	—	—	—
Dover Corporation	May 24	259	204	+ 55	3,819	3,661
Dublin & Lucan Electric Railway	,, 25	152	125	+ 27	2,002	1,855
Dublin U. T., electric cars	,, 23	4,016	3,853	+ 163	—	—
Dublin S. District, Electric	,, 23	1,499	966	+ 533	—	—
Dundee Tramways Company	,, 14	647	678	− 31	—	—
Glasgow Corporation	,, 24	11,940	11,835	+ 105	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 24	1,811	1,589	+ 222	13,244	12,932
Liverpool Corporation	,, 10	9,149	8,850	+ 299	170,172	155,092
Liverpool Overhead Railway	,, 25	1,792	1,565	+ 232	29,887	32,376
Newcastle-on-Tyne Corporation	,, 17	2,464	—	—	—	—
Portsmouth Corporation	,, 17	1,296	542	+ 754	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 25	5,006	—	—	—	—
Southampton Corporation	Mar. 27	775	537	+ 238	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £377 decrease.
Barcelona Ensanche y Gracia, £96 decrease. Barcelona £323 increase.
Brisbane, £125 increase (month of March, £10,934; increase, £1,789).
Buenos Ayres and Belgrano Electric (month of April, receipts £11,872; decrease £615), £8 decrease.
Calcutta, £246 increase.
Cape Town (month of March), receipts, £17,888; expenditure, £7,343.
Isle of Thanet Electric, £280 increase.
Mexico Electric (month of April), receipts, £19,350; expenditure, £10,620.
Perth Electric, £227 increase.
Port Elizabeth (month of March), receipts, £3,818; expenditure, £1,947.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅞-⅞
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¼-¼
—— Ordinary, 1-125,000	1 ..	⅛-⅛
British Insulated Wire, Ord., 1-70,000	5 ..	8-9
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5¼-5½
—— 5 per cent. Mortgage Debentures	100 ..	101-104
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5½-6
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1¼-2¼
—— 4½ per cent. 1st Debenture Stock	100 ..	101-104
—— 4½ per cent. 2nd Debenture Stock	100 ..	96-100
Callender's Cable, Debentures	100 ..	111-115
—— Ordinary	5 ..	17-18
—— 5 per cent. Pref.	5 ..	5¼-6
Crompton and Co.	3 ..	3-3½
—— 5 per cent. Debentures	100 ..	103-108 p.c
Edison and Swan United, Ordinary	3 ..	⅛-⅜
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	75-80
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-1½
—— 7 per cent. Cumulative Pref.	2 ..	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	9½-10½
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	98-101
W. T. Henley's Telegraph Works, Ordinary	5 ..	17-18
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	99-102
Parker, Thos., Limited, Ordinary	10 ..	15½-16½
Telegraph Construction and Maintenance	12 ..	34-37
—— 5 per cent. Bonds	100 ..	103-106
Telegraph Manufacturing, Ordinary	5 ..	10-11
—— 5 per cent. Cum. Pref.	5 ..	5½-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	8½-9½
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107
Electric Railways.—		
Central London, Ordinary	100 ..	103-106
—— 4 per cent. Pref.	100 ..	105-106
—— ,, ,, deferred	100 ..	100-103
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-118
City and South London, Consolidated Ordinary	100 ..	72-74
—— 4 per cent. Debenture Stock	100 ..	113-117
—— 5 per cent. Pref. Stock '91	100 ..	128-133
—— ,, ,, ,, '96	100 ..	125-128
—— ,, ,, ,, '01	100 ..	120-124
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7⅛-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	92-96

Name.	Amount paid.	Last price
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	¼-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	100-104
Bournemouth and Poole, Ordinary	10 ..	11-12
—— 4½ per cent. Cum. Pref.	10 ..	9½-10½
—— Debenture Stock, Red.	100 ..	103-106
Brompton and Kensington, Ordinary	5 ..	8¾-9¼
—— 7 per cent. Preference	5 ..	8¾-9¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	8-9
—— Nos. 20,001-30,000	5 ..	8-9
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½
—— ,, ,, ,, £10 Ord.	6 ..	10¾
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	106-108
Charing Cross and Strand	5 ..	9-10
—— Nos. 50,001-70,000	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5¾
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5-5½
—— 4½ per cent. Debentures	100 ..	110-113
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	103-106
County of London and Brush Provincial, Ordinary	10 ..	7¼-8¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	108-111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6¼-6¾
—— 6 per cent. Cum. Pref.	5 ..	5¾-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	107-110
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4-4½
—— 5 per cent. Debenture Stock, Red.	100 ..	101-104
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¾-6¼
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10-11
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10½
London Electric, Ordinary	3 ..	1¼-1½
—— 6 per cent. Pref.	5 ..	4-4½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	95-100
Metropolitan, Ordinary	10 ..	16¼-17¼
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9½
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	14-15
Oriental, 1879	1 ..	1¼-1½
—— £5 Shares	5 ..	7¼-7½
—— £4½ Shares, New	4½ ..	6½-7
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	98-101
River Plate Electric Light and Traction, Deb.	100 ..	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1¾-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	3-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	98-101
Westminster, Ordinary	5 ..	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	2½ ..	3¼ 4
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4-4½
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	127-132
Blackpool and Fleetwood Tramroad	10 ..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	3-3½
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	104-107
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	7-7½
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9½-10¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	102-104 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13½-14½
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12½-12¾
—— 5 per cent. Perpetual Debenture Stock	100 ..	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1½-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4¾-5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	103-106
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2⅜-2⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	102-105 xd
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	12-13
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	96-99
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14½-15½
—— 4½ per cent. Deb. Stock	100 ..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	4¼-5
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10 ..	10¼-11
—— ,, ,, ,, ,, ,,	5 ..	5¼-6
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	105-107
—— ,, ,, Prov. Crts.	50 ..	54-56
New General Traction, Ordinary	5 ..	2-3
—— 6 per cent. Cum. Pref.	10 ..	3-4
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	100-103
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	9¼-10¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	105-108
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	12s. ..	¼
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	60 p.c. ..	60 p.c.
Telephones.—		
National Telephone, Preferred	100 ..	95-99
—— Preferred, 590,001-790,000	3½ ..	3¼-3⅜
—— Deferred Stock	100 ..	53-57
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-5¼
—— 3½ per cent. Deb. Stock, Red.	100 ..	94-97
—— 4 per cent. Deb. Stock, Red.	100 ..	103-107
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

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Supplement to "The Electrical Engineer,"

MAY 30, 1902.

ELECTRICAL TRACTION ON STEAM RAILWAYS IN ITALY.*

BY PROF. C. A. CARUS-WILSON, M.A., MEMBER.

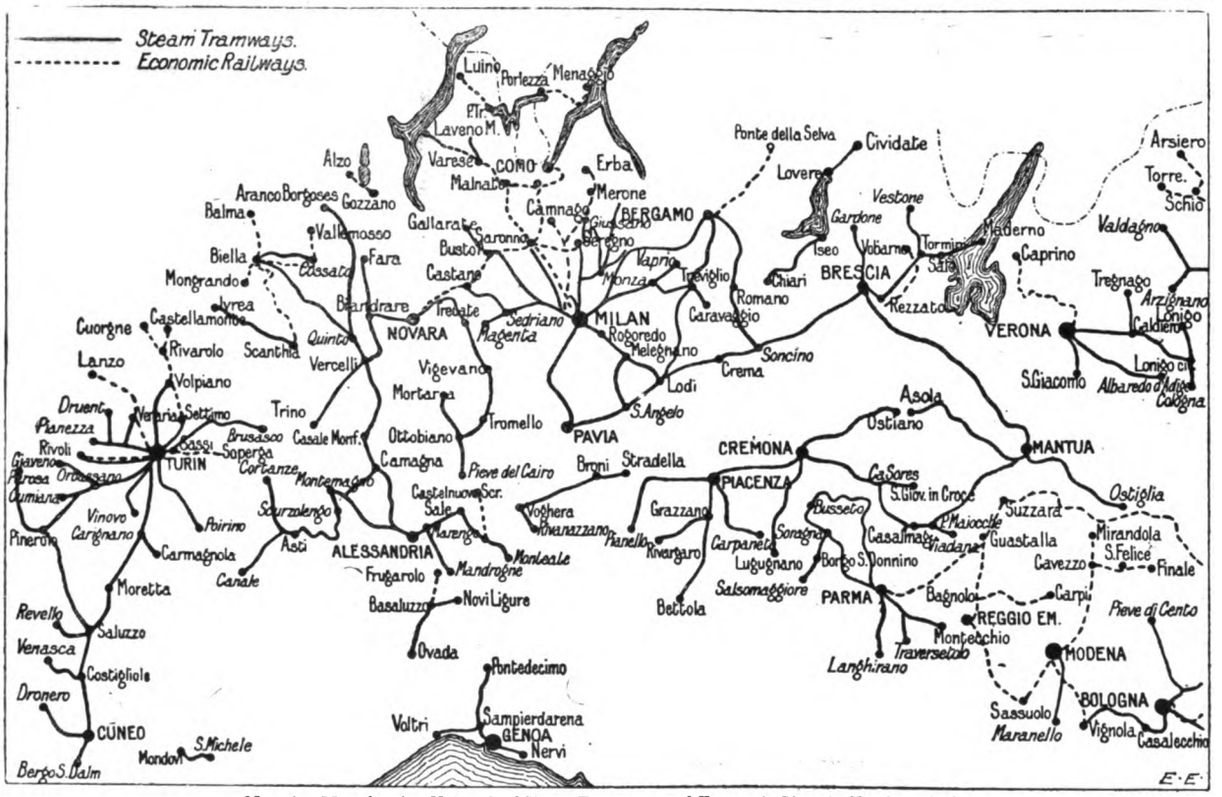
Italian Railways.

The Adriatica and the Mediterranean Railway Companies together work 80 per cent. of the railways in Italy, the former serving the whole of Eastern Italy from Venice to Brindisi, and the latter the whole of Western Italy from Turin to the extreme south. The two systems have their chief connecting points at Milan, Florence, Rome, and Naples. The number of miles of line worked by each company is about the same, nearly 3,690 miles by the Mediterranean and 3,620 by the Adriatica. Each of these companies, therefore, works about as many miles of line as the Great Western and the Great Northern Companies put together. The railways are now being worked under an arrangement with the Italian Government, by which the Government gives the companies an annual subsidy in return for a certain proportion of the receipts. For the year 1900 the Adriatica Company received from the Government a subsidy of £2,166,000, while it paid to the Government a sum equal to 40 per cent. of the total receipts, amounting to £2,040,000, the balance to the credit of the company being £126,000. This arrangement comes to an end in 1905, when the Government has the option either of buying out the companies or of coming to a fresh arrangement with them. For a long time past the Italian railways have been suffering from the competition of tramways and economic lines, which have provided a cheaper and more frequent service, seriously affecting the traffic on the main lines in spite of every effort made to minimise the injury thus caused. The map (A) shows the network of steam tramways and economic lines that has spread over Northern Italy; these not only radiate from most of the large towns, such as Milan, Turin, Verona, etc., but also serve as links to connect one town with another, as, for instance, the line connecting Milan with Pavia, which is 20 miles long, and that connecting Brescia and Mantua, which is 43 miles long. The railway companies have come to the conclusion that the remedy for this competition lies in providing, by means of electricity, a service of short trains running frequently at high speeds. This paper will contain an account, written from an economic rather than from a technical standpoint, of what is being done towards carrying out this object, with some comparisons between the conditions of railway working in Italy and in England.

The Adriatica Railway.

The Adriatica Railway Company has already equipped electrically that portion of its system running from Lecco to Colico, and thence to Sondrio and to Chiavenna (see Map B). The intention is to extend the system ultimately to Milan. Meanwhile the electrically-driven trains are to work their own way as far south as Lecco, and to be hauled thence to Milan by steam locomotives. Trains are now running experimentally, but not yet in actual service. The total distance at present electrified amounts to 66 miles, all of single track, a large proportion between Lecco and Colico being in tunnel. A profile of the line is given in Fig. 1. The hydraulic power-house, with turbines of 6,000 h.p., is at Morbegno, water being taken from the River Adda. Three-phase current is generated at 22,000 volts, and carried by overhead conductors to nine transformer stations, where it is transformed down to 3,000 volts and taken to the two trolley wires, the rail forming the third conductor, and thence direct to polyphase motors on the cars.

The motorcars, of which a view is given in Fig. 2, are 57ft. long, weigh 53 tons unloaded, and have seating accommodation for 56 passengers. Each car is provided with two high-speed motors of 150 h.p. and two low-speed motors of 75 h.p. each, weighing 3·8 tons and driving direct without gearing. Full speed is 37 miles an hour. The four motors are used in cascade connection at starting; at half speed the two low-speed motors are switched out, and the car is driven by the two high-speed motors alone at full speed. On all grades over 1 per cent. the motors are connected in cascade, and the speed thus



MAP A.—Map showing Network of Steam Tramways and Economic Lines in Northern Italy.

halved. The trailers used are passenger carriages of the ordinary type. The goods traffic is to be hauled by electric locomotives.

The company is introducing a new "economic" system for working the line, by which they hope to reduce the traffic expenses, 80 per cent. of which is accounted for by the wages and salaries of the *personnel* at the stations. This system has been in operation on other parts of the company's lines, and has been found to work well, as, for instance, on the section of line, 27 miles long, between Bologna and St. Felice, part of the projected line from Bologna to Verona. In this system the stations are divided into "control" stations and "section" stations. On the Lecco line there are six of the former and eleven of the latter. The responsibility for the control of the traffic rests with the *personnel* at the "control" stations, the agents at the "section" stations having no direct responsibility for the safe conduit of the traffic which depends entirely on an automatic block system operated by an electrical apparatus which the agent has to attend to and keep in working order. Each "section" station is in telephonic communication with the nearest "control" station, to which all questions relating to rates, regulations, etc., can be referred. By this means a considerable reduction in the expense of the *personnel* at the stations is rendered possible.

The block system employed is the Webb and Thompson staff system, supplemented by an electric interlocking apparatus invented by Signor Olper, the controller of telegraphs in the Adriatica Railway Company, combined with an arrangement by which the trolley line at every station is divided into sections, each controlled by a switch, the opening and closing of which takes place simultaneously with the

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movement of the corresponding signal, so that it is impossible for a train to run on to a section against signals.

The Mediterranean Railway.

The Mediterranean Railway Company is equipping electrically the whole of the line from Milan to Gallarate, and thence to Varese, Porto Ceresio, Laveno, and Arona. Some idea of the importance of the change now in progress may be gained from the fact that the passenger receipts from these sections of line amount to about 2 per cent. of the receipts for the whole Mediterranean system. The total length of line is 81 miles, made up of sections as given in Table V. Of the whole distance, all is of single track except the length from Milan to Gallarate, which is of double track. The maximum grades and minimum curves are given in the table. A profile of the line is given in Fig. 3, and a plan in Fig. 4.

The power-house is at Tornavento, about seven miles from Gallarate. Current is at present being supplied from a steam generating plant, but a water-driven plant is in course of construction close to the steam power-house, from which the whole line will ultimately be worked. Turbines of a total of 11,000 h.p. will be driven by water taken from the River Ticino. The power is transmitted as three-phase current at 12,000 volts to sever sub-stations along the line, where the pressure is reduced from 11,000 to 420 volts, and the current is transformed in rotary converters to direct current at 650 volts. From the sub-stations the current is taken to an insulated third rail, as shown in Fig. 5. The motorcars on the Varese line, shown in Fig. 6, weigh 40 tons unloaded, and have accommodation for 63 passengers seated and 12 standing. Each motorcar is driven by four 150-h.p. motors, on the usual one-hour rating, and is geared with a 3 to 1 ratio to 41in. driving wheels. Full speed on a level is 56 miles an hour. Each motor weighs 2·5 tons. The trailers weigh 27 tons empty, and have accommodation for 63 passengers seated and 27 standing. The goods traffic is to be hauled by electric locomotives. The electric trains are now running and in regular operation as far as Varese, though the service of trains as contemplated is not yet complete.

Table I.—Comparing the Weight, Power, and Dimensions of the Polyphase Motorcars on the Lecco Line with the Direct-Current Motorcars on the Varese Line.

—	Total weight empty.	Length of frames.	Seats.	Number of motors.	Maximum H.P. of each.	Total maximum H.P.	Weight of four motors.	Full speed on level.
	Tons.	Feet.					Tons.	M.P.H.
Varese...	40	52	63	4	150	600	10	56
Lecco ...	53	57	56	4	{2 of 150 / 2 of 75}	300	15·2	37

Working Expenses and Receipts.

The working expenses of the Italian railways are given in Table II. These figures actually refer to the Adriatica Railway, but as the corresponding figures for the Mediterranean Railway are almost the same, they may be taken as representing the cost of running on either of the great systems. To afford a comparison, the figures for the cost of running an English railway are placed in the same table. A distinction has been made between those expenses which do and those which do not vary with the number of trains run. Thus to the locomotive expenses, comprising wages of driver, water, oil, and repairs, have been added the cost of conductors' wages and carriage repairs. All these expenses vary with the number of trains run, and are, therefore, dealt with apart from those, such as the maintenance of the line, which do not so vary.

Table II.—Running Expenses per Passenger Train Mile.

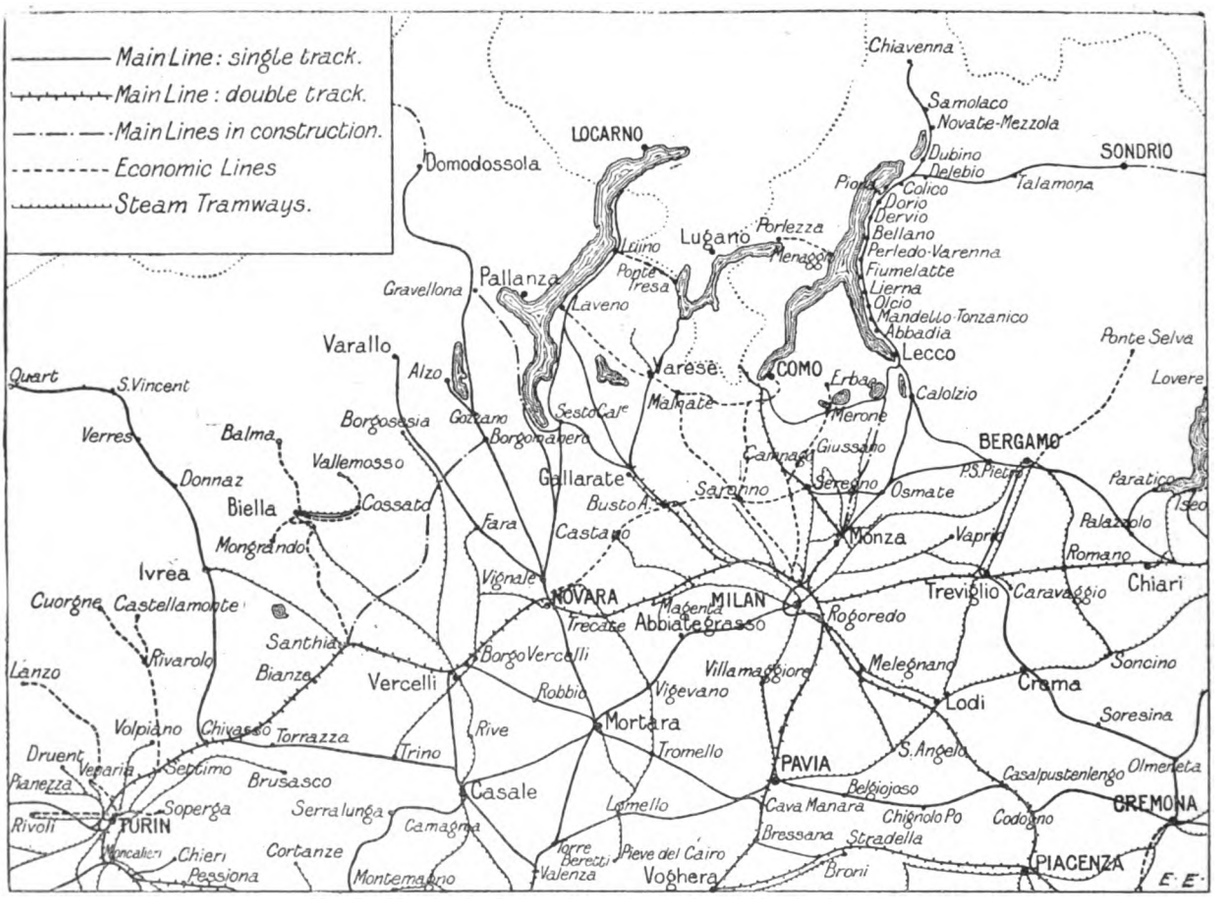
	English. d.		Italian. d.
1. Coal	1·72	...	5·30
2. Wages of driver and stoker	3·81	...	3·18
3. Wages of conductor	1·52	...	2·08
4. Water, oil, etc.	0·77	...	0·60
5. Repairs, locomotives	2·39	..	3·52
6. Repairs, carriages	2·83	...	6·01
Total	13·04	...	20·69

Note.—English items 2, 4, 5, and 6 from official returns for the Great Northern Railway for 1900. Italian items 2, 3, 4, 5, and 6 from official returns of the Adriatic Company for 1899. Item 3 under English costs, obtained by taking the wages of driver, firemen, and conductor in the proportion of 42s., 22s., and 25s.

The coal consumption on an English railway is taken at 40lb. per train mile, and the cost at 8s. per ton. The actual consumption of coal on the locomotive on the Italian railways is given in the official reports as 41lb. per train mile. The statistics draw no distinction between the weight of an average goods train and that of an average passenger train, but the passenger train mileage is stated to be 68 per cent. of the whole train mileage. Taking the weight of coal per passenger train mile to be 70 per cent. of that per goods train, the coal consumption per passenger train mile would be 36lb., which brings the cost, at 27s. per ton—the price paid in 1899—to 5·3d. per train mile.

Table III.—Giving the Receipts and Expenses per Mile.

Fixed expenses.	English.		Italian.
Maintenance of the line	£535	...	£132
Traffic expenses	1,350	...	236
General expenses	537	...	53
Total	£2,422	...	£421
Running expenses	£1,750	...	£699
Receipts.			
Passenger traffic	£2,640	...	£640
Goods and miscellaneous	3,820	...	965
Total	£6,460	...	£1,605
Expenses in per cent. of receipts	65	..	70



Map B.—Map showing Railway Connections in the neighbourhood of Milan.

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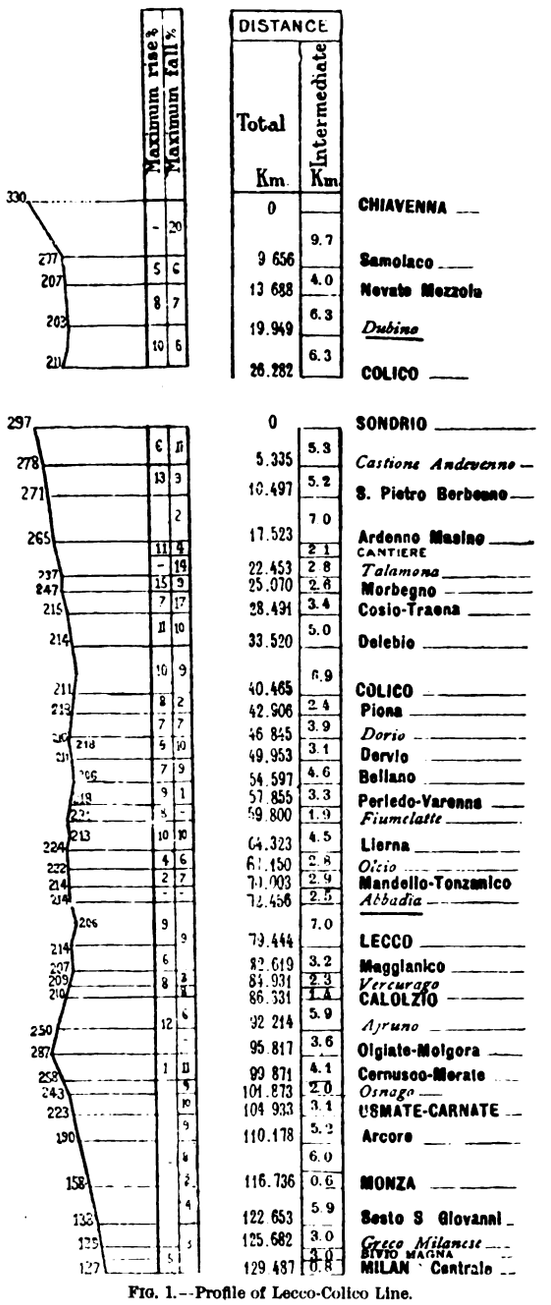

FIG. 1.—Profile of Lecco-Colico Line.

In order to compare the running expenses with the fixed expenses, they have both been reduced to pounds per mile per annum, and placed in Table III., together with the receipts estimated in the same way. The running expenses of an Italian railway constitute a far larger proportion of the total expenses than is the case on an English railway, the percentages being 62 in the former case and 42 in the latter. The proportion of passenger to goods receipts is nearly the same, while the sum of all the expenses is 70 per cent. of the receipts in Italy and 65 per cent. in England. The receipts given for the Italian railways refer to the Adriatica system as a whole, and are greater than the receipts of the lines that are now being electrified. Thus the passenger receipts for the section Lecco-Colico are only £380 per mile per annum, for the section Sondrio-Chiavenna £220, whereas for the section Milan-Varese-Arona-Laveno the passenger receipts are £600 per mile per annum. The most profitable section in the Mediterranean Company's system is the line from Milan to Genoa, which is six times as profitable as the average for the whole system; the most profitable on the Adriatica system is the line from Milan to Como, the continuation of the St. Gothard Railway, a line common to the two systems, and yielding to each railway 3½ times the average receipts per mile on the Mediterranean. The expenses of maintenance, traffic, and central administration on an Italian railway amount to £421 per mile per annum, about one-sixth of what it is in England. Of the item for traffic expenses in Italy, £213 per mile is for stations expenses, out of which again £170 per mile is for the *personnel* at the stations. The Adriatica Company is seeking to reduce this item by the adoption of the "economic" system of working the line referred to above.

Fares.

The fares charged on the various railway lines in Italy are given in Table IV. Column A gives the through express fares on the main lines, and column B the fares for the so-called omnibus trains which stop at all stations. Column C gives the reduced rates charged for omnibus trains on certain sections of the main lines, those, namely, where the competition with the tramways and economic lines is most keenly felt. Thus on the lines Milan-Gallarate-Varese, where there is direct competition, reduced rates are charged. The rates in the economic lines are given in column E, while the tramway rates will be found in column F. The rates in column E cover both omnibus and express trains, whereas the "reduced" rates are exclusively for omnibus trains, so that the main lines do not offer such a good service for the same money as the economic lines, even at the reduced rates.

TABLE IV.—Showing the Passenger Fares, in Pence per Mile, Charged on the Different Italian Lines.

Lines	Main.				Economic.	Tram.
Power.....	Steam.			Electric.	Steam.	Steam.
Service	Exps.	Omnbs.		Exps. Omnbs.	Exps. Omnbs.	Omnbs.
Schedule speed (miles an hour)	25	16		45 25	25 16	9
Fares charged.	Exps.	Ord.	Redcd.	Ordny.	Ordny.	Ordny.
	A.	B.	C.	D.	E.	F.
First-class.....	2·1	1·9	1·5	0·9	1·5	0·9
Second-class ...	1·4	1·3	1·0	—	1·0	0·7
Third-class ...	1·0	0·8	0·5	0·5	0·6	—

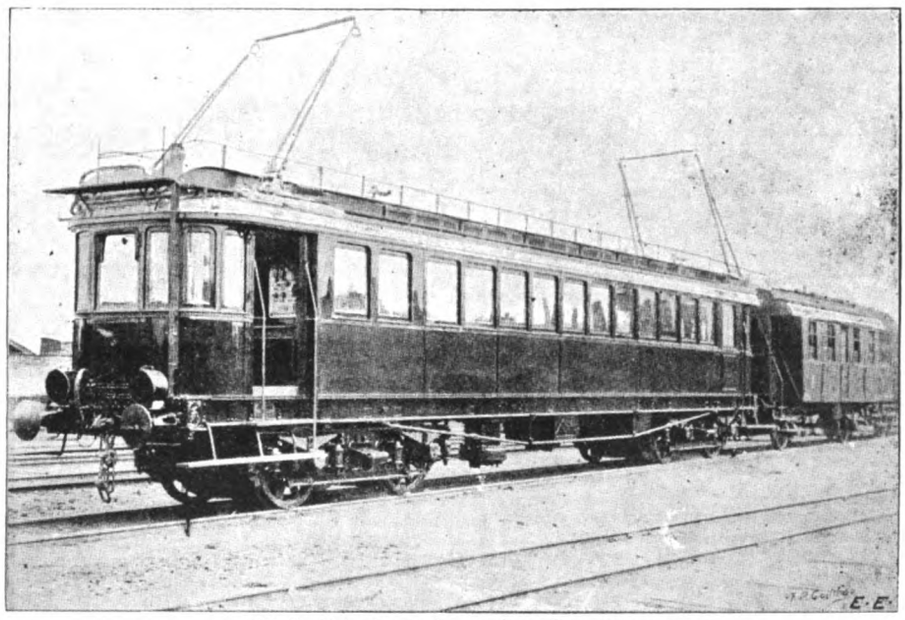

FIG. 2.—Motor Car used on the Lecco-Colico Line.

NOTE.—The figures in this table are obtained from the same sources as those in Table II. "Per mile" means per mile of line, regardless of the number of parallel tracks.

The Train Service.

The service of steam trains that formerly ran on the Milan-Varese line is given in Table V., with the time occupied in covering the

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different sections. This may be compared with the new service of electric trains, particulars of which are also given in the table. Thus on the line from Milan to Gallarate the schedule speed has been nearly doubled and the frequency increased 3·5-fold. On the line from Gallarate to Varese the speed has been increased 75 per cent. and the frequency about four-fold. The old trains, hauled by steam locomotives, have been replaced by trains of about half their weight, consisting of motorcars and trailers, the normal train consisting of one motorcar and one trailer, weighing together 67 tons unloaded, and capable of carrying 165 passengers, or about one-half the accommodation of the steam-driven trains. The carrying capacity of this portion of the line, in passenger miles, has thus been increased 75 per cent. Between Gallarate and Arona and between Varese and Porto Ceresio the speeds have not been increased on account of the

The Cost of Working the Electric Service.

The cost of running the new electric service on the Milan-Varese line may be estimated approximately from the cost of working the old service, and is given in Table VI.

Coal.—The coal consumed per ton-mile in the steam generating plant, pending the completion of the hydraulic power-house, will probably be not much less than that used on a steam locomotive if the speed and rolling-stock is the same in both cases. Thus, as the weight of the electric trains is about half that of the old steam train, the coal used per train mile will be halved. Possibly this assumption does not do justice to the economy of the electric system, but there is not sufficient data available to warrant a more favourable estimate being made. The speed is, however, nearly double, so that if the same rolling-stock

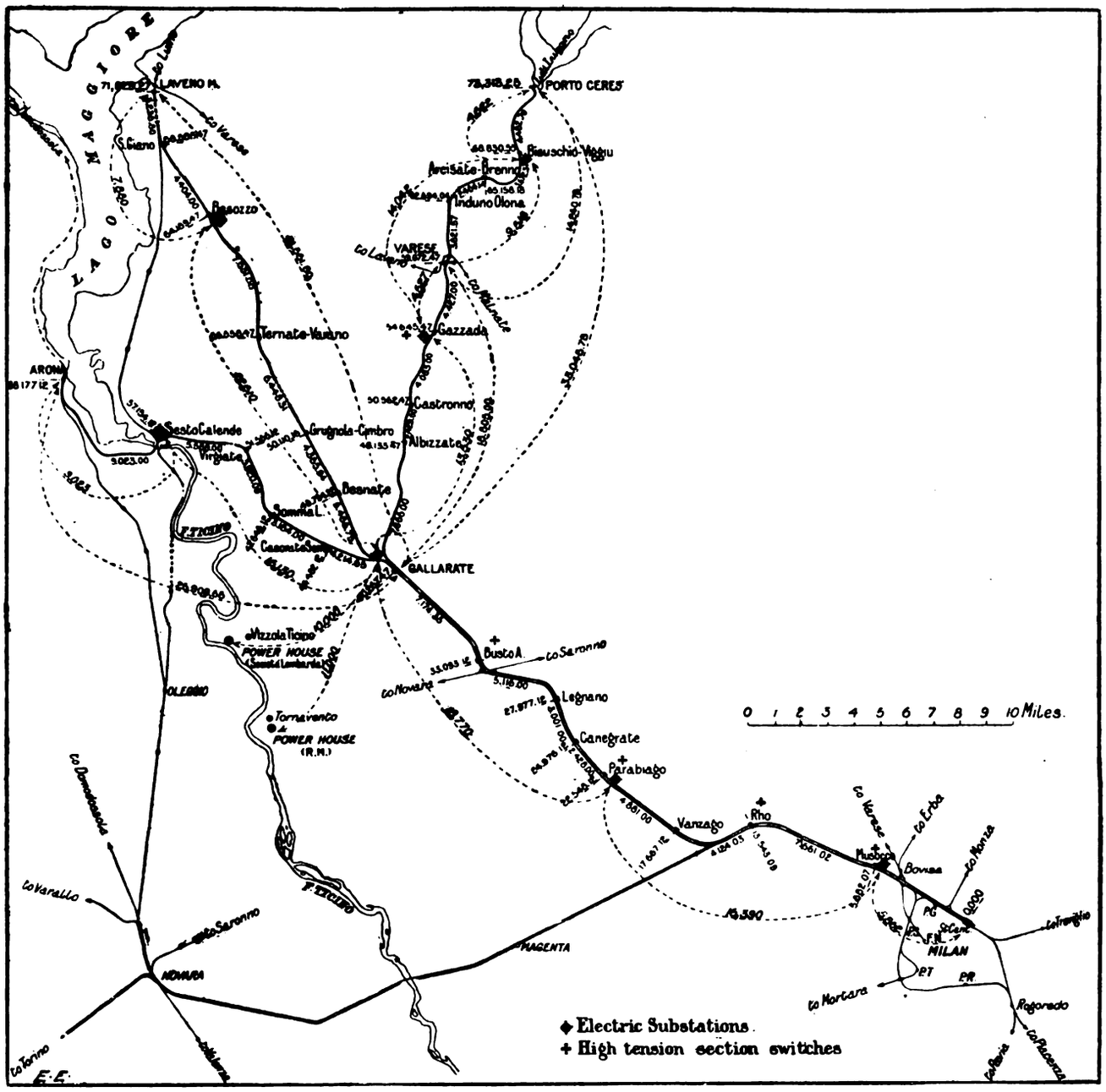

Fig. 3.

grades, which are as much as 2 per cent., and the trains will run with the motors in permanent series connection.

Table V.—Giving the Steam and Electric Train Service on the Milan-Varese Railway.

—	Miles	Max. grade.	Min. curve chains.	Trains each way per day.		Time in minutes.	
		Per cent.		Steam	Elect.	Steam	Elect.
Milan to Gallarate	25·0	0·6	40	10	35	60	34
Gallarate to Varese	11·7	1·0	25	7	27	28	18
Gallarate to Laveno	19·4	0·8	30	6	8	81	50
Gallarate to Arona	16·0	1·1	17·5	5	8	45	45
Varese to Porto Ceresio..... ...	8·8	2·0	15	5	6	28	28

were used, the tractive resistance, and hence the coal consumption, would be increased. But the type of rolling-stock is being improved, and short two-axle carriages are being replaced by long coaches running on bogies so that the tractive resistance at the higher speed should not exceed that at the lower speed by more than 25 per cent., bringing the coal consumption to 23lb. and the cost to 3·4d. per train mile. (Note.—The author learns from Signor Tremontani, the engineer of the Mediterranean Railway, that the coal consumption for a service of trains consisting of one motorcar and two trailers is 28·5lb. per train mile. The weight of these trains is one-third greater than that estimated in the paper, as it was found necessary to add a second trailer on account of the increase in the traffic. This increase in the weight of the train would have brought the author's figure for coal consumption up to 31lb. per train mile; his estimate, therefore, appears to be about 10 per cent. too high. At the present time only 20 trains per day are running each way between Milan and Gallarate, and 17 between Gallarate and Varese.

Wages.—The driver and fireman are replaced by one motorman at about half their combined wages, and as the electric train is always

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ready to start up, a further saving of about 20 per cent. should be effected in comparison with a train hauled by a steam locomotive, which has to spend a considerable time in the shed. These savings should reduce the item for locomotive wages to 40 per cent. of its former value—that is, to 1·27d. per train mile. The item for conductors' wages will be reduced 20 per cent., owing to the saving of time mentioned above, and will be 1·67d. per train mile. The wages at the generating station will amount to about £4,000 per annum; for a line 80 miles long, and with 28 trains per day each way, the cost would come to 0·58d. per train mile. The wages at seven rotary sub-stations should not, together, exceed the wages at the generating station, making the cost for this item 0·58d. per train mile.

Water, Oil, etc.—The cost of water, which is 25 per cent. of that for water and oil combined, will be saved, reducing this item to 0·45d.

Repairs.—The cost of repairs will be reduced. On the City and South London Railway during 1901 the cost of locomotive and generating repairs per train mile, including wages and materials, was 38 per cent. of the locomotive repairs on the Great Northern Railway. Taking 50 per cent. of the cost of steam locomotive repairs, the cost of repairs for electric motors and generating stations would amount to 1·76d. per train mile. As the electric trains are one-half the length of the steam trains, the carriage repairs per train mile will

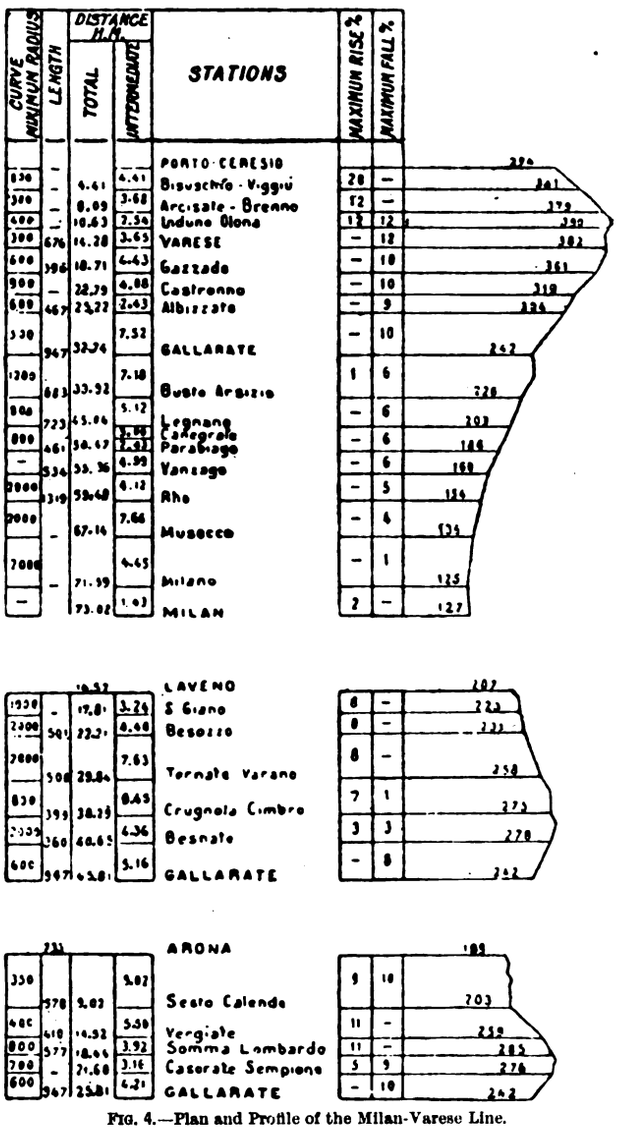

FIG. 4.—Plan and Profile of the Milan-Varese Line.

be halved; this item will thus be reduced to 3d. per train mile. The total cost of running would thus be reduced from 21d. to 12d. per train mile.

ESTIMATE OF TRAFFIC.

The passenger traffic required to pay the expenses of the new electric service can now be estimated. On the Milan-Gallarate-Varese line the service is being increased from 8 to 28 trains per day, while the cost of running is reduced from 21d. to 12d. per train mile. The cost per mile of line is thus increased from £510 to £1,110 per annum. To this must be added the interest on the capital expended in the electric installation. The total estimated cost is 10,000,000 francs, or £5,000 per mile. At 3½ per cent. this would add £175 per mile to the increased cost of running, making the total increase £775 per mile per annum. (See Table VII.) The passenger receipts for this line, including the extensions to Arona and to Laveno, are £600 per mile per annum. Hence the passenger traffic must be increased by 129 per cent. to pay the interest and the increased cost of running. With transformer sub-stations the running expenses are decreased 5 per cent., and the increase of traffic must then be 114 per cent. On the completion of the hydraulic power station coal will no longer be used, and this item in the cost of running will be saved. The cost per train mile will then be reduced to 9·31d., or, say, to 9·5d., making the total increase in the expenses £475 per mile per annum, and the increase in the passenger traffic required to meet this increase 80 per cent., as compared with 129 per cent. for steam plant. With transformer sub-stations the increase need only be 72 per cent. The value of water power may therefore be represented by a reduction of 20 per cent. in the passenger traffic required to pay expenses.

TABLE VI. Showing the Comparative Cost of Running an Electric and a Steam Line in Italy and in England in Pence per Train Mile.

	Italian		English	
Trains each way per day	Steam. 8	Electricity. 28	Steam. 8	Electricity. 28
Coal	5·30	3·40	1·72	1·07
Wages of driver and stoker	3·18	1·27	3·81	1·52
Wages of conductor	2·08	1·67	1·52	1·22
Wages at generating station	—	0·58	—	0·58
Wages at rotary sub-stations	—	0·58	—	0·58
Water, oil, etc.	0·60	0·45	0·77	0·58
Repairs (motors and generating station)	3·52	1·76	2·39	1·20
Repairs (carriages)	6·01	3·00	2·83	1·41
Total	20·69	12·71	13·04	8·16
Figure used in the paper	21·00	13·00	13·00	8 10

TABLE VII.—Showing the Expenses in Pounds per Mile per Annum of Running a Steam Service of Eight Trains and an Electric Service of 28 trains each way per day in Italy and in England.

	Italy			England	
Power used	Steam. Coal.	Electricity. Coal.	Electricity. Water	Steam. Coal.	Electricity. Coal.
Number of trains each way per day	8	28	28	8	28
Cost in pence per train mile*	21	13	9·5	13	8
Running expenses	£510	£1,110	£810	£320	£680
Interest	—	175	175	—	280
Total	£510	£1,285	£985	£320	£960
Increase	—	775	475	—	640
Per cent. increase in traffic required to pay expenses	—	129	80	—	61

* With rotary sub-stations.

On the Lecco line the service of steam trains was formerly about half as frequent as on the Varese line. The proportional increase in the number of electric train miles will be about the same, so that the increase in the cost of running per mile of line, with transformer sub-stations, will be £150 per annum with water power. The capital expenditure has been about eight million francs, or £5,000 per mile, involving an interest charge of £175 per annum, which, together with the increase in the running expenses, brings the total increase to £325 per annum. The passenger receipts are here much less than on the Varese line, being £380 per mile per annum for the section Lecco-Colico, £220 for the section Colico-Sondrio-Chiavenna, and £330 per mile for the whole line. Thus an increase of £325 per annum will require an increase in the passenger traffic receipts of 128 per cent. The conditions of working an electric service on this line are therefore not quite so favourable as on the Varese line.

REDUCTION OF FARES.

The extent to which a combination of reduced fares and increased travelling facilities augment traffic has long been made a subject of careful consideration by the Italian railway companies. For some time past the Adriatica Company has been investigating this question experimentally on the line connecting Bologna with St. Felice, referred to above. The experiment was made with cars driven by electric accumulators. The speed and the frequency of the trains were both doubled, and the fares reduced to 40 per cent. of their original amount. The result has been that the passenger traffic has increased five-fold, and the receipts have been doubled. The fares on the new electric trains are given in Table IV., and are good for all trains whether express or omnibus. On the Milan-Varese line the reduced rates, as given in column C, have been available on omnibus trains only, express fares being charged on all express trains; about 20 per cent. of the total passenger receipts on this line being at the express rate, and 90 per cent. of the receipts from third-class passengers. If this proportion is maintained under the new conditions, the falling off in the receipts due to the reduction in the fares would be about 20 per cent., if there were no increase in the traffic. It has already been shown that to pay the expenses of the new service at the old rates the traffic must be increased 80 per cent. if water power is used, so that with the new rates the traffic must be rather more than doubled. With the new electric service on the Milan-Varese line the minimum fare is still about the same as before—namely, ½d. a mile—but whereas formerly this rate only entitled a passenger to travel on an omnibus train, it now entitles him to travel by any of the express trains, the speed of these trains being twice what it was before, and the service three to four times as frequent, so that for those who formerly patronised the express trains the fares have been halved and the speed doubled. The speed of the omnibus trains is also doubled, but owing to the number of stops the

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saving in time is not more than 30 per cent. The new service has been inaugurated by the railway company in confident expectation that the improved service will increase the amount of traffic to such an extent that the receipts, even at the lower rates, will more than pay the expenses.

Comparison of the Conditions of Running an Electric Service in England and in Italy.

It may be useful to compare the figures obtained above for the conversion of a steam to an electrically-driven railway in Italy with those that would be obtained under similar conditions in England. If the reduction in the weight of the train and the increase in the service are in the same proportion in the two cases, the proportionate reduction in the running expenses will also be the same. With this assumption the cost will be reduced from 13d. to 8d. per train mile; the different items are given in Table VI. With a similar increase in the train service—namely, from 8 to 28 trains each way per day—the working expenses would be £680 per mile per annum, as compared with £320 with the former steam service, or an increase of £360 per mile. The electric installation would probably be more costly than that for the Italian lines, and might come to £8,000 per mile, on which the interest at 3½ per cent. would amount to £280 per mile per annum. The total increase in the expenses would thus be £640 per mile per annum. The passenger receipts for 1900 for the Great Northern Railway, to take a definite case, averaged 43d. per train mile, at which figure the receipts on a line running eight trains each way per day would amount to £1,050 per mile per annum: the average for the whole of the Great Northern Railway being £2,460. Hence, to make up for the increased cost of the electric service, the passenger traffic on such a line would have to increase 61 per cent., if the fares were unaltered. With halfpenny fares the traffic would have to be trebled.

It seems clear that, whether in England or in Italy, the full advantages of electrical traction cannot be obtained without an increase in the total running expenses, and this increase can only be met by a corresponding increase in the passenger traffic, so that the change from steam to electricity should not be made unless the increase in traffic may be reasonably expected at least to cover the increased cost of running and the interest on the capital expenditure. Most railway managers would probably admit that the use of electricity on existing railways is worthy of consideration, and some will even go so far as to say, "if you can show that we should reduce our expenses by adopting electricity, we would do so." It is not, however, by reducing expenses that electricity is going to help the railways, but in enabling them to offer greatly increased travelling facilities to the public at a figure impossible with steam traction, and thus to meet the growing competition of the tramways.

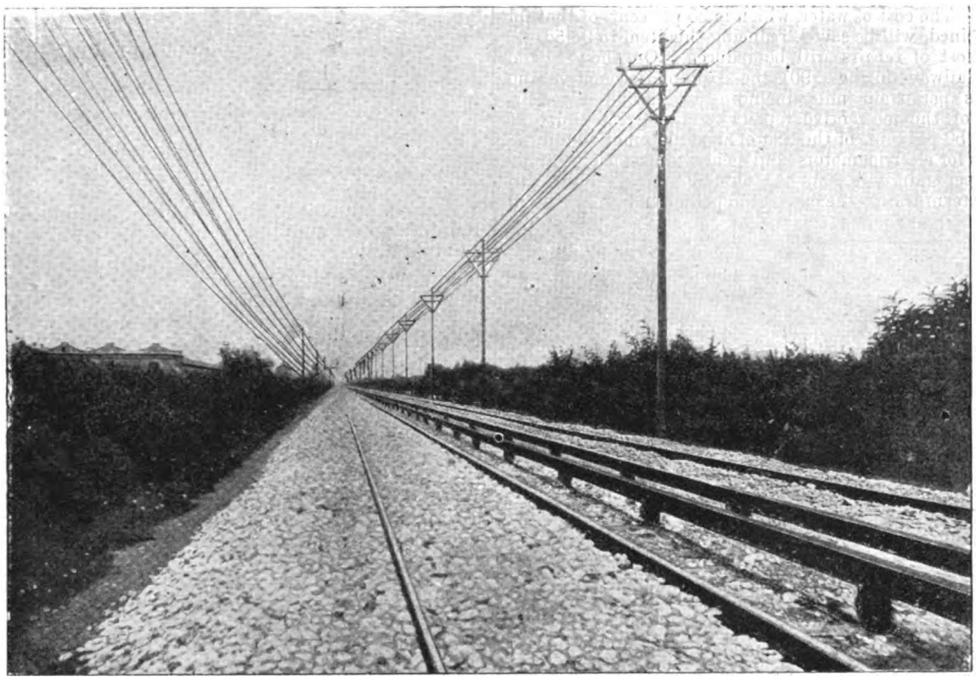

Fig. 5.—View of High-Tension and Third-Rail Construction on the Milan-Varese Line.

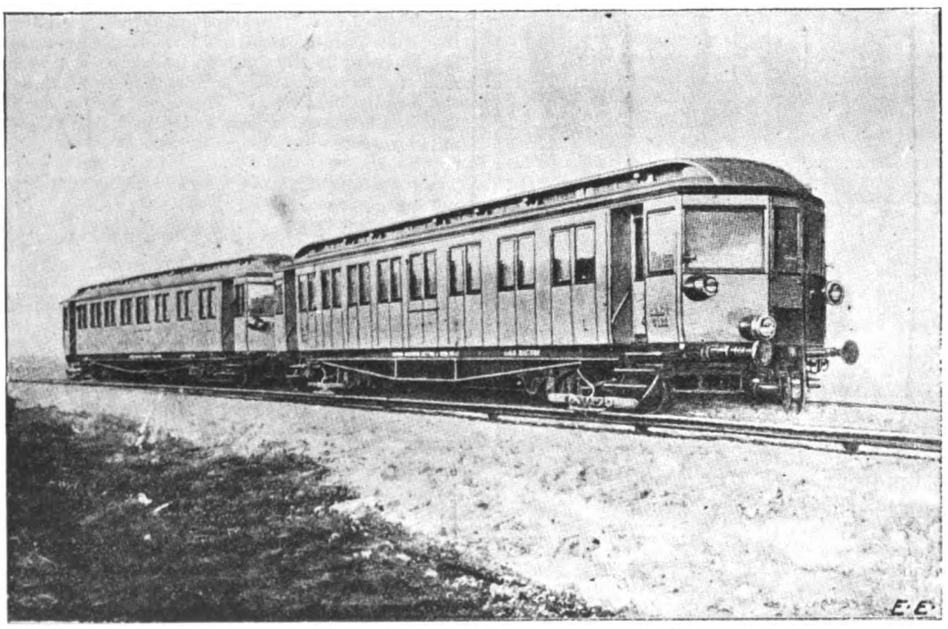

Fig. 6.—Motor Car Train used on the Milan-Varese Line.

In answer to the question as to why the Italian railway companies are adopting electrical traction, it is often urged that they are doing so because of the saving effected by the use of water power in place of coal. This is, however, very far from being the case, since even with water power the expenses cannot be met unless the traffic increases. The use of water power simply reduces the increase required to pay, the reduction in the case of the Italian lines being 20 per cent. The prospects of success in England with cheap coal are more favourable than they are in Italy with water power, as is shown by the fact that the increase in the traffic required to pay expenses is less in England than in Italy.

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The figures given above do not take any account of the relative possibilities of travel development in the two countries. Milan has a population of 471,000, about equal to that of Birmingham, but the towns along the line now being electrified are all quite small, Gallarate having a population of 8,000, Varese of 6,000, and Arona of 4,000, the largest being Busto Arsizio with 13,000. Taking the different lines radiating from Birmingham, by way of comparison, we find that the united populations of the two largest towns on each line within a radius of 45 miles amount to 39, 41, 63, 86, 101, 109, 121, and 185 thousand. With these figures before one, it is difficult to avoid the conclusion that the possible increase in travel is far greater in England than in Italy, and that if there is a field of usefulness for electrical traction on Italian steam railways, there is a still greater field of usefulness on the railways of our own country.

I wish to express my thanks to the officials of the Strade Ferrate del Mediterraneo, and of the Strade Ferrate Meridionli, and in particular to Signor Ing. Victor Tremontani, Signor Ing. Pietro Lanino, and Signor Ing. Leone Olper for their kind assistance in furnishing me with data and information. I am also indebted to Signor Tremontani for the views and plans in Figs. 3, 5, and 6, and to Messrs. Ganz and Co. for the view in Fig. 2. In preparing the maps and profiles the following have been consulted: the map of Italian railways published by the Instituto Geograpico Militaire, and the official train sheets of the Adriatica Railway Company.

Discussion.

The **President,** in opening the discussion on the above paper, said they were all very much indebted to Prof. C. Wilson for his admirable contribution. It seemed to come at a most opportune time, having regard to the proposed visit of the Institution next spring to Italy, and he was sure it would act as an inducement to many to join in the tour. Prof. Wilson had done the railway companies of this kingdom a service in dealing with this question as he had more from the commercial point of view. It was simply the commercial aspect of the subject that would affect our English railway companies. If it could be shown that by the introduction of electricity advantage was to be obtained either in the economising of expenses or by increasing the receipts, then railway companies would be equally anxious with electrical engineers to adopt electric traction. But he was afraid that many, after reading Prof. Wilson's paper, might feel inclined to doubt whether such would be the case, because the author came to the conclusion that railway companies had to look not to economies so much as to increased traffic in order to make electricity pay. He (the president) very much questioned that with respect to British railways, and he was not in harmony with the author in his deductions, because it appeared to him from the tables and figures given in the paper that there was not a fair comparison between the railways in Italy and British railways. The latter were, of course, very much more costly, because the work was carried out in a much more perfect and complete manner. The position was this, that on British railways they had a very much larger traffic, and the lines were more full with trains than on Italian railways; and he thought that if they could only make a more complete comparison of expenses on English lines and Italian lines, they would see that such comparison did not quite support the conclusion to which the author had come. With reference particularly to the introduction of electricity on railways in Italy, he was glad to see that the companies were not adopting extravagant speeds, and he thought it would be far better for railways to consider what was a moderate speed than attempt very high speeds. In conclusion, he felt quite sure that if increased facilities would increase traffic on Italian lines, as they apparently had done, such increased facilities on British railways would be attended with far better results.

Mr. C. Steel, of the Great Northern Railway, said he was bound almost to endorse the chairman's remarks in preference to the observations of Prof. Wilson. The conditions of railway working in Italy and the character of the traffic were widely different from what they were in England. The introduction of an electrical railway, upon which were run trains consisting of few vehicles, could only be accomplished with success where there was a huge population to work upon. Taking, for instance, one of the lines to which Prof. Wilson had referred between Milan and some country town, there was not a large oscillating traffic. He maintained that it did not follow as a matter of necessity that because they had a quick service they would create traffic. Referring to Table VII. in the paper, the author had shown the expenses of running eight trains a day as compared with running 28 trains, and the expenses were given at £320 per mile per annum in the case of steam and £960 in the case of electric trains. The eight trains consisted of, say, eight vehicles each, and the 28 trains of two vehicles each, but the expenses were three times as heavy with the 28 trains and 56 vehicles as with the eight trains and 64 vehicles. Therefore, they were increasing their expenses enormously and not increasing their traffic. That brought him back to the point that one must consider the character of the traffic in dealing with the electrical question. Again trains of two vehicles were not adapted to dealing with London traffic, for instance. There was another matter to which Prof. Wilson had not referred in connection with the adoption of electricity on railways in this country—*i.e.*, trains could not be run at short intervals with crowded lines. This was one of the greatest difficulties with which the English railway companies had to contend with respect to this particular question, and another was that they could not reduce the fixed expenses as they did in Italy. His own feeling was that, so far as English railways were concerned, there was not much hope of their electrification—certainly not in the suburbs of London—but in any case electricity could only be used profitably on railways which were strictly passenger lines. Assuming that they could not introduce electricity on existing railways, the alternative was to provide additional lines, and the cost of doing this in London would be simply prohibitive. He was sure that railway directors would be very slow at this time of day to adopt any system which increased the working expenses and left the question of increased traffic as a problem to be solved in the future. He felt, however, that there was a need for electrical lines in this country, and he hoped that the difficulties in the way of electricity at present would be overcome in the near future.

Mr. H. M. Sayers observed that it did not appear from the previous speaker's remarks that our main lines could do anything in the way of electrification, and, he supposed, Mr. Steel was content to be left with his coal trucks and mineral traffic, because that was what it would come to. On the question of increased facilities creating traffic, he pointed to the case of the electric tramways in this country. In one instance which he quoted, a steam tramway in England used to carry an average of 1,800,000 passengers per annum, but in the first year after the lines were electrified this figure increased to six millions, with only a short extension of the lines. The greater facilities offered consisted of a more frequent service, a higher speed, lower fares, and smaller carrying capacity. He argued from this that even on main lines, if greater facilities were offered, passenger traffic would increase.

Mr. W. R. Cooper expressed the opinion that in some instances the figures given by the author for steam and electric working did not offer a fair comparison. Then, some of the conclusions given at the end of the paper were rather misleading as they stood. They amounted to saying that there must always be an increase in traffic for electric traction to pay, and that conclusion was arrived at by assuming an increase in the number of trains run. Of course, if they increased the number of trains run they must increase the traffic in order to make a profit. As to competition of tramways, the main lines in this country would not be affected as they were in Italy—where the main-line trains were run at slow speed and stopped at practically every station for about five minutes. So that they could not compare the main lines of this country with those of Italy. What they wanted to find out was the true comparison between electrical and steam traction with the speeds they had at present. Then it was not really a question of increasing the traffic. That applied to local lines, but not to main lines. He suggested that, in making such a comparison, it would be as well to take into consideration the goods and mineral traffic, which involved difficulties of shunting and sidings. The importance of considering this class of traffic might be gathered from the fact that the coal used per train mile on a passenger locomotive was 36lb., as against 62lb. in the case of a goods engine.

Mr. Arnold Lupton was inclined to think that the economy of fuel with electricity would be even greater than stated by Prof. Wilson in his comparisons of steam and electric railways. With the introduction of gas engines in the generating stations the charges on account of fuel would be even further reduced. He agreed that in country districts electric traction on the railways might create traffic. In those districts it was often a whole day's work to go 20 miles to a market town and back again, on account of the bad service of trains and the delay at junctions. With regard to the item given by the author of interest on cost of installing electric traction, he pointed out that this would not come in as an additional expense in the case of new lines, but only where steam lines were converted.

Major-General Webber suggested that the discussion at this point should be carried over to the first meeting of next session, as the subject was one of immense importance. Such a set of tables as had been brought before them by Prof. Wilson should be subjected to all the light that experience could give. Therefore, he hoped that this meeting would agree to the adjournment of the discussion as he proposed, and between this and next session the members would have time to think over the subject, which might probably result in giving them one or two most interesting and instructive evenings next session.

The **President** thought it would be unfair to the author if they carried over the paper in the ordinary sense of the word until next session, because Prof. Wilson would naturally like to have it published. He would, therefore, ask the author to reply to the discussion which had proceeded so far, and to supplement the paper by some further information between this and next November. That arrangement, he thought, would answer the purpose equally as well.

Prof. Carus-Wilson, in the course of his reply, remarked that it often happened that the discussion on a paper did not follow on the same lines as the paper itself, and thus the main points of the subject which the author desired to bring forward for discussion were not always taken up by the speakers. In this case it might be supposed that he was advocating the introduction of electricity on main lines. He assured them, however, that nothing was further from his intention. The railways dealt with in this paper were defined by the number of trains run, and he did not think anyone would say that a service of eight trains a day was a main-line service. Therefore, he could at once offer a reply to their criticism that the general drift of the statements in the paper offered no fair comparison between the state of affairs in Italy and that in this country. What they had to do was to compare line for line, and take a line in Italy being electrified and compare it with a line carrying the same amount of traffic in this country. Mr. Steel's remarks, of course, came with very great force from one who had for so long carried on the very responsible duties of the managership of one of our greatest railways. But there was really no difference between his views on this subject and the views expressed in the paper. Mr. Steel had, in fact, put forward in the clearest way the position he (Prof. Wilson) wished to take up—that was to say, that the introduction of electricity on lines (other than suburban) which were at all comparable with those now being electrified in Italy, depended entirely on an increase of traffic. He firmly believed that it was only by looking forward to the increased facilities for developing traffic that electricity would ever be introduced on lines such as these. Mr. Cooper in his remarks had said that it was unfair to consider simply the case where the train service was increased with the introduction of electricity, and that they should include also the case

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where the train service was the same as with steam. He thought that there again Mr. Cooper had struck the fundamental point of difference between the way to look at this whole question. The great advantage of electricity was that they could increase the frequency and the speed of the service, and it was only when they could do that that it was worth while to make the change. Mr. Lupton thought he had made the cost of fuel too high. While he hoped it might be too high, he had endeavoured to be conservative in the statements he had made in the paper. As to the question whether the cost of electrifying a line would be different if the line were constructed *de novo*, he had not gone into that matter, but had simply taken the case of the electrification of existing steam lines. He commended the concluding two pages of the paper to the attention of members who wanted to clearly understand his position. He had endeavoured to find out while in Italy what were the possibilities of traffic on the electrified lines, and when one took the population round the Varese line and compared it with our own lines, he thought there was no doubt that the possibilities of increase of traffic in this country were far greater than in Italy. He might also say that the railway companies in Italy had not approached this problem of increase of traffic in a policy of blind faith. They were electrifying their railways as an outcome of most careful study of this question, and he thought that was what the managers of our great lines ought to do now. He suggested that they should lose no time in taking steps to inform themselves on this very vital question, for, as far as he could find out, very little was known in England outside experienced people as to what was the precise connection between increased facilities and increase of traffic. He thought that if railway managers studied this matter, they would become very much more hopeful of the travelling potentialities of the British public.

A hearty vote of thanks was accorded the author for his paper.

BOLTON ELECTRICITY ACCOUNTS.

The accounts of the Bolton Corporation electricity department to March 31, 1902, show a total expenditure on capital account of £180,258, of which £21,208 has been written off for depreciation. Abstracts of the revenue account, balance-sheet, and statement of electricity generated, sold, etc., are appended:

Revenue Account.

Expenditure.

Dr. Generation of Electricity.	£ s. d.	£ s. d.
Salaries and wages	£2,413 4 2	
Fuel	5,686 2 9	
Oil, waste, water, etc.	803 3 2	
Repairs, etc., of works and plant	1,248 11 7	
		10,151 1 8
Distribution of Electricity.		
Wages	154 18 9	
Repairs, etc., of mains, etc.	160 8 10	
		315 7 7
Management Expenses.		
Salaries and wages	729 13 4	
Stationery and printing	155 19 6	
Miscellaneous expenditure	222 1 8	
		1,107 14 6
Rents, rates, and taxes		906 9 9
Balance carried to net revenue account		17,319 3 9
		£29,799 17 3

Income.

Cr. Sale of Electricity.	£ s. d.
Lighting	14,686 13 3
Power	1,199 6 3
Tramways	12,497 15 0
	28,383 14 6
Profit on fittings trade account	806 10 7
Rental of meters, less allowances	501 15 3
Rental of motors, less allowances	107 16 11
	£29,799 17 3

Balance-Sheet.

Dr. Liabilities.	£ s. d.	£ s. d.
Preston Savings Bank Trustees, less repayments	42,372 10 2	
Leeds, etc., Savings Bank Trustees, less repayments	13,957 5 11	
"Cobra" disaster fund	4,000 0 0	
Ordinary mortgages, less repayments	120,000 0 0	
Floating Liabilities.		
Sundry creditors	£4,443 14 0	
Reserve fund	998 11 4	
Amount transferred in aid of rates	3,850 0 0	
Balance carried forward (profit)	901 15 4	
		10,194 0 8
		£190,523 16 9

Cr. Assets.	£ s. d.
Expenditure on works	159,049 12 10
Accounts owing to electricity department	13,523 15 2
Reserve fund investment in Consols	998 11 4
Cash in hand	13,342 19 0
Stock on hand	3,608 18 5
	£190,523 16 9

Statement of Electricity Generated, Sold, etc.

Units generated			3,825,761
Quantity sold	Tramways	1,999,640	3,120,709
	Private consumers	1,103,602	
	Public lamps	17,467	
Quantity used on works			320,770
Total quantity accounted for			3,441,479
Total quantity unaccounted for			384,282

HULL ELECTRICITY ACCOUNTS.

From the accounts of the Hull Corporation electricity department just issued, it appears that the total expenditure on capital account to March 31, 1902, amounts to £206,246. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are given herewith:

Revenue Account.

Dr. Generation of Electricity.	£ s. d.	£ s. d.
Coal or other fuel	£5,227 12 3	
Oil, waste, water, and stores	419 10 3	
Wages	2,499 11 1	
Repairs, etc., of buildings and plant	1,452 17 0	
		9,599 10 7
Distribution of Electricity.		
Wages to linesmen, fitters, etc.	764 17 6	
Repairs, etc., of mains	384 4 3	
Repairs, etc., of transformers, etc.	94 16 4	
		1,243 18 1
Public Lamps.		
Wages	27 16 6	
Carbons	45 4 0	
Fuse cartridges and ladder box	1 18 4	
		74 18 10
Rents, Rates, and Taxes.		
Rents payable	283 19 9	
Rates and taxes	1,505 1 8	
		1,789 1 5
Management Expenses.		
Salaries	1,396 6 2	
Printing and stationery	182 12 10	
General establishment charges	238 8 3	
		1,817 7 3
Special Charges.		
Law expenses	2 0 0	
Insurance	91 3 6	
		93 3 6
Bad debts		67 7 5
		14,685 7 1
Balance carried to net revenue account		9,826 13 8
		£24,512 0 9

Cr. Income.	£ s. d.
Sale of current per meter	23,440 6 9
Rental of meters	934 3 10
Public lamps	122 8 4
Testing installations, etc., and deposits forfeited	15 1 10
	£24,512 0 9

Balance-Sheet.

Liabilities.	£ s. d.	£ s. d.
Capital—Loans raised by stock	179,132 7 10	
Bank of England	29,719 11 2	
		208,851 19 0
Deposits on supply of current		123 10 0
Sundry creditors		1,527 11 9
		210,503 2 9
Sinking fund, £21,266. 7s.; reserve fund, £8,588. 11s. 5d.		29,854 18 5
		£240,358 1 2

Assets.	£ s. d.
Capital expended on works	202,483 4 8
Discount and expenses on issue of stock	8,717 7 10
Sinking fund investment	21,266 7 0
Stores on hand, March 31, 1902	338 14 5
Sundry debtors for current, etc.	7,552 7 3
	£240,358 1 2

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units			2,308,500
Quantity sold	Public lamps	23,100	1,490,099
	Private consumers by meter	1,466,999	
Quantity used on works			595,762
Total quantity accounted for			2,085,861
Quantity not accounted for			222,639
Number of public lamps			12
Number of customers			1,843
Total maximum supply demanded (kilowatts)			2,044

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NOTES.

Students' Awards.—We are informed that the following awards to students have been made by the Council of the Institution of Electrical Engineers: the Salomons Scholarship, value £50, for 1902, to Mr. Philip A. Laubach; the David Hughes Scholarship, value £50, for 1902, to Mr. Edward Fisher (both of Finsbury Technical College); and the following premiums: Mr. Fielder J. Hiss, jun., £7; Mr. Philip A. Laubach, £5; Mr. E. W. Short, £5; Mr. S. E. Glendenning, £3.

Electro-Harmonic Society.—The annual general meeting of the above society was held on Wednesday at the Institution of Electrical Engineers, 28, Victoria-street. The report of the hon. secretary, Mr. W. E. Lane, stated that during the past season 64 gentlemen have been elected members of the society and 32 old members have resigned. In the same period the society has lost two members by death, while four members have been struck off the register. The membership roll now contains 358 names.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on the afternoon of the 2nd inst., the Duke of Northumberland, president, in the chair. Mr. J. Christie, Mr. F. K. McClean, and Sir John Denison Pender were elected members. We are informed that, owing to the presence of Royalty, it will be necessary to reserve the whole of the available seats in the lecture theatre for the special use of members at the discourse to-night by Sir Benjamin Baker on the subject of "The Nile Reservoirs and Dams."

"Science Abstracts."—We are informed that the following journals have been added since the beginning of 1902 to the list regularly dealt with in *Science Abstracts*, making a total at present of about 150: *Journal* of the Russian Physico-Chemical Society; *Proceedings* of Academy of Sciences at Amsterdam, at Stockholm, at Christiania, and at Copenhagen; also *Zeitschrift für Anorganische Chemie*; *Royal Society of Edinburgh Transactions*; *British Optical Journal*; *Elettricista* (Rome); *Iron and Steel Institute Transactions*; *American Society of Mechanical Engineers' Transactions*; *Engineering and Mining Journal* (New York); *Power* (New York); *American Telephone Journal*; *La France Automobile*; *Der Moterwagen*; *Archives of the Rïntgen Ray.*

Boilers for the Navy.—Official announcement is made that the Admiralty have decided on the following types of boilers for the six first-class cruisers included in the 1901-2 programme and now under construction. The "Devonshire" and the "Carnarvon" will both have a combination of four-fifths Niclausse and one-fifth cylindrical boilers; and the "Hampshire" and the "Antrim" a combination of four-fifths Yarrow and one-fifth cylindrical boilers; the "Roxburgh" is to be equipped with a combination of four-fifths Dürr and one fifth cylindrical boilers; and the sixth vessel, the "Argyll," will use a combination of four-fifths Babcock and Wilcox and one-fifth cylindrical boilers.

Telephone Communication with Lighthouses.—A question put in the House of Commons the other day by Mr. Soares, M.P., with reference to the advisability of setting up telephonic communication with Braunton lighthouse, in North Devon, has elicited an encouraging answer from Mr. Gerald Balfour. The Postmaster-General, he said, was of opinion that, *prima facie*, the proposed connection by telephone was desirable, and the matter is to be submitted to the committee on electrical communications with lighthouse stations for their consideration. It appears, however, that the work cannot in any case be carried out immediately, as the whole of the funds provided by the Post Office for extension of coast communication during the current financial year have already been allotted.

The Deputation to Mr. Balfour.—The secretary of the Institution of Electrical Engineers informs us that Mr. Gerald Balfour, the President of the Board of Trade, has again found it necessary, on account of urgent public business, to postpone his reception of the deputation which has been appointed to wait upon him on the subject of electrical enterprise. The interview was fixed for yesterday at 12 noon, but under the circumstances it has been postponed indefinitely. Mr. Balfour, however, has the matter before him, and will shortly fix another date for receiving the deputation. As already stated, the object of the deputation is to lay the views of the Institution before the President of the Board of Trade with reference to the legislation at present controlling electrical enterprise in this country, the general feeling being that the industry is unduly hampered by over-legislation.

Electric Lighting in East London.—In reference to our note last week under this heading giving the result of the Board of Trade arbitration into the price to be paid by the three districts of Mile End Old Town, Limehouse, and St. George's-in-the East for the electric lighting provisional order held by the County of London and Brush Provincial Electric Lighting Company, that company now inform us that the arbitrator's total award amounted to £6,893. 5s. 4d., made up as follows: cost of preparing, obtaining, and passing the County of London (East) Electric Lighting Order, 1897, £710. 6s. 7d.; costs properly incurred by the company with the object of supply to the East-end districts, £5,814. 13s. 11d.; and costs of the award, £368. 4s. 10d. The arbitrator also made an order for one-half of the company's costs of the arbitration, to be paid by the local authorities concerned.

Tunbridge Wells Telephones.—We have much pleasure in being able to congratulate the Corporation of Tunbridge Wells and Mr. A. R. Bennett, their consulting engineer, on having obtained the sanction of the Local Government Board to the expenditure of a further £15,000 on the municipal telephone system. It will be remembered that at the official enquiry into the matter a short time ago the Corporation had to contend with the most hostile opposition on the part of the National Telephone Company, and the decision of the Local Government Board to sanction the loan has, therefore, given the greatest satisfaction among supporters of the municipal system in the town. That the money in question is badly needed for extending the Corporation lines, may be gathered from the fact that the subscribers to the municipal exchange have increased by as many again in the past six months.

Polyphase Traction.—A very interesting plant for polyphase traction at 3,000 volts has just been laid down at Neustadt, near Vienna, with the object of connecting the Government arsenal with the Schneeberg railway, some two-thirds of a mile apart. From information gathered from *L'Industrie Electrique*, it seems that the locomotive consists of a 36-kw. three-phase induction motor geared to the wheels and fed from two trolley wires, upon which the usual Continental bow trolleys are employed. The track is used as the third element of the circuit. The locomotive is provided with an air-compressor for brakes and also for the operation of the controller, which is indirectly handled with compressed air. The locomotive is said to greatly resemble those constructed by Ganz and Co. for the Valtellina railways in Italy. The line has now been in operation about three months, and has given the greatest satisfaction. It is considered to have demonstrated that

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the use of 3,000 volts alternating on a trolley wire is relatively simple and easy and commercially economical.

Commutator Insulation. — A common trouble experienced with the ordinary form of commutator insulation, which consists almost invariably of mica, because of its good insulating qualities and its ability to resist high temperatures, is that the mica and the copper do not wear down at the same rate. The result is that after a considerable period of service the mica strips project slightly above the general level of the commutator segments, and cause the brushes to jump and spark. A method of correcting this trouble has been patented in the States by Messrs. E. D. Priest and G. L. Schermerhorn, which consists of using strips of some soft material, such as asbestos, between two strips of mica. According to our contemporary the *American Electrician*, the advantage of this construction is that the mica may be made very thin, so that it will break off readily as soon as it projects appreciably above the commutator segments, while asbestos, being soft, will wear away at least as rapidly as the commutator segments.

Post Office Telephones.—A return of Post Office telephone exchanges just completed shows that the total number of subscribers at the end of last year was 2,420, of which North Wales alone is responsible for 1,044. Newcastle heads the list with 437 subscribers, Cardiff comes second with 236, and Newport (Mon.) third with 132 subscribers. Liverpool and Manchester have 29 and 27 respectively, the same as Abergavenny and Bridgend. It is noticeable that in no part of the kingdom has the rate of increase and extension of lines been so great as in South Wales and the western valleys of Monmouthshire. The tariff does not differ greatly, though the use of the penny-in-the-slot machine is on the increase. The above figures, of course, do not include London subscribers, as they were abstracted from a report for a period ending before the metropolitan exchanges were opened. In connection with the movement for extending the telephone system in Mid-Wales a conference of delegates representing the towns of Welshpool, Montgomery, Newtown, Llanidloes, Machynlleth, Aberystwyth, and Towyn was held last week at Aberystwyth, when a resolution approving of the principle was unanimously passed.

Electric Elevators.—An interesting paper was read by Prof. G. Lever at a recent meeting of the American Institute on "The Power Consumption of Electric Elevators," the main object of which was to draw a comparison between direct-current and alternating-current motors for this class of service. Approximately, there are 3,000 elevators in New York operated by the former, and only 300 driven by alternating-current motors. The author gave the results of some 20 tests made on installations in New York, five of which were on direct-current machines and 15 on alternating-current machines. One conclusion drawn by Prof. Lever was that, with power at 5d. per horse-power hour, it is more economical to use direct-current motors for elevator work where both direct and alternating current are available. Other conclusions expressed were that if the controlling apparatus of the alternating-current motor is more simple, and the absence of commutator and brushes can be considered as an advantage, the extra expense for power required by an alternating-current machine might be offset by the decrease in repairs and attendance. Apart from these considerations, the direct-current motor has every advantage.

Conductivity of Liquid Dielectrics.—The current number of the *Journal* of the Chemical Society abstracts a paper by Mr. Curie on the conductivity of liquid dielectrics under the influence of radium or Röntgen radiations. It is shown that liquid dielectrics, like gases, acquire conductivity under the influence of radium, results of the same order of magnitude being obtained in the two cases. In the case of gases, the intensity of the current increases proportionally to the difference of potential between the electrodes when this difference is slight, but becomes almost constant when the difference is increased sufficiently. In the case of the liquids, however, the proportionality exists up to a potential difference of 450 volts. Of the liquids examined, carbon disulphide gave the greatest conductivity, which reaches 20×10^{-14} mhos per one cubic centimetre. Liquids which are ordinarily almost perfect non-conductors exhibit this effect, as, for example, liquid air, light petroleum, etc. The effect was exactly the same whether the radium was kept at the ordinary temperature or at the temperature of the liquid, from which it follows that the radiation from the radium does not vary with temperature between the limits of the ordinary temperature and that of liquid air.

Skin Effect in Electrical Oscillations.—A recent paper by Mr. C. A. Chant gives an account of elaborate experiments undertaken to find whether electrical oscillators with very thin surfaces of metal are as efficient as similar ones made solid or with thicker skins. Oscillators of the cylindrical and of the spherical type were used. The cylindrical oscillators were 2·5cm. in diameter and 12·5cm. long, the ends being hemispherical. The materials used were respectively solid brass, solid Norway iron, copper tubing 1·5mm. thick and 0·8mm. thick, solid electric light carbon, sheet platinum 0·0013cm. thick on a wooden form, sheet silver 0·002cm. thick, tinfoil 0·0025cm. thick on wood, gold leaf 0·0000114cm. thick on wood, silver leaf 0·00003cm. thick on wood, copper deposited electrolytically to thicknesses 0·0001, 0·00015, 0·0002, and 0·0005cm., silver deposited chemically on glass to a thickness of 0·000013cm. The spherical oscillators were of the Righi pattern. The oscillator spheres were of three sizes—viz., 2·5cm. in diameter, 4cm., and 10cm.; each size was made in solid brass and in gold leaf on wood. The receiver used was a Rutherford magnetic detector. The results given in tabular form show that, in the case of the cylindrical and spherical doublets, the various thin mantles and even the excessively thin gold-leaf shells were as efficient as the solid metal bodies.

E.M.F. of the Hydrogen Chlorine Element.—In a recent paper by Mr. E. Müller, abstracted in the current number of the *Journal* of the Chemical Society, the author describes an attempt to determine the E.M.F. of the above element in an apparatus similar to that used by Wilsmore. The electrolyte was hydrochloric acid solution, and the gases were continuously passed over the electrodes. The following values were obtained for the E.M.F. with the various concentrations of acid:

Normality of acid	1	1/10	1/100	1/1000
E.M.F.	1·3660	1·4849	1·5460	1·5868 volts

Assuming that N-hydrochloric acid is dissociated to the extent of 78 per cent., it is calculated that the electrolytic potential is 1·3532 volts. The observed values of the E.M.F. are not in agreement with those calculated, and it is shown that this is partly due to the hydrolysis of the chlorine which takes place, and this increases the concentration of the H· and Cl′. In N/10 solution of hydrochloric acid, the H· or Cl′ concentration rises from 91 to 94·03 millimols. per litre by this hydrolysis, in N/100 solution from 9·6 to 33·48, and in N/1000 solution from 0·98 to 30·48. With the aid of these concentration differences, the calculated values of the E.M.F. agree better with the observed values, but the deviations remain greater than the experimental error.

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The origin of the chlorine (hydrochloric acid and dichromate, hydrochloric acid and pyrolusite, or electrolytic) has no influence on the E.M.F., and heating the gas in order to decompose chlorine peroxide is also without influence.

Electric Cable Specifications. — The important subject of the tests and specifications for electric cables was recently discussed before the Société Internationale des Electriciens of Paris, and the conclusions arrived at are published in the society's *Bulletin*. It seems that a committee were appointed to circularise a number of cable manufacturers and experts in order to elicit their views on the subject. The principal results of the enquiry may be shortly summarised as follows: In the first place it is recommended that electric cables should be subjected to a volt-resistance test of 100 per cent. pressure over and above that of full normal load, if the test be applied before laying, and 25 per cent. extra pressure after laying. Secondly, that the insulation resistance per kilometre should be adopted on the following sliding scale: 700 megohms for cables up to 1,000 volts normal working pressure; 3,000 megohms up to 4,000 volts; and 6,000 megohms up to 10,000 volts. In the course of the discussion before the Société Internationale a member criticised this sliding scale, suggesting that 500 megohms per mile would be sufficient for all pressures in normal use. In general, it would be better to adopt reliable means for preventing the occurrence of abnormal rise of pressure in a cable, than to spend much money upon so great a thickness of insulation as would withstand all the rise of pressure that could ever occur in it unchecked.

A Year's Patents.—The Comptroller-General of Patents, Designs, and Trade Marks has just issued his report for 1901—a year of considerable activity seeing that the number of applications under all heads is the largest since 1899. Thus last year there were 26,777 applications for patents, and of these 17,813 were from the United Kingdom, 601 from other parts of the British Empire, and 8,363 from foreign countries. Of these last 3,246 came from the United States and 2,844 from Germany, making together nearly 73 per cent. of the total number of foreign applications. Remarking on the trend of invention last year, the Comptroller-General says that during 1901 the attention of inventors was specially directed, as in 1900, to the subject of electric traction. The protection of the public from accidents due to broken wires was an object which occupied many minds. Motor-cars showed a considerable increase, especially as regards cars propelled by oil motors. The experimental trials of air-ships and submarine boats led to a number of applications for patents relating to these subjects. Among other applications, obviously suggested by various occurrences of the year, were cases for preventing vibration in "tube" railways and spark guards for locomotives. The increase in the applications relating to improvements in all classes of electrical apparatus, with the exception of galvanic batteries, is very striking, the total being the largest on record. It is interesting to see the difference between the number of applications for patents and the number that attain to full age. For instance, of 9,817 patents sealed in 1888, only 506, or 5·2 per cent., were maintained for the full period of 14 years by the payment of the annual recurring charges. The accounts showed total receipts amounting to £232,331, against which the total expenditure in the year was £125,040, leaving a clear surplus of £107,291.

Electricity in Mines.—In the House of Commons on Thursday week Mr. Markham asked the Secretary of State for the Home Department whether he would state the number of deaths that were directly due to the use of electricity in mines or shafts since May 2, 1901, and what course he purposed adopting to prevent this loss of life in view of the development of electric power in mines; whether, in view of the fact that Mr. A. H. Stokes, his Majesty's inspector of mines in the Midland district, in his report for the year 1901 states that in a mine in his district, owing to the short-circuiting of a cable, an explosion of gas occurred which would have resulted in loss of life if any men had been working in the mine at the time, he was aware that accidents were constantly occurring in mines from the short-circuiting of cables, causing in some instances fire in the mines, and that none of these accidents were reported to his department, except when an actual explosion or injury or loss of life occurred, and whether he had any power to insist upon colliery companies making a return of all such accidents. Mr. Ritchie, in reply, said he could give the number of deaths in mines due to the use of electricity in the year 1901. There were four deaths in all—two caused by electric shock, and two by machinery moved by electricity. All these accidents could be found described in the inspectors' reports. The use of electric power in mines was being carefully watched by the inspectors, and in due time he should be prepared to consider whether any steps ought to be taken with regard to it. He had no information as to the number of accidents caused by short-circuiting in mines, but the cases in which serious injury or loss of life had resulted had been very few. There was no power to require owners of collieries to report accidents caused by short-circuiting to the inspectors unless death or serious injury was caused or an explosion was produced; but a committee had been appointed by him to enquire into the general subject of the reporting of industrial accidents, and this and similar matters would, no doubt, be considered by them.

Australian Aluminium.—Although the discovery of aluminium dates only from 1828, it has long been recognised as one of the most useful and important of the minor metals, chiefly by reason of its extreme lightness, its weight being only one-fourth that of silver. This lightness has determined its use, among other things, in the construction of very delicate balances designed to register fractional weights It is obtained principally from bauxite, a mineral consisting chiefly of alumina, or oxide of aluminium and oxide of iron, which, until recently, was obtained principally from France. The existence of bauxite in New South Wales was not known until 1899, but almost simultaneously it was detected in extensive deposits in the Inverell and Emmaville districts, in the northern part of the State, and at Wingells, about a hundred miles south of Sydney. Its mode of occurrence is similar in both districts; it is frequently roughly stratified, and is generally found capping small hills, in many cases surrounding points of eruption. It is clearly of volcanic origin, and while in some cases it appears to consist of volcanic ash, in others it may have been derived from the decomposition of basalt *in situ*. In colour the New South Wales bauxite varies from pale yellow to deep red. Only the bauxite deposits near Emmaville have been officially mapped out as yet; nor has there been anything in the shape of a systematic examination of those whose existence in the State has so far been ascertained. At the present time aluminium is largely used for many purposes, and others are continually being discovered. In metallurgy, shipbuilding, and other directions the use of the metal is steadily increasing, and should its manufacture be started in New South Wales, where, according to Mr. John Plummer, of Sydney, bauxite is more abundant than generally supposed, a new and

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profitable industry would become established. The ore could be conveyed by rail to places where coal is cheap and plentiful; also the materials for constructing smelters. Or the coal could be taken to the neighbourhood of the bauxite deposits. Either way there appears to be a good opening for those possessed of the necessary capital, experience, and energy.

Simple Forms of Resistance.—A German contemporary recently described two simple forms of adjustable resistance, one for dealing with fairly large currents, and another for small currents. The first of these is a metal resistance designed by Haber, and used by himself and Geipert in an experimental investigation relating to the electrolytic reduction of alumina. It is claimed that the use of this device avoids all danger of overheating and of fire. The apparatus consists of a large number of nickel tubes, placed parallel and joined at their ends to one another by U-shaped couplings. The end tubes are joined by rubber tubing to some water supply and to the waste-pipes. The gaps between the neighbouring tubes are provided with sliding bridge pieces of brass or nickel, which can be fastened by a thumbscrew in any desired position. When all the bridge pieces are at the top end of the resistance, the whole of the current passes direct to the apparatus through the heavy couplings and the bridges, whereas when all the bridge pieces are at the bottom of the resistance, practically the entire length of the nickel tubing has to be traversed by the current. By adjusting the various bridge pieces the current can be regulated within very close limits, and as the nickel tubes are kept cold by the constant flow of the water through them, the trouble caused by the variations due to heating in the ordinary forms of resistance is said to be avoided. The second form of resistance is of the liquid type. The U-tube, in which the resistance liquid is contained, is formed with enlargements at its upper ends, and is provided with an elongation at the bottom of one leg, and an escape cock. The mouth of one leg is covered with a flat cork disc, and through this a glass rod slides easily. The electrodes are fused in the glass. The variation in the resistance is effected by sliding the glass rod up and down in the tube containing the electrode. As shown in the diagram accompanying the description of the device, the rod nearly fills the narrower part of this tube, and only a very thin body of liquid is then present by which the current can travel. By using a modified form of the apparatus with two additional legs containing sliding rods, and with electrodes connected in parallel, it is claimed to be possible to regulate the current within very wide limits.

Mercury Cathode Cells.—Mr. C. P. Townsend, in an article published by the *Electrical World*, describes two recent improvements in the production of chlorine and caustic alkali by the mercury cathode process. Both improvements relate to the form of the cell and to a peculiar arrangement of several cells in series, whereby is assured the presence of a sufficient quantity of sodium in the mercury to prevent oxidation of the latter metal in the caustic compartments. In the first form of construction of the new cell the controlling idea is the distribution of the mercury in both compartments in a thin film over metal plates or discs. The carbon anodes are immersed in sodium chloride solution in a cell, sealed at the bottom by mercury in open troughs, and at the top by a cover with depending flanges. The cathodes, which may be grooved discs of copper, are rotatably mounted on the shaft, and dip into mercury contained in a series of transverse troughs communicating with the lateral troughs. By the rotation of the cathode discs the mercury is taken up by the groove, distributed evenly over the surface of the discs, there becoming charged with alkali metal, and the resulting amalgam is collected by the mercury in the troughs. This amalgam then flows through troughs to the oxidising cell, there to function as anode and be denuded of its alkali metal. In this cell the mercury acts as a bipolar electrode, constituting the cathode in the decomposing compartment and the anode in the oxidising or caustic cell. If, however, the entire current passing to the mercury as cathode passes also from it as anode, some danger is incurred of oxidising the mercury as well as the sodium. The second improvement above referred to aims at getting rid of this difficulty by the series arrangement of the cells. The direct connection through the mercury is broken at four points by transfer devices, and the current carried around the gaps by circuit. It follows, therefore, that the four cells are decomposing cells, in which the amalgam is produced, whereas in two of the cells the amalgam functions as anode and the oxidation of the sodium to caustic occurs. Since all the cells are connected in series, and since the number of decomposing cells is in excess of the number of oxidising cells, it is clear that an excess of sodium above that required for carrying the current is ensured, and that no oxidation of the mercury can occur. Both improvements are the inventions of Mr. Chas. J. Reed, who, we understand from our contemporary, has taken out patents in the States for their protection.

City and Guilds of London Institute.—The annual meeting of the City and Guilds of London Institute was held at Mercers' Hall, Cheapside, on Wednesday week, under the presidency of the Lord Chancellor. Conspicuous among those supporting the chair was Lord Kelvin, who has recently returned from a visit to the States. The report of the Dean of the Central Technical College (Mr. O. Henrici) stated that the Clothworkers' Scholarship was this year awarded to Mr. J. A. Esnouf, who was educated at the Royal College, Mauritius, and who holds a scholarship of £200 a year from that school. The Siemens Memorial Scholarship was awarded to Mr. W. E. G. Bender, the youngest of the candidates, being under 16 years of age. The three institute's scholarships were gained by Mr. V. B. Hurley Mason, Mr. T. F. Lee, and Mr. C. D. McCourt. The Siemens medals were adjudged to Mr. J. J. Fasola for electrical engineering (to which a premium is added) and Mr. J. D. W. Ball for civil and mechanical engineering. An interesting paragraph in the report is the announcement that, in order to give the engineering students an opportunity of more extended practical surveying work, a fortnight's trip to Mersea Island in Essex was made in the summer vacation. In regard to the report of Prof. Silvanus Thompson on the work of the Finsbury College in the past year, it is noteworthy that the electrical department is again the largest, having 92 entries against 49 in the mechanical department and 46 in the chemical department. A good deal has been done during the present spring to reorganise many of the experiments in the elementary part of the college, but as yet nothing has been attempted in the way of renewing the dynamos, all of which are of types now obsolete. Towards the end of his report Prof. Thompson stated that the demand from employers for students capable of undertaking electrical work in one or other branch has exceeded all previous experience. The Brush Electrical Engineering Company's free pupilship has been awarded to Mr. T. A. Davies, who will join that company's staff in November. The Lord Chancellor, speaking on the above reports, referred to the offer of the London University to devote a substantial sum towards further extending the work of the Central College, and expressed the hope that this recog-

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nition by so important a body as the university might encourage the institute to maintain its pre-eminent position as an engineering college. In the course of some further remarks, Lord Halsbury mentioned that out of a staff of eight engineers working on the great Nile dam at Assuan, four of them are old students of the college. Lord Kelvin added a few sentences, expressing the thought that the governing body should exercise the utmost liberality in its treatment of the Central College and the Finsbury College in the matter of equipment. Both reports were unanimously adopted.

Municipal Trading.—A conference, under the auspices of the London Municipal Society, was held on the 28th ult. at the Constitutional Club, Northumberland-avenue, to discuss the question of municipal trading. Sir Edward Clarke, K.C., was in the chair, supported by a large number of members of Parliament and others, including Sir John Dorrington, M.P., Mr. C. A. Whitmore, M.P., Captain Jessel, M.P., Colonel the Hon. H. Legge, M.P., Mr. Sidney Morse, and Mr. J. A. Baines. The chairman having introduced the subject, the discussion was opened by Major L Darwin, who urged that they should set their faces against anything in the way of competitive trade being in the hands of municipalities, and contended that such undertakings as gas, electricity, and tramways should be left in the hands of private companies. He was convinced that municipalities could not trade as cheaply as private concerns. The germ of corruption would spread if they gave it a chance, and by means of municipal trade they were putting a new and a very great danger in their path. As to the tramway question, he argued that they ought further to restrict the power of veto which was possessed by the municipalities, and, among other things, they should press for the reappointment of the House of Commons Committee on Municipal Trading, or else for the appointment of a Royal Commission immediately on the subject. Mr. Whitmore, M.P., in the course of the subsequent discussion expressed the opinion that as long as they could keep private enterprise working well they should do so, but they must not declare that all municipal enterprise was bad. Sir John Dorrington referred to the undesirability of making use of municipalities for all purposes because of the tendency to restrict individual enterprise, and because it was very apt to burden the ratepayers with the cost of enterprises which were bound to be financially disastrous to the community. The discussion was closed by Sir Edward Clarke, who held that wherever there was anything in the nature of a monopoly, a municipal government, like the State Government, had a right to say that the monopoly, if granted at all, should be granted for the benefit of the community. One of the many dangers of municipal trading, however, was that of bringing a large part of the population into the direct service of the municipality—a mischief of the deepest possible character, leading to corruption in political affairs and mismanagement in municipal affairs to a great extent. He urged, therefore, that this requirement should be imposed on every form of municipal trading—namely, that the accounts of each form of municipal trading should be kept absolutely separate and distinct; and that the profits upon each particular branch should be devoted to the purposes of that particular undertaking. He would like to see the re-establishment of a strong committee on municipal trading, which ought to lay down, and no doubt would lay down, propositions of very great value. Those principles were that municipal trading should only be allowed in matters which were incidental to the good government and keeping of the district in which it was carried on. He did not include in that the provision of housing. He thought that within the limits mentioned municipal trading might not only safely be allowed, but in some respects would be advantageous.

Single-Phase Motors.—One of the most serious defects in the behaviour of single-phase motors is to be found in their lack of starting torque, to remedy which many ingenious devices have been developed. Writing on the subject in the *American Electrician*, Mr A. S. M'Allister says a simple method of producing the requisite quadrature magnetic flux for the purpose of giving a single-phase induction motor a starting torque is available in the use of "shading coils," which are extensively employed in alternating-current fan motors. Each coil consists of a low-resistance conductor surrounding a portion of a field pole. As ordinarily applied there is cut in each pole a slot parallel to the shaft of the rotor. In this slot is placed the conductor, which is connected by a closed path of high conductivity around a portion of the pole included between the slot and the side of the pole. The coil of each pole is placed similarly to that of the other poles, and the secondary revolves in the direction from that portion of a pole not surrounded by a coil towards the "shaded" side of the pole. The action of the "shading coils" is described as follows: Consider the field poles to be energised by single-phase current, and the current to be flowing in a direction to make a north pole at the top. Consider also the poles to be just at the point of forming; lines of force will tend to pass downward through the shading coil and the remainder of the pole. Any change of lines within the shading coil generates E.M.F., which causes to flow through the coil a current of a value depending on the E.M.F., and always in a direction to oppose the change of lines. The field flux is, therefore, partly shifted to the free portion of the pole, while the accumulation of lines through the shading coil is retarded. However, so long as the magneto-motive force of the field current is of sufficient strength and in the proper direction, the lines through the shading coil increase in number, although the increase is retarded, which is to say, that, even after the lines in the other part of the pole begin to decrease in number, the flux within the shading coil is increasing, and continues to increase till the exciting current drops to a strength just sufficient to maintain that density of flux which is within the coil. At this instant the flux in the shading coil has its maximum value as a north magnetic pole. As the flux on the other portion of the pole continues to decrease, the lines within the shading coil tend to decrease also; but the E.M.F. generated by their rate of change causes to flow a current which tends to prevent any change of lines, so that when the other portion of the pole contains no lines whatever there is yet within the shading coil an appreciable amount of flux, forming a north magnetic pole, the result being a shifting of the field from the unshaded to the shaded side of each pole. This is repeated when the magnetism reverses. The lines within the shading coil decrease with an increasing rate of charge, and a condition of zero lines within the coil is soon reached. At this instant there is a south magnetic pole at the "unshaded" end of the top field pole, and a north magnetic pole at the "unshaded" end of each adjacent field pole, and south and north magnetic poles begin immediately to form within the corresponding shading coils. Looking back over the process of formation of the magnetic poles, it will be seen that the north pole, though varying in strength, has travelled a counter clockwise direction. This process is continuous, and results in a truly rotary field. The one disadvantage of this method of getting a good starting torque is that it cannot be applied to motors of large size satisfactorily.

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DONCASTER ELECTRIC TRAMWAYS.

On Monday last the tramways of the Doncaster Corporation were officially opened under most auspicious circumstances. The proclamation of peace was seized upon by the inhabitants of Doncaster as a good reason for a general holiday, and in consequence the streets were crowded with people to witness the procession of decorated cars which inaugurated the public service.

MR. W. H. R. CRABTREE, BOROUGH SURVEYOR.

COUNCILLOR THOS. WINDLE, MAYOR OF DONCASTER.

MR. W. WYLD, BOROUGH ELECTRICAL ENGINEER AND TRAMWAY MANAGER.

The history of the tramway undertaking at Doncaster commences in 1899, when the British Electric Traction Company brought forward a scheme for the provision of tramways in Doncaster and its suburbs. A light railway order was applied for with this object, and the opposition to it by the Doncaster Corporation took the form of a rival scheme, which is practically that inaugurated on Monday last. The work has been done under the Light Railway Acts, with the consent of the Light Railway Commissioners. The chief alteration which had to be made in the scheme then brought forward was that the tramway over the level railway crossing at Frenchgate, on the route to Bentley, had to be abandoned, owing to the opposition of the railway companies interested.

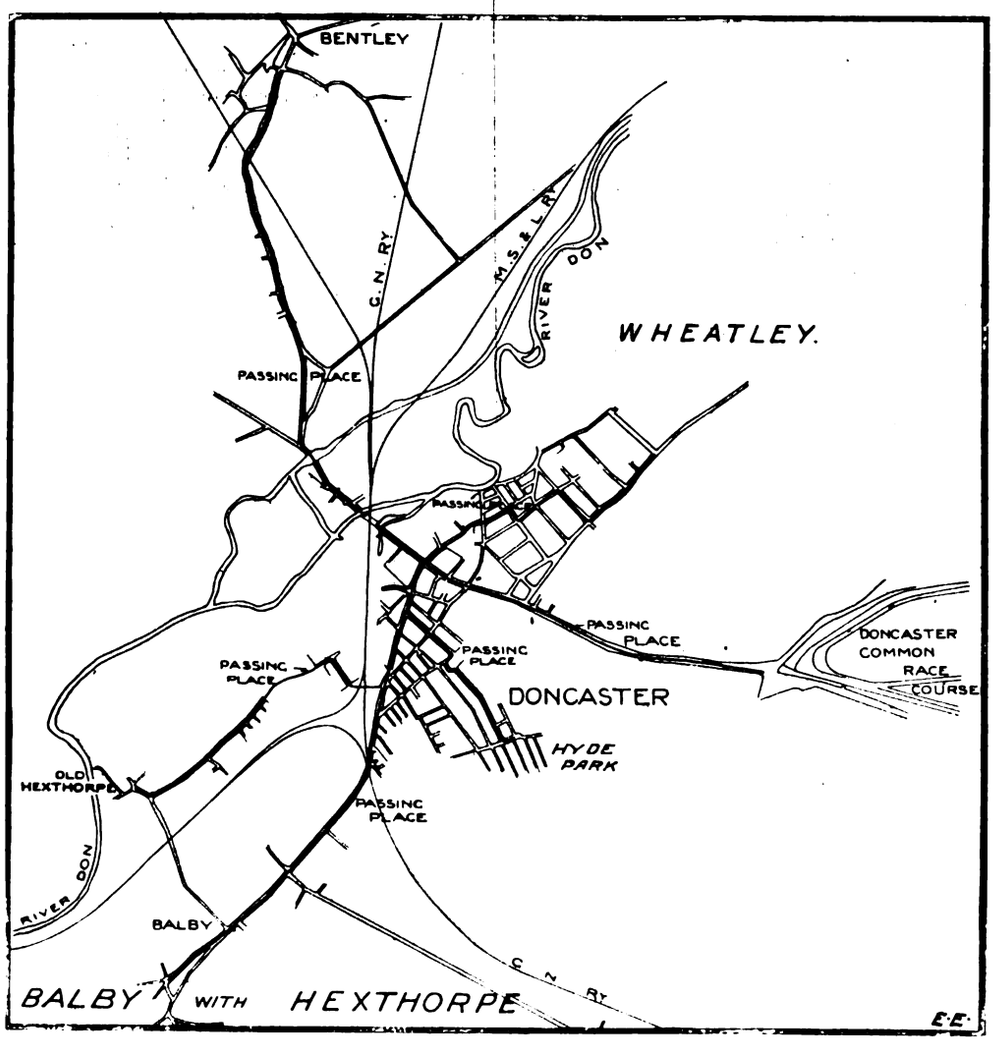

FIG. 1.—Map of the Electric Tramways at Doncaster.

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This alteration is unfortunate, as it necessitates a break in the tramway connections to Bentley, in consequence of which every passenger has to change cars and walk over the level railway crossing. With this exception the scheme of the Corporation was sanctioned without alteration, and

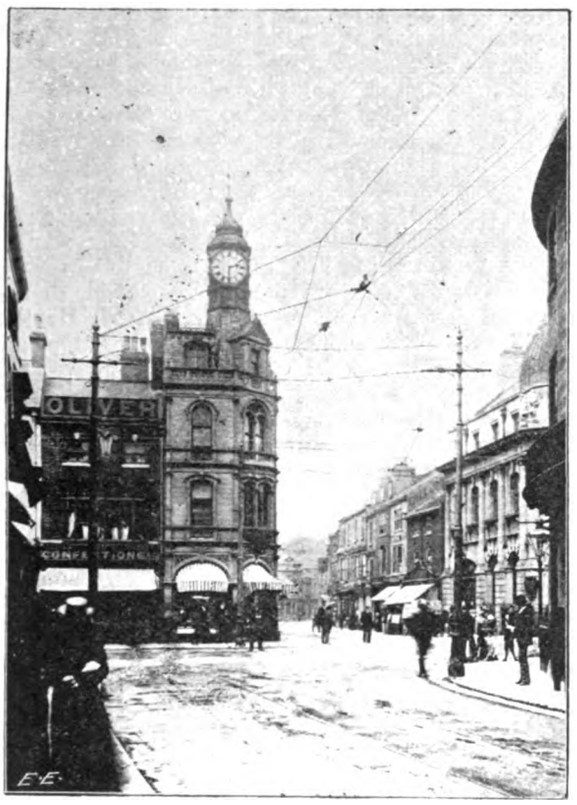

FIG. 2.—The Clock Corner, Doncaster.

the order, after confirmation by the Board of Trade, received the final approval of Parliament in 1899. For this promotion work the town clerk and the borough surveyor were chiefly responsible, but they were advised as to the work has been carried out. When the time arrived for the preparation of specifications for the electrical equipment the work was done by Mr. C. A. L. Prusmann, A.M.I.E..E., the then electrical engineer of Doncaster (now

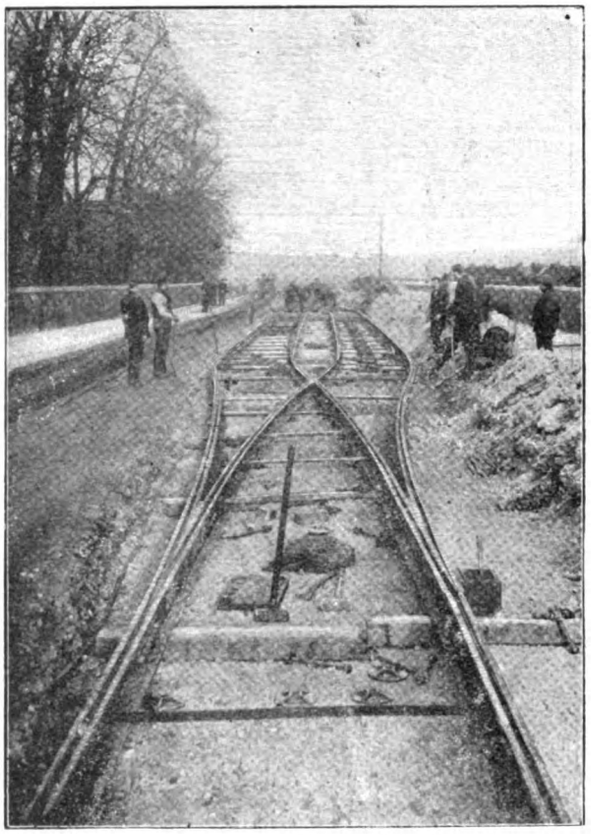

FIG. 3.—Rail-Laying at the Passing Places at Balby Road, Doncaster

borough electrical engineer at Swansea). Mr. Prusmann left for Swansea about the time the actual work was about to commence, and since he left, Mr. William Wyld, A.M.I.E.E., the borough electrical engineer of Doncaster,

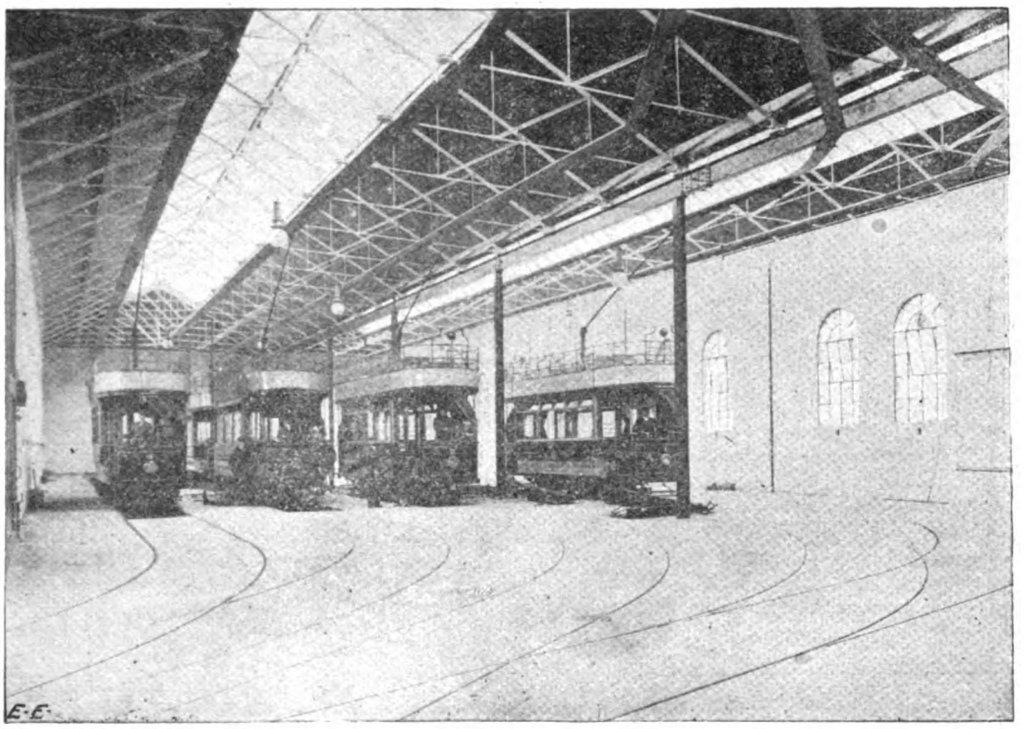

FIG. 4. View of the Interior of the Car Shed at Greyfriars Road.

electrical equipment and costs by Mr. J. N. Shoolbred, M.I.C.E. The plans and estimates for the construction of the various lines, car-sheds, etc., have since been prepared by Mr. W. H. R. Crabtree, M.I.C.E., the borough surveyor, under whose supervision the whole of this portion of the has had sole charge of the electrical equipment, and has had the care and responsibility in carrying out the whole of the electrical portion of the work. The Corporation has let every branch of the work by contract, but carried out the excavating, concreting, and laying of the track by

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their own workmen, and these have been under the supervision of Mr. Tench, who has had considerable experience in constructional steelwork.

In the map (Fig. 1) we show the routes to be equipped under the orders now obtained, and a few words as to each

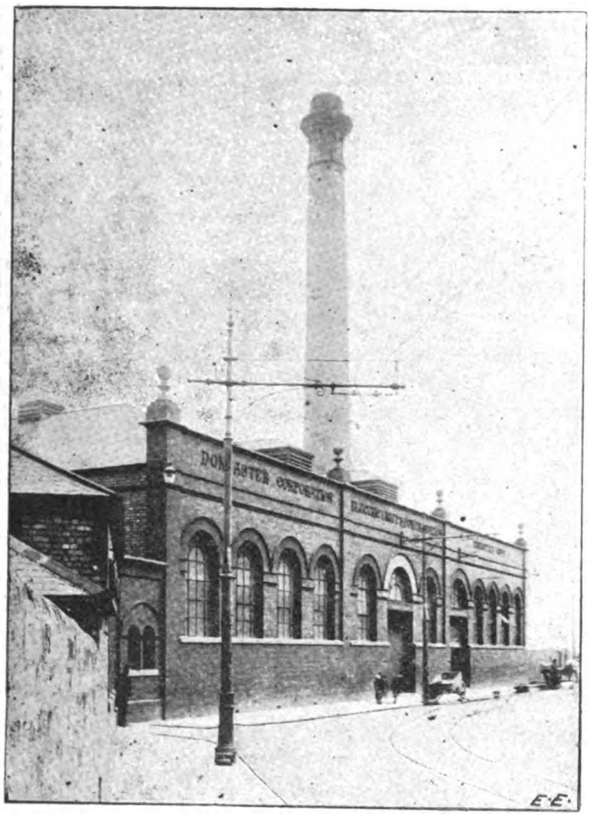

FIG 5.—The Outside View of the Electricity Works, showing Tramway Poles.

will be of interest. The line to Balby starts just outside the Great Northern Railway station in Station-road and terminates at Balby, where a tramway shelter has been constructed for the convenience of passengers. As there are three passing places on the way and the distance is one mile four furlongs eight chains, it will be possible to have four cars running and a quick service if necessary. At the commencement it is intended to run half-hourly from 5.30 a.m. to 8 a.m., and from then up to 11 p.m. a quarter-hour service. The line to Hexthorpe is a branch of the Balby line near St. James Church, and from this point to the terminus at Hexthorpe, a distance of one mile five chains, there is only one passing place provided. The construction of this section has involved a considerable amount of expenditure in addition to the ordinary cost of tramways. In the first place, the nine-arch bridge over the Great Northern and Great Central Railways had to be strengthened. Then at the junction of Hexthorpe-road the Old Plant Inn, with three adjoining shops and one house, have been set back, so as to increase the width of Hexthorpe-road from about 29ft. to 42ft. Further on the Corporation have caused Hexthorpe-road to be widened to the borough boundary by arrangement with owners of adjoining property. In the district of the Balby-with-Hexthorpe Urban District Council, where the Corporation own the adjoining land, they have set back the fence walls and made a new road nearly half a mile in length to a uniform width of 42ft. This has resulted in a good wide thoroughfare in the place of the old narrow road. At the Hexthorpe terminus the line is doubled so as to enable outgoing cars to proceed the moment the incoming car arrives. The same plan will be adopted at all similar termini. It is expected that the traffic on this line will be a constant growing one, owing to the number of new houses erected and in prospect in the neighbourhood of the Great Northern new plant works. It will develop the building estates of the Corporation in that district, and affords a speedy means of access to Hexthorpe Flatts, which belong to the Corporation, and are a pleasant resort in summer. Another line runs from Station-road to Grey Friars-road, and one more still continues the line along Grey Friars-road to the car-shed. The sections which were opened to the public with the Board of Trade sanction on Monday last are the following: from Station-road to Balby, the Printing Office-street loop, from St. Sepulchre's-gate to Hexthorpe, from Station-road to Grey Friars-road, and Grey Friars-road. The total length of routes opened is about 3¼ miles, but inasmuch as these include all the special track work at the car-shed, the Clock-corner (Fig. 2), Station-road, and the various junctions along the route, it is expected that the remaining lines, being of a more straightforward character, will be completed during the summer. Already a portion of the double line to the racecourse, and part of the single line to Hyde Park, have been constructed. The total length, inclusive of the double line to the racecourse, and the passing places and junctions, will amount to nine miles of single line. Sunny Bar is now being widened so as to enable the tramway to be laid through.

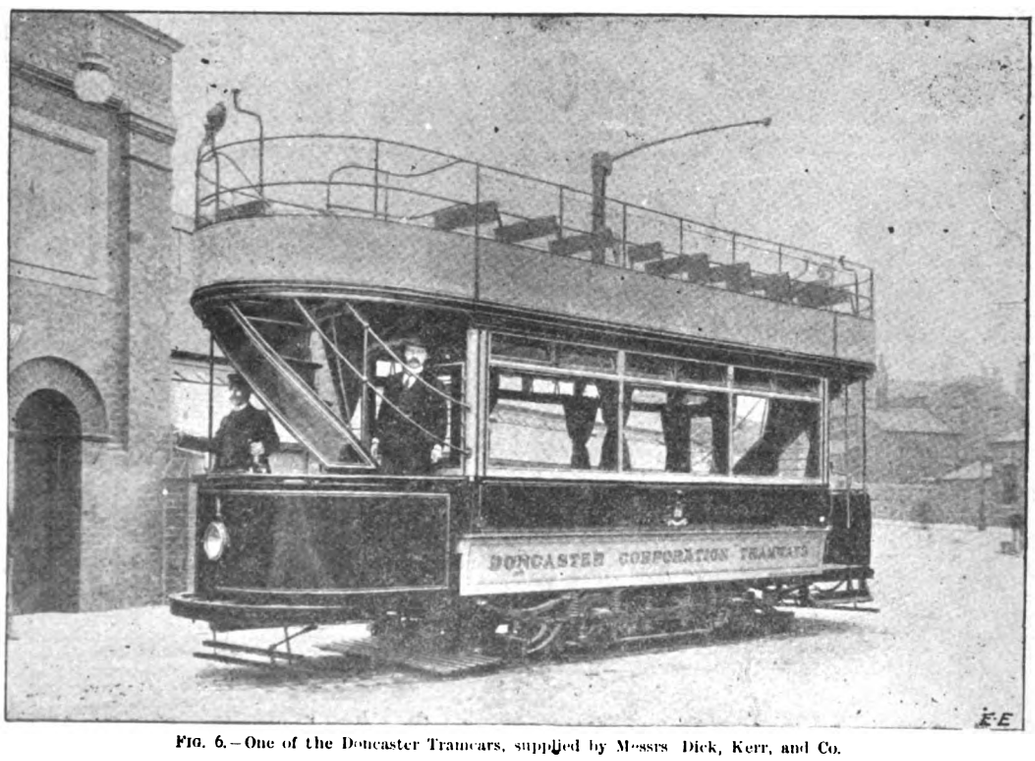

FIG. 6.—One of the Doncaster Tramcars, supplied by Messrs. Dick, Kerr, and Co.

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The rails used at Doncaster are of steel, 60ft. lengths, laid to a 4ft. 8½in. gauge, and weighing 94lb. per yard. Following the example of Hull, these rails are of the centre-grooved type, with diagonal ends, coupled at the rail ends by fishplates and sole-plates, and held in position by cross ties and holding-down bolts bedded in the concrete at 6ft. intervals. In Fig. 3 is given a view of these rails as laid at a passing place on the Balby-road. The whole of the steelwork has been supplied by Mr. H. Gielgud, of 140, Leadenhall-street, London, acting for the Société Anonyme des Acieries d'Angleur. Mr. E. A. Jones, of Brussels, has tested the steel at the works before delivery, and found entirely satisfactory. Messrs. Hadfield's, of Sheffield, have supplied the whole of the points, crossings, and special track work. Whilst the track was laid the underground conduits supplied by the Albion Clay Company, of Woodville, were also put in position ready for the feeding cables. The cement has been supplied by Messrs. Skelsey's Adamant Cement Company, of Hull; the holding-down plates by Messrs. Burnett and Co., of Hexthorpe; and manhole covers by Messrs. George Harvey and Co., of Chapeltown. The paving setts have been supplied by Messrs. the London Basalt Stone Company; the Balby Brick Company have supplied bricks; and Messrs. Farr, Longbottom, and Charles sundry items. Messrs. Woodhouse and Co. have supplied the cast burrs for the steel poles.

The Grey Friars-road car-shed (Fig. 4) is situated directly opposite the electricity works. The car-shed construction involved building over part of the River Cheswold, with very deep walls on the river side. The shed is 200ft. long, and will accommodate 20 cars, but only 15 are now delivered or on order, and of these two will be housed in the Bentley car-shed. This car-shed was designed throughout by Mr. Crabtree, and built to his supervision by Messrs. H. Arnold and Son. The shed is well lighted, and is most suitable for its purpose. The other car-shed to receive the cars on the isolated section of the tramways beyond the railway crossing is situated on the vacant land in Marshgate. The lighting of these sheds was carried out by the Northern Electrical Company.

The whole of the feeding cables have been supplied by Messrs. the Callender Cable and Construction Company, and are of their usual type for a drawing-in system. The same firm also supply the section pillars, which are placed at half-mile intervals along the track. For the most part the overhead equipment consists of poles with brackets (Figs. 2 and 5) supporting the trolley wires, at a distance of 40 yards apart, but in portions of St. Sepulchre-gate and at the racecourse, where the road is of considerable width, there are poles on each side with a connecting span wire supporting the trolley wire. This method of support was adopted by the Corporation on the racecourse route with a view to making the poles as little noticeable as possible. In fact, when the trees are in full foliage, it is expected that the poles on this route will be almost hidden by the trees. Guard wires are provided in all cases where telephone and other wires are above the trolley wires, so as to prevent their coming in contact should the wires above break. The drivers will be provided with indiarubber gloves, so as to be able to handle the trolley wires in case of breakage. The whole of the overhead work has been done by Messrs. R W. Blackwell and Co.

The 15 cars (Fig. 6) supplied by Messrs Dick, Kerr, and Co., Limited, are all of the same design, and are of the top-seat, reversed-staircase, single-truck type, suitable for the standard gauge of 4ft. 8½in. They are mounted on Brill 21-E trucks, the equipment consisting of two 25-A motors and rheostatic brake controllers. The total over-all length of car is 27ft. 5in, the clear height inside at centre 6ft. 9in., and the over-all height from rail 13ft. 2in. The seating capacity of these cars is 22 inside and 34 outside. The trucks have a wheel base of 6ft., the diameter of wheels being 30in. and the axle 3¾in. The wheels are of best chilled iron, and the trucks are fitted complete with hand brakes. The floor frames are built up of pitch pine and oak, and there are the usual openings over the motors to afford convenient access. The interior woodwork is of quartered oak, and over the side windows is a cornice of embossed mouldings. The panels of the doors and partitions are fielded. The cars are fitted with hand brakes, and there is the usual equipment of sand-boxes, gongs, etc. The finish of these cars and their upholstering was much admired on Monday.

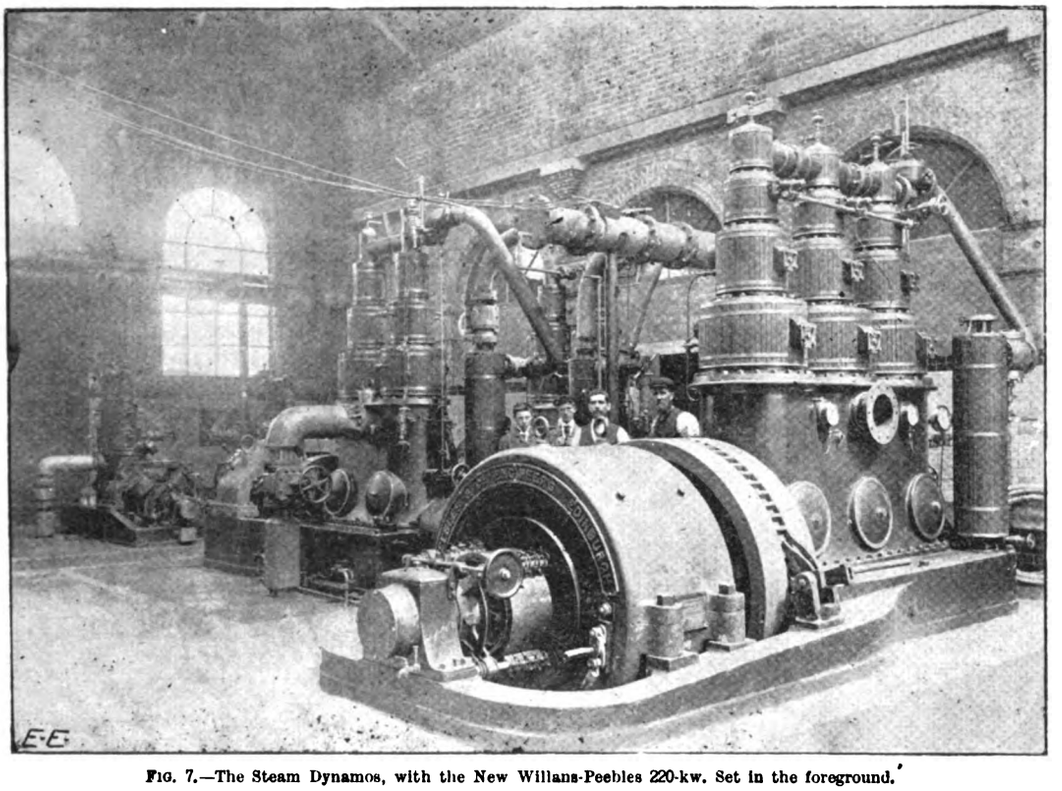

FIG. 7.—The Steam Dynamos, with the New Willans-Peebles 220-kw. Set in the foreground.

Having now described the tramway equipment, a few words are necessary with respect to the generating works. It was the fact that the Corporation already owned the electric lighting undertaking that was one great argument in deciding that they should also keep the tramway work in their own hands. We gave in our issue of April 6, 1900, a full description of the electric lighting works, which give a supply on the three-wire system. In the works as originally illustrated by us there were three 56-kw. machines for working between the middle wire and

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either of the outers, and two of 150 kw. wound for 500 volts. The dynamos were of the Mather and Platt make, whilst Willans engines were used throughout. In making provision for the tramway load, a new set, consisting of a Willans engine driving a Bruce-Peebles 220-kw. dynamo, was installed. This dynamo is over-compounded, but can be used as a shunt machine to work on the lighting 'bus bars. Mr. Wyld has also had a compound winding added to one of the Mather and Platt 150-kw. dynamos so that it can be used for tramway purposes. This can be seen in Fig. 7, while Fig. 8 gives a good view of the whole of the plant and switchboards in the engine-room. The traction switchboard (Fig. 9) was supplied by Messrs. Dorman and Smith, and to the right of it can be seen the throw-over switches which connect the two compounded dynamos on to either the lighting or the traction switchboard. It will, of course, be a great advantage to the electric lighting undertaking to supply the tramway load, but up to the present the actual price per unit has not been fixed. The estimated cost of the tramway undertaking is £77,500, and we gather that this sum is not likely to be exceeded. The undertaking has the advantage over many others, in that it starts with a clear field, as there were no tramways in Doncaster to be bought out. In consequence the capital charges are not excessive, and the undertaking should be financially successful from the very first.

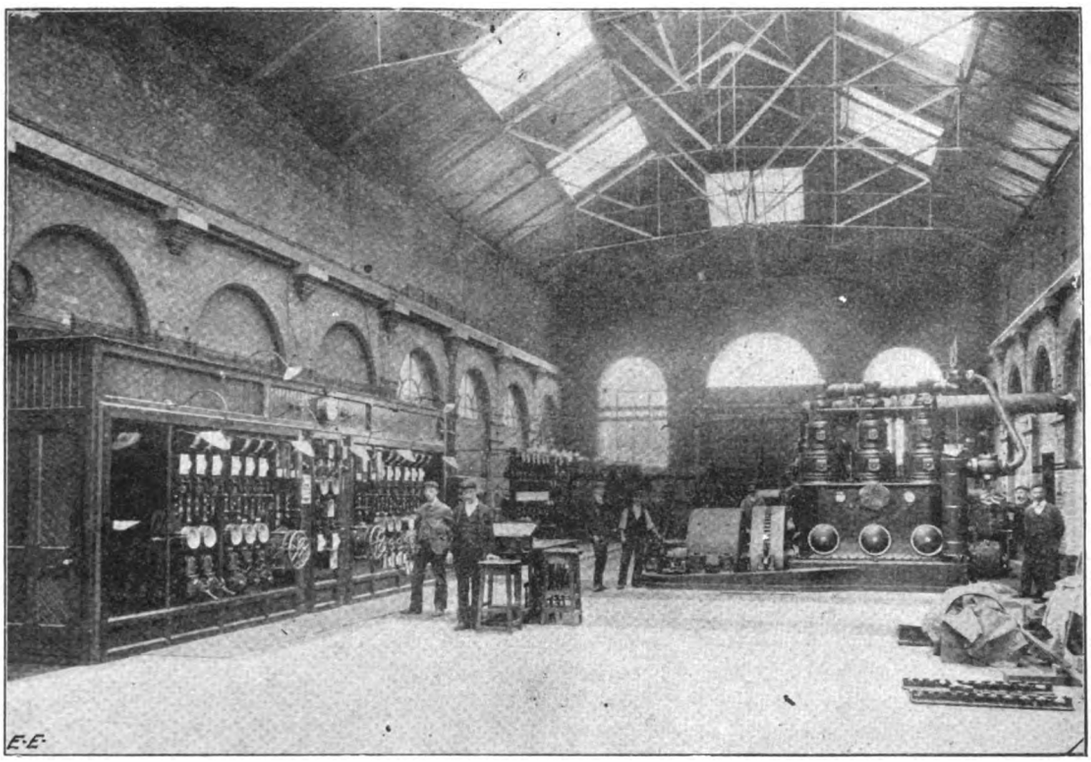

FIG. 8.—The Engine-Room of Doncaster Electricity Works.

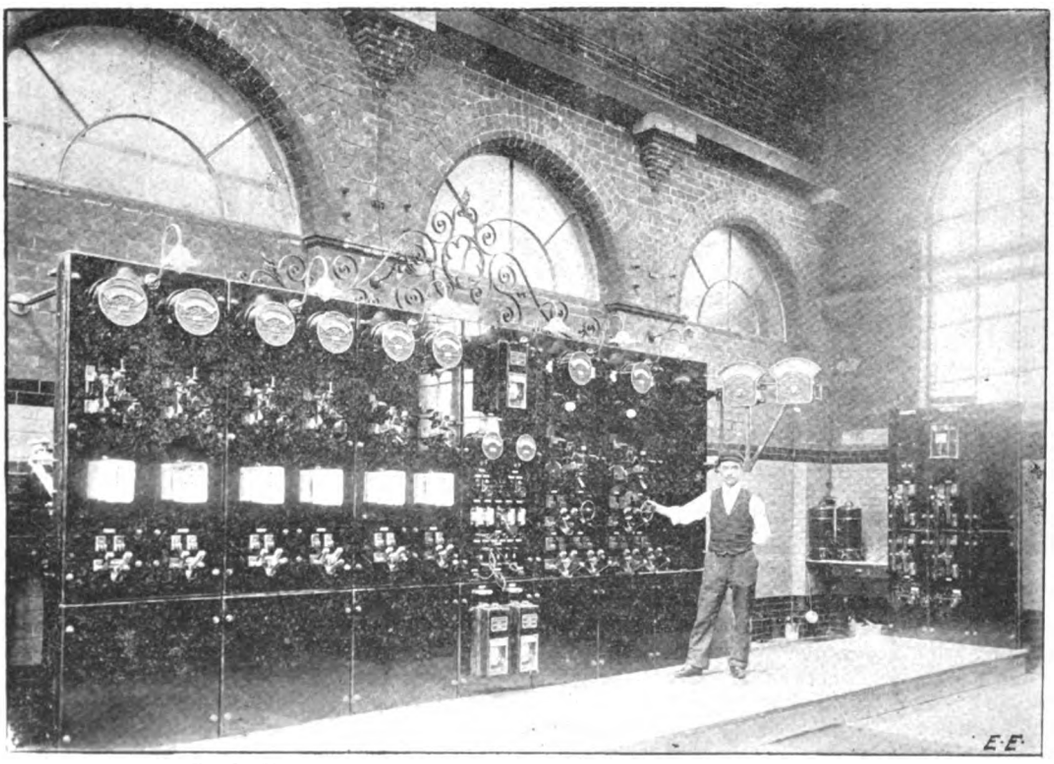

FIG. 9.—The Doncaster Traction Switchboard, made by Messrs. Dorman and Smith.

The working of the lines will be in the hands of Mr. W. Wyld, the borough electrical engineer, who will act as tramway manager under the direction of the Tramway Committee. The lines which were opened on Monday

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last were inspected previously for the Board of Trade by Major Druitt, R.E., and Mr. A. P. Trotter. The result was a clean bill of health.

The opening ceremony was somewhat marred by the fact that the public stormed the car-shed after the guests had entered, and practically filled the space round the impromptu platform. The noise in consequence rendered a good portion of the speeches inaudible. Councillor Smith, the chairman of the Tramways Committee, in presenting a gold key of the car-shed to the Mayor, commented on the large amount of time which his committee had expended in investigating the tramways systems in other towns. They finally agreed to follow the example of Hull and to use a centre-groove rail. He alluded to the large amount of extra work which the construction of the tramways had brought on Mr. Crabtree, the borough surveyor, while the praise of the Board of Trade inspectors would in part compensate him for the same. The old art of prophecy was not extinct. They had had the prophets prophesying that when they got cars in Doncaster these would have to be drawn by horses. Others that Doncaster would never have cars running at all. Others that no cars would run in the year 1902; which prophecies had already been falsified. The prophets, now that all their previous prophecies had failed, said, "Yes, you will see they won't pay." How comforting Some of them believed they would pay. What was wanted was for the 42,000 inhabitants of the town and district to make up their minds that at least they would have a car ride once a week. The interest and sinking fund to which they were already committed, when the whole of the lines were completed, amounted to about £70 per week. The cost of working and wages would be about another £100, which was equivalent to 7d. per car mile. They felt confident that in providing a quick service at the uniform rate of 1d. for the journey they would see their cars laden with passengers, and that both pleasure to the inhabitants and profit to the town would be the result of this the latest and great enterprise which the Corporation had undertaken on behalf of the people. Councillor Smith added that the contractors had one and all given the committee general satisfaction, and they were pleased to see them all represented at the opening ceremony. The Mayor then declared the car-shed and tramways open, and wished the undertaking every success. He hoped the tramways would soon become a paying concern.

After a vote of thanks to the Mayor had been proposed and carried, Councillor Dowson, the chairman of the Electric Lighting Committee, presented Councillor Smith with a gold watch charm, which was an exact model of the controller handles used on the car.

The next procedure was the presentation by Mr. Beeton, representing Messrs. Dick, Kerr, and Co., of two silvered controller handles to the Mayoress and Mrs. Smith. These two ladies drove the first two cars in the procession which was then formed to go over the different routes. The proceedings were terminated by an excellent luncheon served in the historical Mansion House of Doncaster, in the menu of which "Corporation tarts" appeared. We believe that the date on the Roman receipt for the manufacture of these articles cannot be deciphered, but the tarts have for centuries been forthcoming whenever a luncheon or dinner is given at the Mansion House. After the usual loyal toast, the toast of "The Contractors" was given and the health of Councillor Smith, the chairman of the Tramways Committee. We have not for some time attended an opening so well organised as that of Doncaster, or of a scheme which promises to be so successful financially and so useful to the inhabitants of the town served.

FORMERS AND FORMER-WINDING.

BY F. W. DAVIES.

(Continued from page 777.)

V. Formers for Drum Armature Coils (Bar-Wound).

A coil or section of a symmetrically-wound bar drum armature is of precisely the same contour as an equivalent coil for an armature with formed wire winding. A bar winding such as that used in some of the designs of Mr. Gisbert Kapp, in which the bars are of various lengths and the end connections made with semi-circular plates is unsymmetrical; and, therefore, does not come within the genus of former-winding. The two distinctive types of former-winding for bar-wound armatures are the evolute and the barrel, the intermediate or bastard type of winding being impracticable with bar winding. The evolute bar winding has been in constant use for 10 years or more. Several patents have been taken out for this method of winding, notably by Messrs. Siemens and Messrs. Crompton.

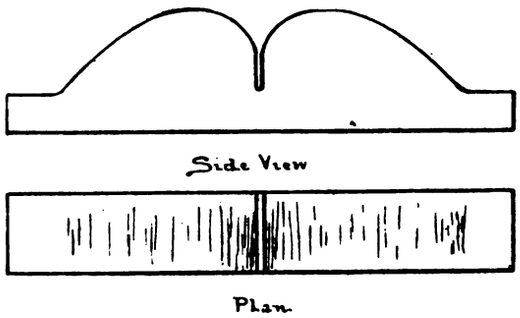

Fig. 13.—Former for Evolute End-Connectors for Bar-Wound Armatures.

Both this and the barrel winding are too well known to require much description. With the evolute winding the bars are straight and require no forming whatever. The evolute end connectors, by means of which the bars are cross-connected at the ends, however, require a former or templet on which they may be formed to their well-known evolute shape. Such a former is of the simplest description, and for end connectors which are fairly pliable may be cut out of a block of hardwood. If the end connectors are of stout, stiff copper, it should be made in metal. A sketch of the former is given in Fig. 13. Each coil of the armature consists of two straight bars and two end connectors. The latter are usually mounted on a sleeve at each end of the armature. Each coil may be comprised either of two bars of equal (or, more correctly, nearly equal) length; or of one long bar and one short bar, according to the way in which the end connectors are arranged. The two methods are shown diagrammatically in Fig. 14. For

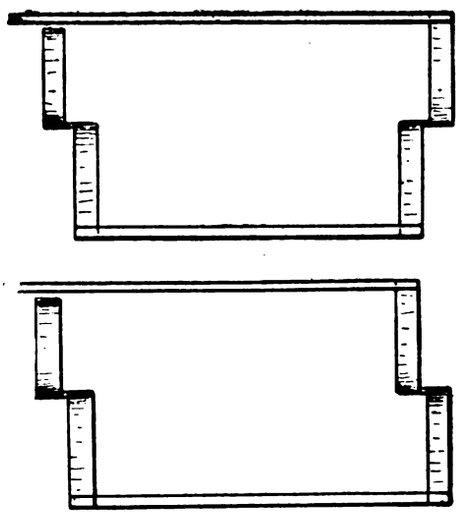

Fig. 14.—Diagrammatic Plans of Bar-Wound Coils, showing the Alternative Arrangements.

some reasons it is more convenient to have the two bars of a coil of nearly equal length, as shown in the lower view of the figure; but this arrangement has the disadvantage that every alternate bar projects beyond the others at each end of the armature. This introduces serious difficulties in the soldering up of those ends of the bars which come between the projecting ends. It is far preferable to have each coil made up of one long bar and one short one, as shown in the upper view of the figure, as then all the short bars can be put on the armature first and soldered up without difficulty before the long bars are put on.

The barrel type of winding for bar-wound armatures has not been in actual use for so long a time as the evolute

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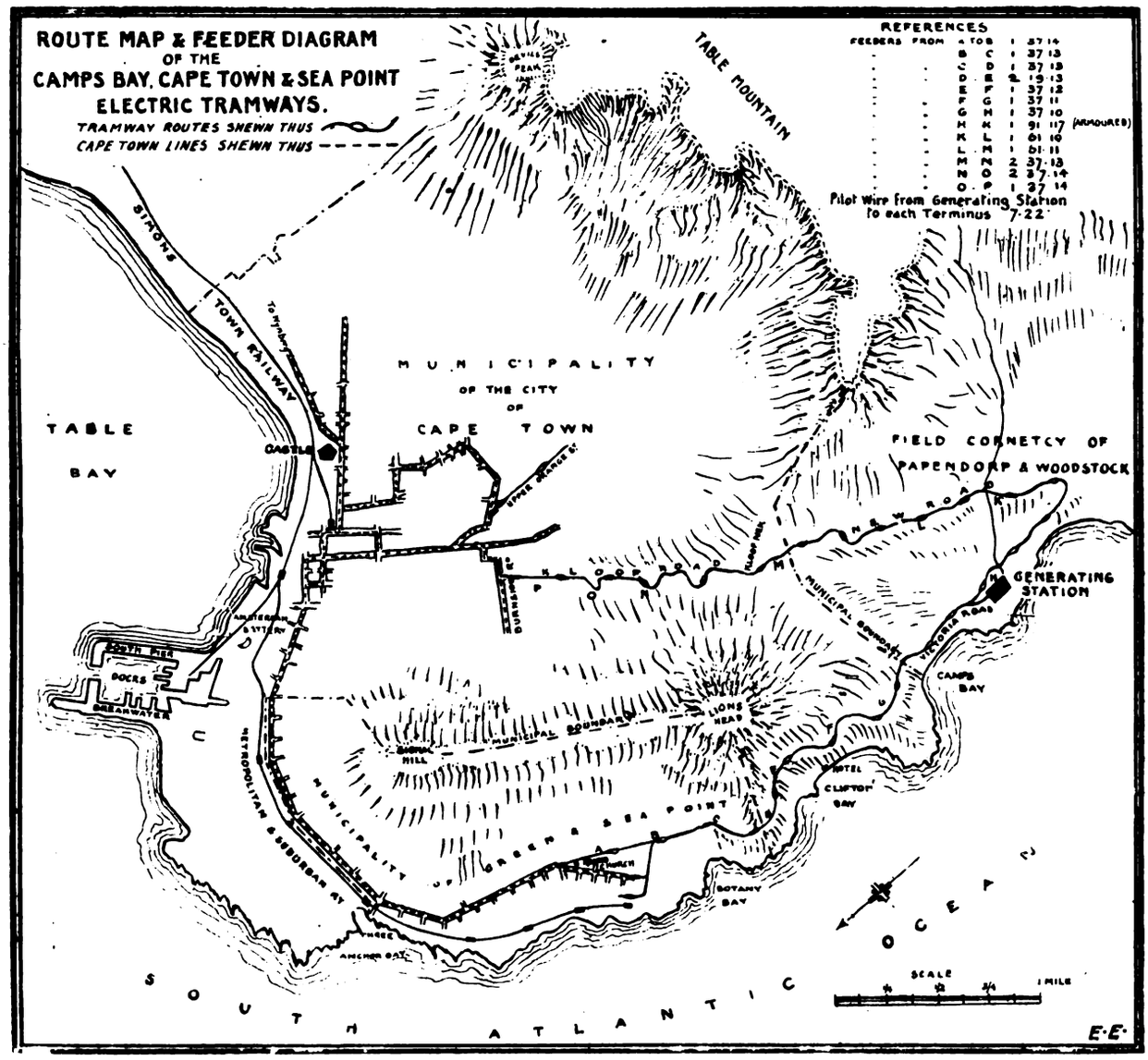
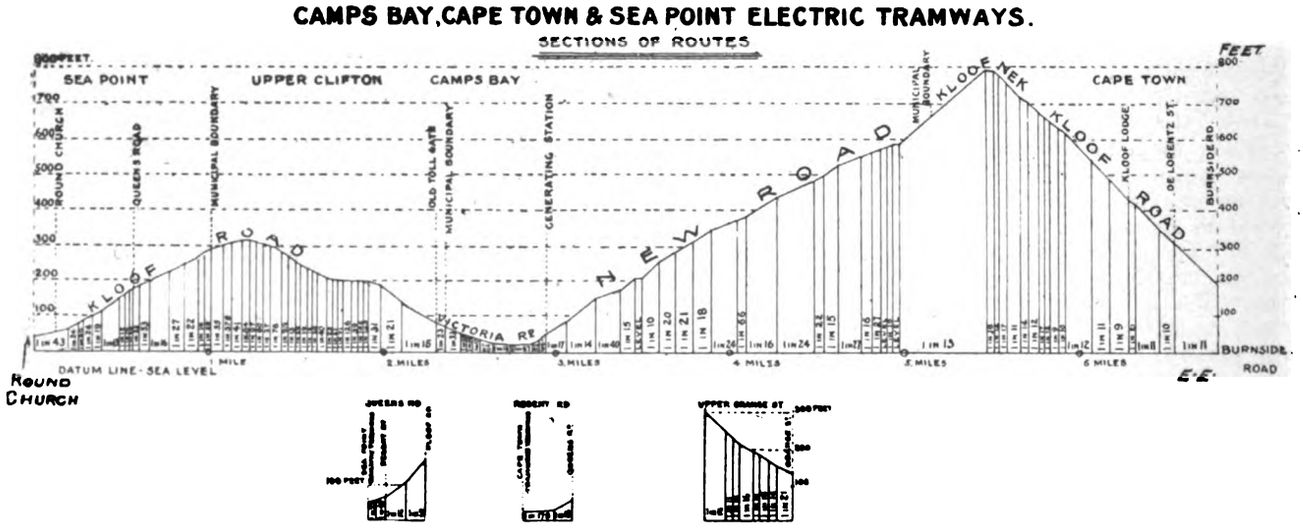
type of winding, and it is only of late years that it has come into prominence. It offers better facilities for ventilation than does the evolute winding. Not only so, but edge of the coil trough is cut away all round the former so as to be level with the bottom of the trough. This is in order that the coil may the more easily be tapped into



in many instances it is decidedly cheaper as regards both material and labour; and, moreover, is not so liable to a breakdown. Evolute end connectors frequently give trouble where they are grouped together on the sleeve, as the arrangement

the required shape with the mallet. The coil may consist either of two bars, fastened together at the end of the armature remote from the commutator by being soldered into a clip or shoe; or it may be formed from a single



is highly favourable to the accumulation of copper dust. The former for the barrel type of bar winding may be of similar construction to the former shown in Fig. 11, but with the difference that that part of the block which forms the outer

long bar bent like a wire-wound coil. This latter method is certainly the better and cheaper one to employ where the conductor is light and flexible enough to allow of it. For conductors of large section, however, it is advisable to adopt

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the previously mentioned plan—that is, to make each coil or section of two bars, which are soldered into a clip, as the bending of a heavy conductor is a very difficult operation.

(To be continued.)

CAMPS BAY, CAPE TOWN, AND SEA POINT TRAMWAYS.

The accompanying map of the above line, which was fully described in a recent issue, reached us too late for insertion in that issue. It is of great interest when consulted in connection with the section of the work also given below, as showing what great difficulties as to grades have been overcome by electric traction in the able hands of Messrs. Dick, Kerr, and Co. We would note our readers to refer to our issue of the 23rd inst. for details of the equipment when looking at the map.

ENGINEERING STANDARDS COMMITTEE.

A deputation from the Engineering Standards Committee recently waited upon the First Lord of the Treasury to discuss the question of standardisation, and a report of the proceedings has now been published. The deputation consisted of the following gentlemen: Mr. Mansergh (chairman of the committee), Mr. Charles Hawksley, Mr. Maw, Mr. Whitwell, Mr. J. Swinburne, Sir William Preece, Colonel Crompton, Mr. McDonald, Mr. A. Denny, Mr. Windsor Richards, Prof. Unwin, Mr. Ainsworth, Dr. Tudsbery, and Mr. Leslie S. Robertson (secretary).

Mr. MANSERGH stated that the question of standardisation was originally brought before the council of the Institution of Civil Engineers by Sir John Wolfe Barry, and that the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, and the Institution of Electrical Engineers were co-operating with them. The work of the committee was originally divided into four sub-committees: (1) bridges and building construction, with Sir Benjamin Baker as chairman; (2) sections used in shipbuilding, of which Mr. Denny was chairman; (3) rails, with Sir John Wolfe Barry as chairman; (4) railway rolling-stock underframes, with Sir Douglas Fox as chairman. Two other sub-committees had since been added: (5) electrical plant (chairman, Sir William Preece); and (6) locomotives, of which Sir Douglas Fox is chairman. He hoped that the deputation would be able to make out a sufficiently strong case to enlist the active support of the Government.

Mr. ARCHIBALD DENNY, the chairman of the Ships Committee, said the work of this committee was divided into two parts—the fixing of standard sections of materials, and the fixing of standard tests. With regard to the latter, he anticipated no difficulty in reconciling the requirements of the three registry societies, the Admiralty, and the Board of Trade, because they involve difficulties for the steelmakers. With regard to the standard sections, his committee had arrived at a provisional decision. Up to the present the various supporting institutions had contributed towards the expenses of the work, but they hoped that the Government would now recognise the work as being worthy of their support.

Mr. J. SWINBURNE, as president of the Institution of Electrical Engineers, spoke on behalf of the electrical industry of the country. A certain amount had been done already, and they gratefully acknowledged the assistance of the Government with regard to the wire gauge, but there was a great deal to be done in standardising besides wires. They wanted to get dynamos and their engines standardised, so that they could be ordered from different makers and yet be found to fit. The American Institute of Electrical Engineers had taken the matter up, and something ought to be done in this country. Electrical traction was one of the cases in which this country had suffered enormously from lack of standardisation. In America the traction plant was mostly made by one or two very large concerns, and the trade, being in the hands of these concerns, they could standardise for themselves. In this country there was a large number of firms, and standardisation could not be effected unless it were done more or less officially. A considerable amount of money could be saved if standardisation were carried out now instead of waiting until a multiplication of designs were in use. The Government were directly interested in telegraphs, telephones, and electricity on board ship, and if the Government would take the matter up and work with the committee it would enormously benefit the electrical industry of this country.

Mr. WINDSOR RICHARDS, past-president of the Iron and Steel Institute, said that the steel trades of the country were greatly hampered by the fact that the rolled sections of rails, tramroad rails, and girders were not standardised, and that the testing to ascertain the quality of the steel varied too much. He spoke of the trade being hampered from his own knowledge as a director of two very large works, one in the North of England and the other in South Wales, the combined capital of the two being over £9,000,000, some 30,000 workpeople being employed. In the works referred to above several thousand tons of rolls were kept constantly in stock, and the amount of money uselessly invested in rolls over the whole country must be enormous.

Colonel CROMPTON, as an electrical manufacturer, could support what Mr. Swinburne had said about the electrical industry—viz., that it was greatly hampered from the fact that no recognised standards in sizes of the material were to be found.

Mr. LESLIE S. ROBERTSON, secretary, described what had been done in Germany, France, and America with regard to standardisation

The deputation stated that they had considered the question of the use of the metric system, but after very careful consideration they could not see their way to recommend its adoption unless its introduction were made compulsory by the Government.

Further remarks were made by Mr. HAWKSLEY, president of the Institution of Civil Engineers, Sir WILLIAM PREECE, Mr. DEAN, and others.

Mr. BALFOUR, in reply, said the advantages of standardisation were obvious. After what had been said no human being could have a doubt as to the importance and magnitude of the subject. As far as he could offer an opinion he entirely agreed with the views expressed by the members of the deputation. It would be necessary for him to lay the matter before his colleagues, but he was authorised to say that both the War Office and the Admiralty were prepared heartily to co-operate with the efforts of the committee in the direction of standardisation. As these two departments were the largest consumers of iron and steel their co-operation would be absolutely invaluable in furthering the objects of the committee. He could hardly add more at the present time, but would very glad to lay the views expressed by the deputation before his colleagues in the Cabinet.

The deputation then withdrew.

TELEPHONIC COMMUNICATION WITH FRANCE.

A convention drawn up by the British Post Office has just been signed by the French Minister of Commerce providing for telephonic communication between London and some 300 of the larger industrial cities in France. Hitherto the telephone line to Paris has been almost exclusively used for Stock Exchange and Press messages, but with the new arrangement there is likely to be a large increase in the number of calls. A uniform charge of 8s. for a three minutes' conversation, which is the present Paris rate, will be made, and the use of the system will be restricted to subscribers to the State telephones of both countries.

Folkestone.—A petition to the Board of Trade for an extension of time for the commencement of the proposed tramways has been approved by the Town Council.

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HOLMES MOTOR EQUIPMENTS.

Last week we had the opportunity of interviewing two or three of the engineers of Messrs. J. H. Holmes and Co. who devote their time to the motor department of that firm. We were particularly interested with the Holmes-Clatworthy patent system for driving web newspaper printing machines by electricity. In previous issues we have referred to this system, but until now we have not had the opportunity of giving an illustration like Fig. 1, which shows the motor equipment as supplied to a large printing machine in the offices of the Northern Press and Engineering Company, of South Shields. It will be seen at once that in this case there are two distinct equipments on the Holmes-Clatworthy system, and this arrangement has been made in order that the printing machine can be used for various purposes and in various sections—*i.e.*, the whole of the printing machine working together can be used to print off a full daily paper, or one half of it can be employed to print an evening paper while the other half is standing. In consequence, the two electrical equipments are independent and only work as one when the whole printing machine is required at the same time. Each of the individual equipments consists of a small 3-h.p. motor which drives the main shaft of the larger 25-h.p. motor by means of worm gearing. This larger shunt-wound motor is connected to the printing machine. A single controller operates the two motors. In starting up, the small motor is first switched on and brings the speed of the cylinder of the printing machine up to 10 revolutions per minute. It can be regulated to run slowly at any speed, from two revolutions up to this. When the speed of the cylinder has reached about 10 revolutions, the large motor is switched on and takes up the work. A clutch in the worm gear is then over-run and released, and the small motor automatically shuts down. Owing to it being a series-wound motor, it follows up the speed of the larger one until the current is small, when the automatic switch breaks the circuit. The controller is then moved on round until the printing machine is up to full speed, which is about 200 revolutions of the cylinder per minute. To show the advantage of using the small motor to overcome the starting friction of the printing machine, Mr. Clatworthy made some experiments at Liverpool as to the minimum current required to start up first with the small motor and then with the large. It was found that only 13 amperes at 200 volts, or 10 per cent. of the full load current, was required with the small motor,

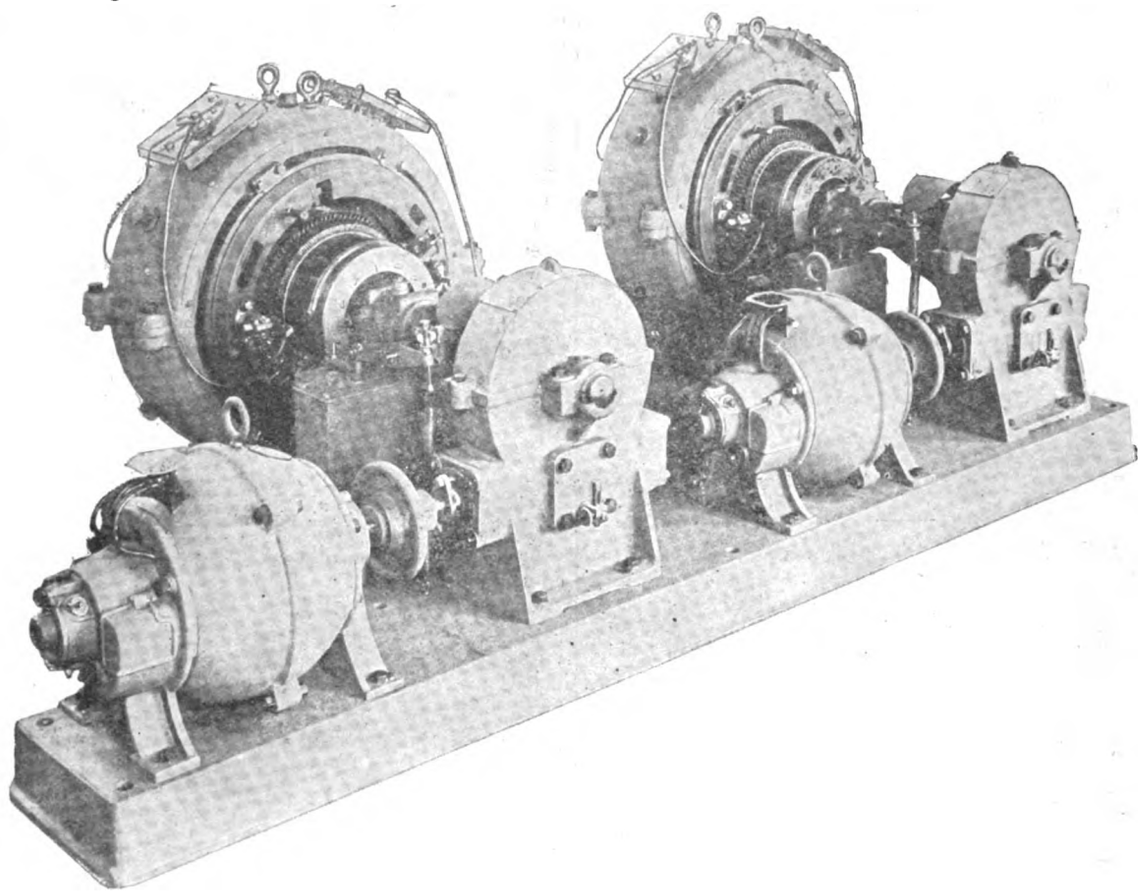
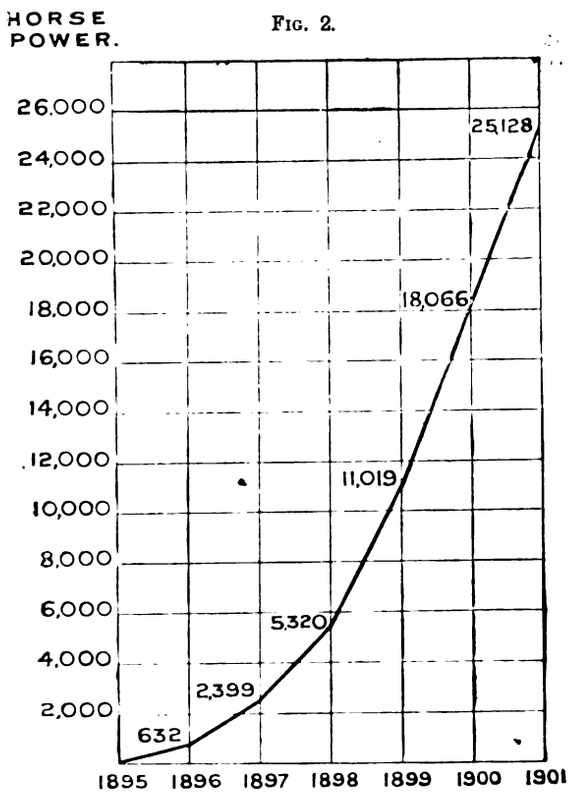


FIG. 1.—Two 25-h.p. Holmes-Clatworthy Equipments for Driving a Printing Machine.

FIG. 2.



MOTORS.

CURVE SHOWING YEARLY PROGRESS OF SALES IN HORSE POWER.

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whereas 160 amperes had to be passed through the large motor before the machine began to move. These Holmes-Clatworthy combinations have stood the test of several years' running, and it is of interest to note that the firm have received a large number of repeat orders from those newspaper printing firms who first tried them. For instance, the *Globe* Company have 10 of them at work, and the *Liverpool Courier* six, we believe. The curve (Fig. 2) shows how the output of motors manufactured by the above firm has increased of late years, and we believe we are correct in saying that the bulk of these motors are of the Lundell type. In Fig. 3 we show one of the 7½-h.p. motors used to drive by means of worm wheel two shear-leg hoists. The hoist is arranged for two speeds—*i.e.*, 34ft. per minute when lifting 1½ tons, and 10ft. per minute when lifting five tons. Fig. 4 gives three views of a recently-designed motor controller introduced by the firm, which is of special service for large motor work, where it is essential that the current taken from the main shall not exceed a predetermined limit, and that there shall be ample contact for the large currents to be dealt with. The screw adjustment of the controller contact ensures the slow starting up of the motor, and the arrangements are such that the circuit is immediately broken if the supply should be turned off. This starting and controlling gear is designed on engineering lines, and it will in consequence survive a time test, as is not the case with certain types of starting switches designed to sell. The success of Messrs. J. H. Holmes and Co. in connection with electrical power distribution is an indication of the rapid way in which

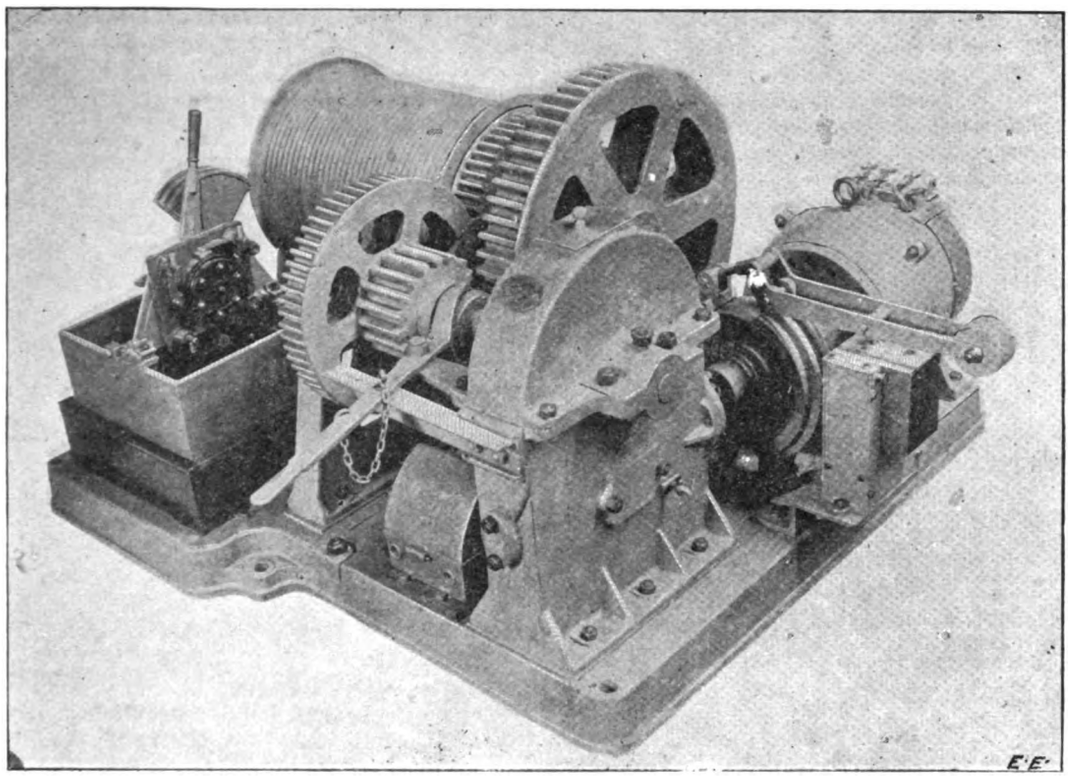

FIG. 3.—A 7½-h.p. Motor Driving Gear for Shear Legs Hoist.

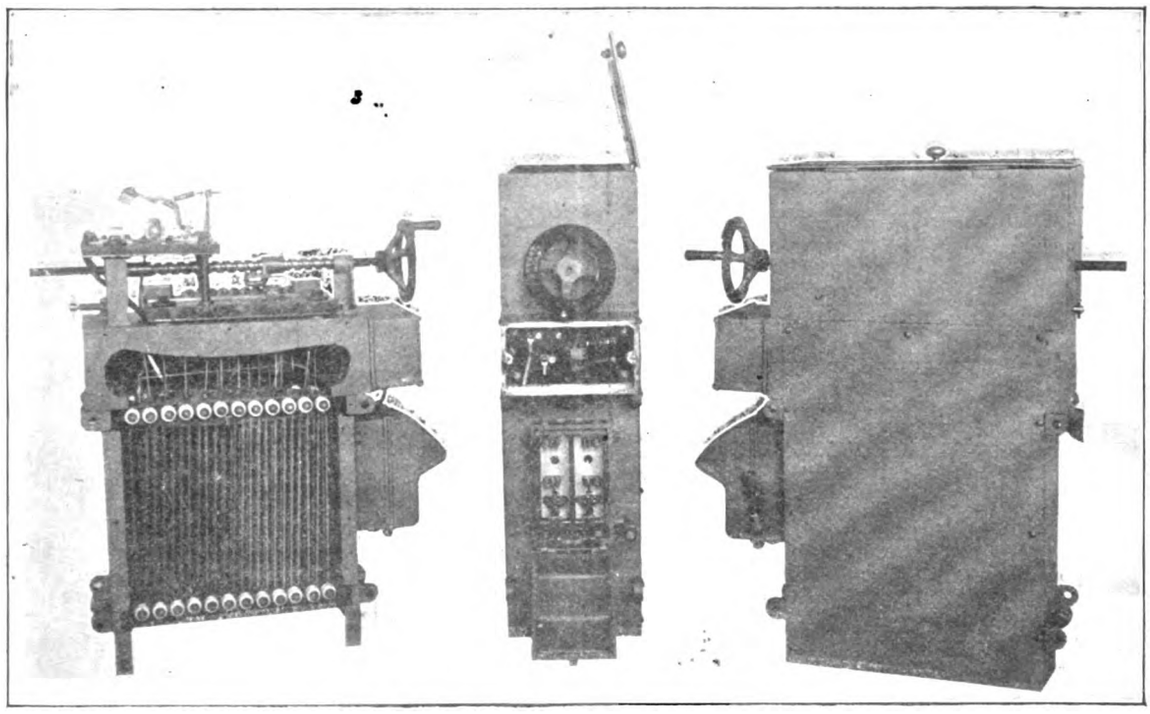

FIG. 4.—A New Type of Motor Starting Switch and Controller, made by Messrs. J. H. Holmes and Co.

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this class of work is increasing in this country. It is also interesting to know that export orders are being secured in the face of severe foreign competition.

ELECTRIC TRACTION PROGRESS.

In our issue of the 16th ult. we reprinted a paper by Mr. Philip Dawson on the above subject, and the general manager of the Corporation tramways at Dover has just written us pointing out a discrepancy which has occurred in Table V., on p. 696. In that table the ratio of expenses to receipts at Dover was given as 85 per cent. The actual figure, we are informed, is 72 per cent, as the other figures given will show. As the article in question will doubtless be much used as a standard for comparison, we take this opportunity of making this correction.

TUBE BILLS IN PARLIAMENT.

LORD WINDSOR'S COMMITTEE.

FRIDAY, MAY 31.

Lord Windsor's Select Committee met again for the purpose of considering the compensation clauses to be inserted in the Tube Bills which have been passed by this and Lord Ribblesdale's Committee.

Mr. Balfour Browne, K.C., on behalf of the combined Piccadilly and City and London United Electric Railways Companies, submitted a clause providing "that if any building shall have been injuriously affected, either by the construction of the railway or works, or by the working of the railway, any owner or lessee of any such building shall be entitled to recover from the company compensation for any such damage proved to have been actually caused to such building," and that any question of disputed compensation should be determined by an arbitrator, who, failing agreement, was to be appointed by the president of the Surveyors' Institution.

Mr. Littler, K.C., brought up a clause on behalf of the Brompton and Piccadilly-circus Railway similar to that suggested by Mr. Balfour Browne, with the exception that the arbitrator, failing agreement, was to be named by the Board of Trade.

Mr. Balfour Browne said he did not press that point.

Mr. Littler said his clause also provided that the railway company should, even before the opening of the line, have the right to go in and remedy any injury caused by the construction of the line as quickly as possible without waiting for the court of arbitration.

Lord R. Cecil, K.C., submitted a clause on behalf of the landowners generally, providing that, in addition to the provisions incorporated in the Act with respect to compensation, "the company shall make compensation for all damage or loss of every description which may be caused to the owner, lessee, or occupier of any lands, house, or building by reason of the working of the railway, including the working of lifts and any other works in connection with the said railway, notwithstanding that no part of the property of such owner, lessee, or occupier is actually taken by the company, provided that all claims for compensation under this section shall be made within three years from the date of the opening of the railway for public traffic."

In reply to Lord Ribblesdale, counsel said he thought that subsidence arising through working would not be covered by the clause. As to subsidence during construction, they were content to leave themselves under the Lands Clauses Act.

Lord Ribblesdale asked whether, as the word "land" did not occur in Mr. Balfour Browne's clause, the owner of a garden with stonework and statuary, such as those of Lord Peterborough's and Pope's Villa, Twickenham, would be entitled to compensation for injury through subsidence.

Mr. Balfour Browne thought that such a case as that put by Lord Ribblesdale should be met, and he should have no objection to the inclusion of the word "land" in his clause.

Mr. Ram, K.C., asked the committee not to limit them to damage actually caused. They desired to have it safeguarded that they were entitled, at the arbitration hearing, to show prospective damage such as might reasonably be apprehended.

Mr. Littler and **Mr. Balfour Browne** opposed the landowners' clause, and contended that its adoption would absolutely prevent any tube railway from being made in London.

The committee adjourned the further consideration of the clauses.

TUESDAY, JUNE 3.

The committee heard further arguments of counsel in connection with the compensation clauses submitted by the promoters of the combined Hammersmith, Charing Cross, and City Railway and the landowners as the basis of the model clause to be inserted in all "tube" railway Bills.

Lord R. Cecil, K.C., on behalf of the landowners, said that, acting upon the suggestion of Viscount Knutsford, they had made certain alterations in their clause, which now read as follows: "In addition to the provisions incorporated herewith with respect to compensation for land taken or injuriously affected, the company shall make compensation to the owner, lessee, or occupier of any land, house, or building which shall be injuriously affected by reason of the working of the railway (including the working of lifts and any other works in connection with the said railway), notwithstanding that no part of the property of such owner, lessee, or occupier is taken by the company, as fully and to the same extent as if a part of his property had been taken by the company. Provided that all claims for compensation under this section shall be made within three years from the date of the opening of the railway for public traffic, and the provisions of the said incorporated Acts with respect to the settlement by arbitration of questions of disputed compensation shall extend and apply to and in the case of any such claim save that the amount of compensation payable by the company shall, if not agreed upon, be settled by a single arbitrator to be agreed upon by the parties, or, failing agreement, to be appointed by the Board of Trade; (2) an arbitrator under this section may, with the consent of all parties concerned, hear together any class or group of claims under this section." In deference to what he gathered to be the view of the committee, they had withdrawn the words "for all damage or loss of every description which may be caused," which appeared in their original clause.

Mr. Moon, K.C., representing the Great Northern and City Railway, said that if a liability such as that involved in Lord R. Cecil's clause was imposed on the promoters, there was grave doubt whether the capital could be raised. He suggested an extension of the operation of Section 68 of the Lands Clauses Act so as to include compensation for damage done in respect of the working as well as the construction of the railway.

Mr. Balfour Browne, K.C., for the combined companies, also opposed the amended clause.

The committee having consulted together,

The **Chairman** announced their decision as follows: The committee have decided to proceed on the basis of the last clause brought up by Lord Robert Cecil. They have decided to take the clause as it is drafted down to the word "railway." At this point they desire to make it clear that their intention is to make this apply to the railway so far as it is constructed in tunnel, and that it should not apply to the continuation of the line in the open. The actual words to carry out this intention we leave to be drafted. With regard to the words "as fully and to the same extent as if a part of his property had been taken by the company," the committee consider that at this stage of their proceedings it is of very great importance that their labours should not be indefinitely prolonged. The committee have decided to leave those words out, but they desire to lay down that, in arriving at this decision, they do not wish to prejudice their full discussion in the other House. The period for making claims will be two years instead of three years as provided in the clause. The rest of the clause down to the words "Board of Trade" will remain as it is, and the committee desire to insert here the words "and, subject as aforesaid, all the provisions of the Arbitration Act, 1889, shall apply to every such arbitration." The committee keep in Sub-Section 2 of the clause.

Lord Ribblesdale, who sat as a member of the committee for this special purpose, said he was armed with authority to represent and to act for his committee in that room, and he desired to say that he entirely concurred with the clause as laid down by Lord Windsor, and he wished it to be understood that the conditions he attached to the Bills which were passed by his committee were subject to the insertion of this clause.

Mr. Littler, K.C., hoped the committee would keep an open mind as to whether this clause should apply to already authorised lines or only to those that were asking for powers for the first time this session.

Lord Ribblesdale said that, speaking for himself, he laid it down that where a railway which had been authorised for some time and had done nothing got an extension of time, it must be subject to the insertion of the model clause.

The committee next proceeded to hear applications for special protective clauses in respect of particular buildings affected by the Piccadilly and City Railway.

The **Chairman,** in a discussion as to procedure, said it was a matter of the greatest importance in the public interest that these Bills should go to the other House at the earliest possible moment, and the committee hoped that every effort would be made to reduce the points of discussion before them.

The committee adjourned.

WEDNESDAY, JUNE 4.

The committee further considered the applications for special protective clauses in regard to particular buildings.

The promoters of the Brompton and Piccadilly-circus and the Piccadilly and City Railways agreed to accept a clause, in pursuance of the principle laid down by the committee, providing that, where two tubes run in close proximity under the same road, an owner could claim against the two railway companies. The claim was then to be referred to one arbitrator, who was to say which of the companies should pay such compensation as he might award, the hearing to be under the Arbitration Act, 1899.

The committee granted a special clause in the case of the Adelphi and Vaudeville Theatres enabling the owners of these theatres to appoint an engineer with power to inspect the carrying out of the work of constructing the line.

Mr. Littler, K.C., brought up a clause for the protection of the halls of the Middle and Inner Temples, the Temple Church, and the Master's house. He stated that an agreement had been arrived at with regard to the greater part of the clause, but the promoters objected to the following sub-section: "The company shall pay to the societies compensation for all damage and injury of every description which may arise to the societies' special buildings by or from the construction or working of the railway."

The committee passed the sub-section, but limited its operation to a period of five years from the opening of the railway.

Mr. Shiress Wills stated on behalf of the Albert Hall, that a clause had been agreed on with the promoters of the London United

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Electric Railways, but, in view of the national character of the building, he asked for a further clause imposing on the company unlimited liability.

Mr. Coward, K.C., for the London United Electric Railways Company, pointed out that the line was 130ft. away from the Albert Hall, and that ample protection was afforded by the special clause that had been agreed on.

The committee said they could not accept the proposal for perpetual liability.

Lord H Cecil, K.C., applied for a special clause in the case of the Phillimore Estate, which extended from High-street, Kensington, to the summit of Campden-hill, and of which Sir Walter Phillimore is the life owner. What he asked was that the company should "indemnify the owner, lessee, and occupier against any damage to, or depreciation in the value of, their respective property which they may sustain through or by reason of the works of the company causing the drainage of underground water or springs."

The committee refused the application, and shortly afterwards adjourned.

THE SALFORD ENQUIRY.

On June 3, at the Salford Town Hall, his Honour Judge Parry opened the long-expected enquiry into the electricity undertaking of the Salford Corporation. According to the formal notice, evidence was to be taken: "(1) as to the building, etc., of the Walness works; (2) as to whether the aforesaid works could have been enlarged so as to use the machinery at present contained therein sufficiently to supply electric current for the necessary lighting and to run the tramways at the present time and for the next five years; (3) as to the total power provided in the Walness works and the new works, and if found to be in excess of the requirements, to go thoroughly into the matter and report to the Council as to who is responsible; (4) as to all matters appertaining to any specifications, tenders, or contracts in connection with the erection of Strawberry-road station; (5) as to any other matters that should be enquired into."

The Town Clerk (Mr. L. C. Evans) appeared for the Corporation. Messrs. W. Hunt, F. W. Wheatcroft, and C. R. Turner appeared on their own behalf. Mr. H. Galloway was in attendance on behalf of Messrs. Galloway, Limited, Mr. C. H. M. Wharton for Mr. Alderman Shaw, Mr. E. Desquesnes for Sir Richard Mottram, Mr. Hawkins for Messrs. W. T. Glover, Limited, Mr. T. W. Fox for Messrs. W. H. Bailey and Co., Mr. A. H. Dean for Mr. A. Haworth (a former member of the Borough Council), Mr. W. L. Hockin for Mr. Alderman Holland, and Mr. W. Cobbett for Messrs. Lacey, Clirehugh, and Sillar.

Before the enquiry opened Judge Parry elucidated two points, first, that privilege could be pleaded for *bonâ fide* statements if, subsequent to the enquiry, an action were brought against a witness; and, second, he could not compel witnesses to come to the enquiry.

Before the general points were gone into Mr. Hunt's observations with regard to such contracts were disposed of. Mr. Hunt stated that he did not make any charge of illegality or bad faith against Mr. Alderman Shaw or against Mr. Alderman Holland, and the judge relieved the counsel of these gentlemen from further attendance. Mr. Fox having no evidence to offer on behalf of Messrs. Bailey and Co. also withdrew.

Mr. Wheatcroft then opened his case with reference especially to Clause 3. He made a detailed statement in comparison of the electrical power installed by the borough for lighting and tramway purposes with that of Hamburg, to which town the Corporation had sent two deputations to gain information. While the requirements of Salford were not likely for many years to be more than one-third or one-fourth of those of Hamburg, the Salford installation amounted to 10,750 h.p. and that of Hamburg to 8,400 h.p. He went on to state that a sub-committee recommended that Messrs. Lacey, Clirehugh, and Sillar should be engaged to consider and revise specifications for work for 50 guineas. Ultimately the resolution of the General Committee was that they should be employed at £1,500. They were afterwards placed on a commission basis, and in March, 1899, they made a recommendation as to the generating plant that would be required. The committee had expected to receive a scheme much more moderate in cost than that previously drawn up by Mr. Turner. They received a scheme practically the same size, but under which the whole construction was to be rushed up and paid for within four years, whereas Mr. Turner's scheme was to erect the buildings as required. At Mr. Wheatcroft's request, the minutes were read relating to the provision of 16 Lancashire boilers. The longest period allowed for the delivery of these boilers was, he said, first 14 months. On his initiative this was made 18 months, and the words were added "if required.' At a later date, when he was not present, the committee rescinded the latter resolution and reverted to the original term of 14 months. Passing to Clause 4, Mr. Wheatcroft said that through the interference of certain parties in the latter part of 1898 the recommendations of the consulting engineer became "demoralised," and the official life of Mr. Turner not an enviable one. Mr. Turner informed him and the deputy-chairman and others that the representative of a certain firm had been to him, and pressure had been put upon him to include certain specifications for boilers in his scheme. Mr. Turner did not comply, and subsequently Mr. Turner was dismissed. Mr. Wheatcroft contended that on Dec. 7 a resolution was put on the agenda paper of the Council, which had not been passed by the committee, to the effect that the Electric Light Committee be authorised to arrange for the appointment of a consulting electrical engineer with reference to machinery and plant. The chairman had stated that he had been worried into putting this on the paper. (**Mr. Haworth,** who was then chairman of the committee, and was now present, here declared that this evidence was fabricated.) Judge Parry reminded Mr. Wheatcroft, who spoke of "sinister rumours," that the enquiry had to be into facts. Then the judge enquired as to what had been the specific wrong or ill done to the ratepayers.

Mr. Wheatcroft said that the chairman went and put this on the agenda paper because he was influenced by a gentleman who was not a member of the committee.

The **Town Clerk** contended that the matter actually did appear on the minutes.

Judge Parry said it was on the minutes in one form and not in another. He asked Mr. Wheatcroft whether he protested at the time about this matter, and he replied that he did so; what he suggested was that it was intended to appoint an engineer to upset the scheme of Mr. Turner. He thought the chairman in this matter had broken faith with the committee.

On the resumption of the enquiry on the 4th **Mr. Wheatcroft** continued his statement. He suggested that the consulting engineers employed by the Corporation were weak advisers. He thought undue preference was shown to a firm of boilermakers.

Mr. Dequesnes produced a letter from **Mr. W. M. Mather,** in which he said that however satisfactory an electrical engineer the Corporation might have, having regard to the extreme importance of the matter, Salford was really departing from the practice of other municipal corporations in not seeking advice from well-known authorities, and his firm would not tender on a particular specification.

Mr. Wheatcroft admitted that, so far as Sir Richard Mottram was concerned, his understanding was now modified. He was unaware till that day of this letter, yet he thought Sir Richard ought not to have attended a meeting of the committee when they considered certain boilers, nor should Mr. Haworth have asked Messrs. Galloway to tender. He had nothing to say against Messrs. Galloway as a firm.

Mr. Turner also said he had nothing to say against the firm.

Judge Parry said that such charges as were made appeared to be against Sir Richard Mottram personally, and he would give evidence. He relieved Mr. Galloway from attendance till Saturday. With regard to a charge by Mr. Hunt against the firm, nothing would be heard before them.

Mr. C. L. Turner then said he entered the service of the Corporation in October, 1894, and on the completion of the Walness-road station he became manager, when in March, 1897, the Council elected a standing Electric Light Committee. He was appointed borough electrical engineer, in which office he continued till May, 1900. He complained that he had not been supplied with certain information which he had asked for from the town clerk.

The **Town Clerk** read a letter from Messrs. Lacey, Clirehugh, and Sillar showing that he had applied to them for the information in question. They had replied complaining of vague and damaging charges, and expressed their readiness to afford to Judge Parry any information on specific points which he might require.

Mr. Turner rejoined that what he had asked for was Corporation property, and not that of the firm named.

Judge Parry said he would consider the matter later.

Mr. Turner, continuing, said as to Clause 2, the Walness works could not be enlarged, and if they had been the cost in cables would have been £15,000 more. On Clause 3, he considered the Corporation had now 3½ times more plant than was required. The estimated cost at Strawberry-road alone, including cables, was approximately £400,000. He did not say the amount of work put in for trams was so much in excess of the requirements as that for lighting, and he thought the two ought to be separated. At least half of the capital cost might have been left over for a future date.

Mr. Cobbett did not admit on behalf of his clients that the plant was 3½ times too big, and the plant Mr. Turner desired would have been 11½ times too large.

At this stage the enquiry was adjourned till next morning.

FORTHCOMING EVENTS.

FRIDAY, JUNE 6.

Royal Institution.—At 9 p.m., Sir Benjamin Baker on "The Nile Reservoir and Dams."

FRIDAY, JUNE 13.

Royal Institution.—At 9 p.m., Mr. G. Marconi on "The Progress of Electric Space Telegraphy."

Physical Society.—From 3.30 to 6 p.m., visit to the National Physical Laboratory, Bushy House, Teddington. Trains leave Waterloo (south station) at 2.36, 3.14, 4.15; and Waterloo (Windsor line station) at 2.40, 3.17, 3.40.

APPOINTMENTS VACANT.

Assistant, for India, versed in electrical (and with a good knowledge also of mechanical) engineering, 300 rupees per month. See advertisement.

Manager and Engineer to take charge of South Wales branch for contractors. See advertisement.

Calarashi-Stirbein (Roumania).—The Municipality invite tenders for the installation and working of electric lighting for 35 years. Tenders by June 13.

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THE
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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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PEACE AND ITS TROUBLES.

Since our last issue, not only the British Empire, but the world has welcomed the realisation of peace in South Africa. It is now time for business men to turn their attention to what will happen as soon as the ordinary avocations of life commence in earnest in what has been the seat of war. For the past two or three years Great Britain has been the most vituperated nation in the universe. For a long time it was difficult to see why this should be so; and especially when it is understood that we have long been looked upon as a nation of shopkeepers, and not as a nation who revel in aggressive warfare. It seems, however, that the peaceful tendency of our policy, coupled with the justness of our rule, are the principal reasons which have drawn upon our heads the calumny of competing nations. A German paper sums up the matter very tersely, as will be seen from the following extract taken from the *St. James's Gazette* of Wednesday last:

"According to the *Börsen-Courier*, German merchants interested in the export trade to South Africa have long reckoned upon an increase of business consequent upon the declaration of peace. The *Rheinisch-Westfälische Zeitung* takes a somewhat different view, and observes: 'For us Germans the final surrender of the independence of the Boers is a heavy blow. Not only on political grounds is the situation serious, seeing that as a South African Colonial Power we shall in future be face to face with a compact and gigantic South African Power which is entirely English, and which is no more menaced by a Boer State. . . . We shall also have to suffer from commercial exclusion. England is now supreme over the Boer Republics, and will consequently have a vast quantity of custom to dispose of. All the railways will be built by England; all German monopolies, like the famous German dynamite monopoly, will be abolished; English, not German, officials will be employed; industry subject to English influence will be preferred; and English goods, English imports, will be favoured by the customs arrangements. In a word, a portion of the earth is once more lost as a market for the products of German labour and is secured for our English rival.'"

The intense selfishness of this view will be realised when the question comes to be more clearly examined. In this question of business our Colonial possessions are quite as free to other nations as to the Motherland. This is not only unfair, but unjust; but it passes the bounds of comprehension of those who look at the matter clearly. Take this latest instance of increase in British territory. Dealing with it only from a monetary point of view, it has cost at least two hundred millions of money, and for the moment the nation is saddled with an increased annual interest payable, owing to the war. Part of this interest may, no doubt, in the future be borne by the new colonies, but that will not affect our argument. The amount of money expended may be likened to the paper capital of any company, which bears interest, but does not exist and never has existed in the shape of working capital. Every business man clearly understands the added difficulties to the success of a company which possesses a large amount of watered capital. The products of the company cannot be sold so cheaply, or they are not produced so perfectly, as would be the case if such excessive capital did not exist. Great Britain is in a similar position. If it admits free competition from all other nations, it has to face such competition heavily handicapped because of the burden imposed by this expenditure upon it, and therefore cannot so easily or so satisfactorily compete with those manufacturers and merchants who have to bear none of the liabilities. It seems to us, therefore, that in fairness and justness to our

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own people some method ought to be found in order to place competitors upon the same footing as ourselves; and in this we are asking for nothing exceptional, but merely a fair field and no favour. If England and Englishmen cannot hold their own when all other things are equal, it is time the nation took a back seat; but we do not think that this has yet come, nor do we think our manufacturers and merchants unable to completely hold their own when the disabilities on all sides are equal. How exactly the burdens are to be shared by those who propose to do business in South Africa, it is not our province to say. We have merely to point out that the burden exists, and it should be so apportioned that it does not handicap this country too heavily. Let us take a word or two from our German contemporary: "All the railways will be built by England." That is a very wide statement, and of doubtful accuracy, and especially so if foreign merchants who have taken none of the risks, and upon whom lie none of the liabilities, are permitted to compete without restraint with those of the Motherland. The industry with which we are more intimately connected with is one which ought to hope for great development, not only in the new South African provinces, but over the whole of South Africa, now that peace is assured, and the argument we have used above applies to this industry as much as to any other. It is to be hoped, therefore, that politicians will consider the exact condition of matters, and will act clearly and justly to secure what we have termed a fair field to the British community, and not give over the land into the hands of those who have stood by and neither shared the dangers nor the costs, but who are quite ready to take all the profits.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

AIR-PUMPS.

SIR,—With your kind permission I should like to point out a few of the most glaringly misleading statements made by your correspondent "T Square" in reply to Question No. 478.

The correspondent responsible for this question is evidently in search of information, having taken the trouble to make a couple of drawings to scale, and it seems a pity that he should be misled.

To begin with, "T Square" states that with a jet condenser a vacuum of "26" certainly could not be obtained. This statement is quite erroneous, as there are scores of jet condensers giving a vacuum of 27in. in Lancashire alone.

Secondly, "T Square," in computing the volume of the air-pump, fails to take into account any air to be dealt with by the pump except such as "leaks in."

Thirdly, the diameter given for the air-pump barrel—viz., 11½in.—gives a valve area through the bucket 50 per cent. less than is necessary to obtain decent results.

Fourthly, "T Square" informs us that "if the air-pump is double-acting, we need only make it half the size." As a matter of fact, no double-acting air-pump can be made to do the work of a well-designed single-acting vertical air-pump twice its capacity.

Indeed, sir, the whole article, including the sketch of a *horizontal* jet condenser, shows a charming innocence of things mechanical. Now, sir, there are hundreds of your readers who are engineers in addition to being electricians, and who will endorse every remark written above.

I should recommend the correspondent who sent you Question 478 to consult some standard work, such as Seaton's "Manual of Marine Engineering" or Hurst's "Hints on Engine Design."—Yours, etc.

E. COSGRAVE.

[N.B.—Would it not have been better if our correspondent had answered the question himself.—ED. *E. E.*]

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

487. Give details of the best method of regulating the direct-current E.M.F. of a rotary converter.—T.

488. Give a full description of the proper tests which should be applied to girder section steel tramway rails, say 100lb. per yard; also what results would be considered satisfactory from such tests.—G. W.

[N.B.—Will Mr. H. Taylor kindly forward to us his address.—ED. *E. E.*]

ANSWERS.

Question No. 481.—In a central station in which both batteries are temporarily disconnected, a 350-kw. machine and two 70-kw. steam balancers are on load (lighting and power) connected on + and − respectively of a three-wire system, the 350-kw. being across the outers, with its field excited from the negative 'bus bars. A slight load comes on to the − side, causing the volts on that side (−) to drop slightly; as the big machine and balancers are fully loaded up, another machine is ordered to be got ready. Before this can be done the volts on both sides suddenly drop to zero, and a total shut down is the result. How can this be explained, and could the shut down have been avoided? I might mention that the two 70-kw. steam balancers were self-exciting two-pole machines.

Best Answer to No. 481 (*awarded* 10*s.*).—The probable cause of the occurrence mentioned is the instability of the fields of the balancers. Very likely these are double-voltage machines giving any voltage between, say, 280 and 220 volts (supposing the station voltage to be 440 across the outers) by means of shunt regulators, the former voltage being employed when charging the cells and the latter when acting as balancers. When working at the lower voltage, as in the case under consideration, the magnet iron of the machines will be very far from saturated; thus, supposing the density in the iron to have a usual value of about 15,000 C.G.S. lines per square inch at the higher voltage, the figure for the lower voltage would only be about 12,000, and this value would lie on the straight part below the bend of the permeability curve for ordinary wrought iron or even cast steel. Any shunt dynamo working at this low density would be in great danger of losing its field—*i.e.*, of its volts dropping suddenly—if the machine is slightly overloaded or if the speed falls slightly.

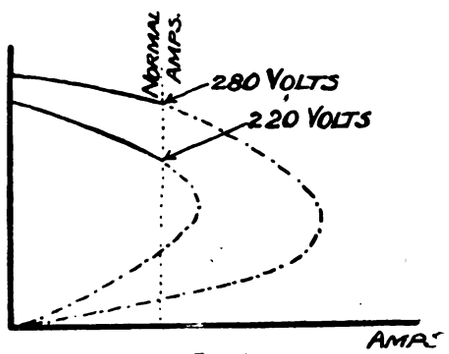

FIG. 1.

The way in which the characteristic (volt-ampere) curve of a shunt machine differs at the high and the low voltages is shown in Fig. 1. At the high voltage the machine will stand two or three times its full-load current before reaching the unstable point A, whilst in

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the case of the low voltage the unstable point B is reached with only a slight overload. When an additional load is thrown on to the negative side of the system, as described in the question, most of it naturally falls on the negative balancer, and this being in an unstable state, the slight addition, aided, perhaps, by a drop in speed due to the sluggish action of the governor on the negative balancer engine, would cause the unstable point on the curve to be reached. The balancer volts would then rapidly fall to zero, and its armature would become a short-circuit across the negative side of the system. At the same time the volts across the shunt of the 350-kw. generator, which is excited off the negative side, would fall and cause this generator also to lose its field. Even if it were excited across the + side or across the outers, it is highly probable that the excess load thrown on the main generator, due to the practical short-circuiting of the negative side by the negative balancer, would alone be sufficient to cause loss of field. Finally, the + side balancer, being practically short-circuited by the other two armatures, also loses its field. Even supposing that the balancers are not double-voltage machines the above occurrences might take place, but this is not very likely unless the machines are quite wrongly designed or unless the sudden increase in load is a large one.

With regard to the prevention of the recurrence of the accident, the simplest remedy consists in separately exciting all the machines (or, at least, the balancers) off the battery, even where the latter is not connected to the supply circuit, for separately excited dynamos are not troubled with unstable points in the same way that shunt ones are. A small auxiliary dynamo might be used for separately exciting the machines in place of the battery. If, however, this plan is not feasible, owing to the battery being wholly discharged or out of order, and no auxiliary dynamo being

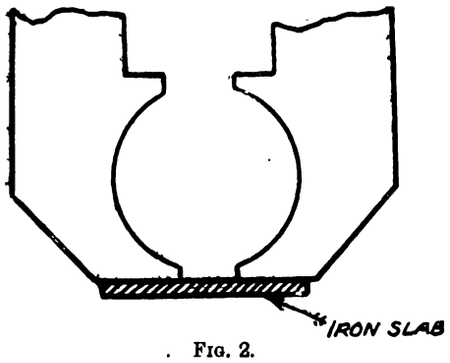


FIG. 2.

available, the balancers could be rendered more stable by fitting them with removable magnetic shunts (Fig. 2), which would be in use at the low voltage only to produce the volt reduction (from 280 to 220) by saturating the magnets in place of the usual method of reducing the exciting ampere-turns by means of a resistance. The magnetic shunt might be arranged to produce most of the volt reduction, and the field regulating resistance might be used for fine adjustments only. This arrangement would have the effect of making the machines, if anything, more stable at the low voltage than at the high, and there would be no likelihood of loss of field occurring at either voltage.—Q.

Answer to No. 481 (*awarded* 7*s.* 6*d.*).—The cause of the shut down mentioned by "R. M." would be due to the exciting current of the 350-kw. set being supplied from one side of the three-wire system (Fig. 1), instead of being connected across the outers (Fig. 2), and the drop in pressure due to the increase of load occurring on the side supplying this exciting current. If we assume a drop in pressure of, say, 10 volts in 200 between negative and neutral, it will mean a drop of 5 per cent. across the field of the 350-kw. set: but had this 10 volt drop occurred when field is connected across the outers, it would only mean a drop of 2½ per cent. The drop of the assumed 10 volts across the field of the large set would cause its voltage to drop considerably, the result being that the two balancers in series will reverse the direction of the current through the armature of the 350-kw. set, and thereby themselves become considerably overloaded, and, being shunt machines, will lose their volts. On the other hand, if the large set had been excited across the outers, it would not have been to any great extent affected by the drop on the negative side. To avoid the complete shut down, the rheostats in fields of negative balancer and large set should be opened up so as to keep proper pressure, but if all stops are cut out and speed of machines cannot be increased, then the most unimportant circuits on the negative side should be switched off until another set is coupled to bus bars, then

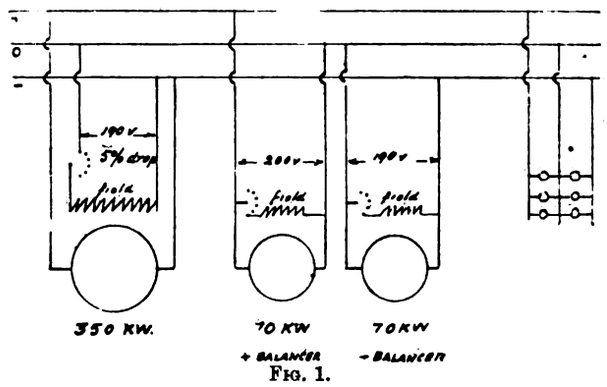


FIG. 1.

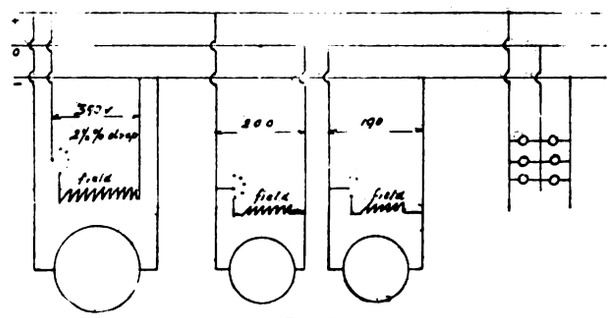
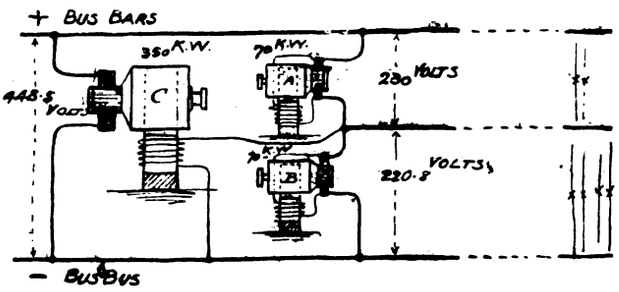


FIG. 2.

the circuits can again be switched in, and the balancers will only have to deal with the out-of-balance load. It would always be better to keep the battery connected up, as it is such handy plant to deal with out-of-balance or sudden load.—S. F. R.

Answer to No. 481 (*awarded* 5*s.*).—Let (C) represent the 350-kw. machine, and (A) and (B) the smaller machines on the (+) and (−) sides respectively; all



machines being steam driven. As stated in the question, the large machine and the two small machines are fully loaded up when there comes a small extra load on the (−) side. The following is the sequence of events:

1. The volts on (B) drop, let us say, by 2 per cent.—*i.e.*, from 230 to 225·4 volts.
2. The *fields* of both (B) and (C) are thereby reduced by, say, 1 per cent., depending on the state of magnetic saturation.
3. The *volts* of (B) are further reduced by 1 per cent.; ditto (C); due to (2).
4. The *field* of (B) is further reduced by, say, ½ per cent.; ditto (C); due to (3).
5. The *volts* of (B) are further reduced by ½ per cent.; ditto (C).
6. The field of (B) is further reduced by ¼ per cent.; ditto (C).
7. The volts of (B) are further reduced by ¼ per cent.; ditto (C); and so on.
8. So that if the fields of (B) and of (C) were in precisely the same state of saturation, the ultimate voltage drop on

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(B's) armature would be, say, 4 per cent., and on (C's) armature, say, 2 per cent.

Now, 4 per cent. on 230 volts is the same as 2 per cent. on 460 volts, so that no relative shift of load occurs between generator and balancers under these conditions.

9. But, *if (C's) field be more susceptible than (B's) field*, we may easily get, say, 2½ per cent. drop in (C's) volts for 4 per cent. in (B's) volts.

10. Now, 2½ per cent. on 460 – volts = 11·5 volts, and 4 per cent. on 230 – volts = 9·2 volts, giving an excess of voltage on the balancer system of 2·3 volts, (A's) volts volts remaining at 230.

For $C = 460 - 11{\cdot}5 = 448{\cdot}5$ volts;

$$A + B = 230 + (230 - 9{\cdot}2) = 450{\cdot}8 \text{ volts.}$$

11. Therefore, with the *commencement* of the fall in the volts of (B), the tendency is for (A) and (B) to snatch away all the load from (C).

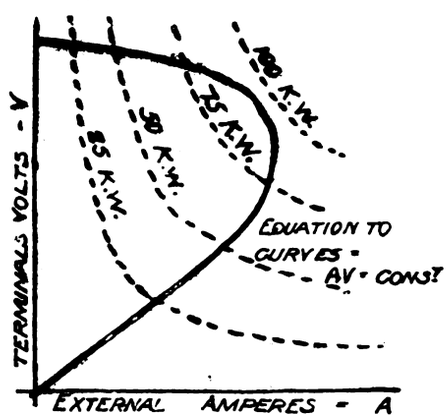
12. This would tend to put on (A) a load of three times its normal full load, and on (B) of more than this.

13. Consequently the drops in (B) and (C) would be largely augmented above those considered in paragraph 8, with the result that the two balancers would still further overpower (C), till they were pulled up and lost their fields and C's field together with them, the "minimum" automatics being also thrown, a shut-down ensuing.

Remedy.—Put (C's) field across the outers.—A. M. T.

Answer to No. 481 (*awarded* 5*s.*).—It is well known that, owing to the characteristic relation between external amperes and terminal volts in a shunt machine, the effect of overloading the generator is to cause the excitation to fail and the machine to cease work. This is the probable cause of the failure described.

The course of events may have been as follows: The slight increase of load on the negative side may have made the load on the negative balancer a little in excess of its limit of stability, and consequently this machine failed, since its exciting coil was placed across the machine terminals. This produced three effects: the system became unbalanced (the other balancer probably passing an excessive current in an attempt to restore balance), a part of the load was transferred from the steam-driven negative balancer to the main generator, loading this up to or beyond its limit of stability (for it was, before, fully loaded), and the armature of the magnetic balancer, having now no back E.M.F., forms a short-circuit between the negative and neutral bus bars. All the machines being shunt wound, it is an open question whether the positive balancer failed through excessive load and the main machine, running on two dead armatures in series across the bars, also failed; or whether the simple increase of load on the main set caused it to fail in the first instance, the remaining balancer shutting down afterwards.



The way to have prevented the accident was to have immediately strengthened the field of the negative booster if this were possible—*i.e.*, if all shunt resistance were not already withdrawn—in order to raise the limit of stability of the machine. If this could not be done, the best course would have been to pull off some of the load on the negative side by switching out one or more of the feeders until another generator had been put in. This would have to be done very promptly, however, in order to save the balancer, as a field once weakened in this way is very quickly overcome by the armature reaction. The mishap shows, by the way, the utility of a "floating" battery in a traction system to take care of sudden variations of load and the inadvisability of leaving too small surplus generating power at any time.—S. A. J.

Question No. 482.—Describe exactly how you would calculate the load factor of a lighting and traction station respectively, and in what way would the conditions for a maximum load factor differ in each case?

Best Answer to No. 482 (*awarded* 10*s.*).—The calculation of the load factor for a station which is in operation is comparatively easy. All we have to do is to take readings, say, every half-hour throughout the day, of the total kilowatts being generated by the machines and then plot these readings. We shall then get curves somewhat as in Fig. 1, according to the nature of the load on the station. Thus the load curve of a station on a private lighting load only would be represented by a curve something like A in Fig. 1.

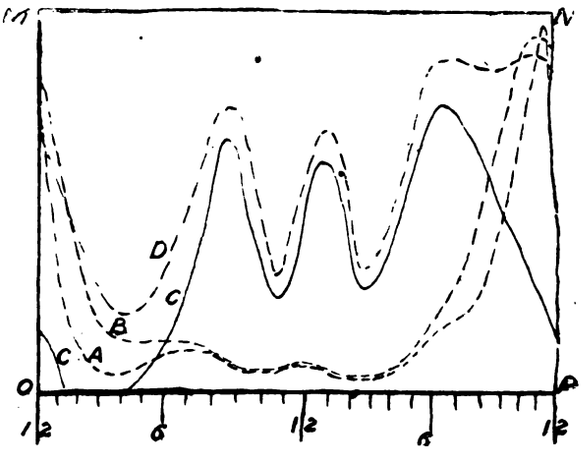


FIG. 1.

B represents a combined public and private lighting load, C is a traction load, and D a combined lighting and traction load. The shape of the curves hence depends very greatly on the special conditions of each case, and also on the time of the year and the weather, and in a mixed system on the percentage of the constituents. Let O M represent the maximum rate of output of the station in kilowatts. Then the area of the rectangle O M N P represents the maximum possible output of the station in kilowatt-hours during a day; also the area below the load curve represents the actual kilowatt-hours which have been generated. This can easily be found by a planimeter. And the load factor

$$\text{L F} = \frac{\text{energy generated}}{\text{maximum possible}} = \frac{\text{area below load curve}}{\text{area of rectangle O M N P}}.$$

To estimate the probable load factor of a station which has not yet started operations is more troublesome, and can only be done approximately. A careful canvass of the district must be made, and an estimate made of the approximate power which each intending customer will use at each hour of the day. These amounts must be added up and the load curve plotted as above. The total cost per kilowatt-hour generated may be divided up as follows: (*a*) coal; (*b*) oil, waste, water, and stores; (*c*) wages of workmen; (*d*) repairs and maintenance; (*e*) rents, rates, and taxes; (*f*) officials' salaries, legal and insurance expenses; (*g*) interest on capital and depreciation of plant. Now, the higher the load factor the greater the output of a given plant, hence items (*b*), (*c*), (*d*), (*e*), (*f*), and (*g*) are at once reduced, since although the actual sums of money devoted to these purposes remain about the same, the kilowatt-hours produced by them has gone up. Also (*a*) will be improved, since the plant will be working more efficiently as it is running nearer its full load. The effect of load factor on the cost per kilowatt-hour when generated is given in the following table by Mr. Philip Dawson for stations of not less than 2,000 kw. capacity. These total costs include all the items except the last (*g*).

The average load factors actually obtained in station work in England are about as follows: private lighting, 10 per cent.; public and private lighting, 12 to 15 per cent.; tramways, 15 to 20 per cent.; tramways and

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lighting, 20 to 25 per cent.; tubes and large power distribution stations, 25 to 30 per cent.

Load factor. Per cent.	Coal at 10s. per ton (*a*).	Total cost per unit generated.
10	·6d.	1·0d.
15	·5d.	·78d.
20	·4d.	·56d.
25	·35d.	·45d.
30	·32d.	·4d.
35	·3d.	·35d.
40	·26d.	·33d.
45	·25d.	·3d.
50	·24d.	·28d.
60	·22d.	·25d.
70	·19d.	·24d.
90	·16d.	·23d.

In order to have a good load factor we must try to comply with the following conditions: (1) Our station must contain just sufficient plant to be able to tackle the peak of the load when giving its maximum output. If, however, the peak is very sharp and high, we may meet it by overloading the plant for a short time. If we carry this too far, however, we may find ourselves unable to cope with any extra high peak which may at any time be caused by some particular set of circumstances (2) We should try to keep the peaks of the load curve as flat as possible—*i.e.*, the maximum demand lasting as long as possible. The most usual way of flattening out the peaks on the generator load curve is by the use of storage batteries. The cells are charged up when the load is light, and are then used to relieve the generators when the peak comes on. It is true that we lose some energy in the cells, but the generators are working with a higher mean and a lower maximum load—*i.e.*, with a higher load factor—and so they have a higher mean efficiency. We are thus enabled to use smaller generators, engines, and boilers, or fewer of them, but against this has to be put the cost of the batteries. As, however, the price of a battery is much less than that of engine and boiler plant, which would take the peak as well, we are enabled to cut down the first cost of plant considerably, and hence item (*g*) as well. Unfortunately, however, batteries are rather unreliable, and need a lot of attention; many engineers prefer to do without them if possible.

Something may be done in the way of improving the actual load factor of the station output by means of special tariffs to encourage customers to keep their maximum demand as low as possible. The usual systems of charging in vogue at present are as follows: (1) *flat rate*, comprising those in which a single price per unit is charged for lighting, or a discount is given not based on the "load factor value" of the customer; (2) *sliding scale*, including the Hopkinson system and discounts based upon the number of units consumed per lamp wired, etc.; (3) *maximum demand*, in which the price per unit charged varies directly as the maximum load taken, the lower the maximum the lower the price per unit.

The following results have been found by Mr. A. Baker by comparing these three systems on a large number of purely lighting load stations in England:

	Load factor. Per cent.	Year's lamp increase. Per cent.	Price per Kw.-hour.
Flat rate	12·57	25·2	1·92d.
Maximum demand	11·78	36·3	1·79d.
Sliding scale	11·85	29·13	1·8C3d.

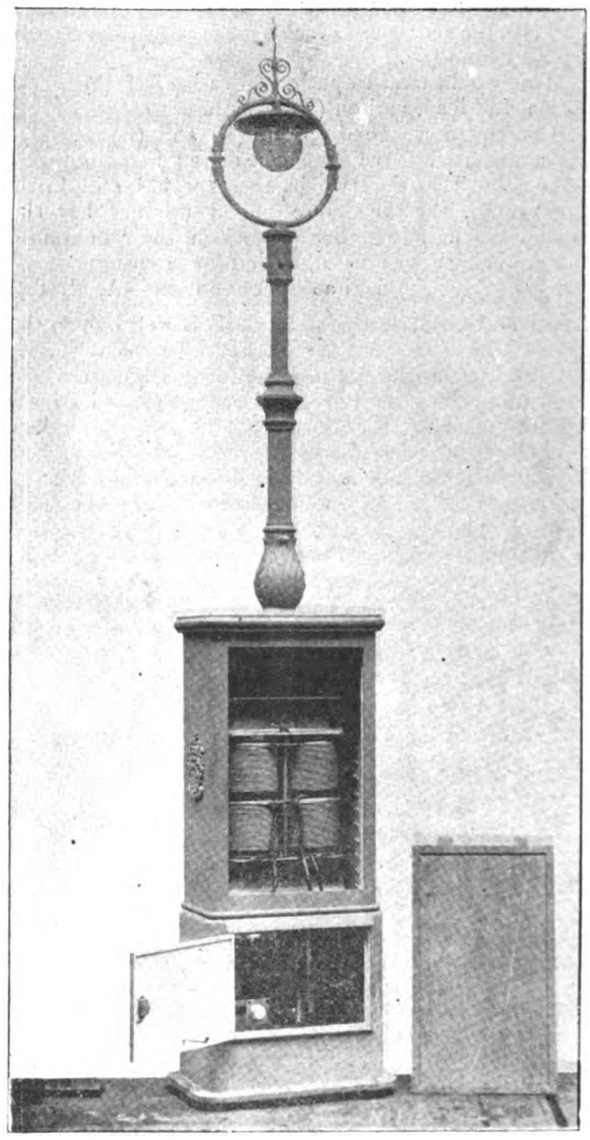
From this it appears that on the average the maximum demand system attracts the most new customers, but the flat rate gives the best load factor. We can, however, only take this table as indicating roughly the tendency of the different systems. In Canada the maximum demand system has been found to greatly improve the load factor.

It also usually improves the load factor to have several different kinds of load on the station. Thus any mixture of traction, lighting, and motor loads will have a better load factor than any one separately, since the maximum loads on each occurs at different times of the day. An additional motor load during the day is also a good thing in both traction and lighting stations, and especially good terms can be offered if the customer agrees only to take power during the light hours of the day. Something might also be done in the case of lighting stations to encourage the use of electricity for domestic purposes, such as heating and cooking.—T. SQUARE.

TRADE NOTICES AND NOVELTIES.

Wilkinson's Street Transformer Pillar and Lamp Standard.

We illustrate herewith one form of the Wilkinson's patent combination of a lamp column with an overground transformer box, which are being manufactured by Messrs. John Fowler and Co., of Leeds and London. The details of the apparatus are so clear that a full description is hardly necessary, but we may mention that all the pillars are designed to contain a 50-kw. transformer. Of course, a smaller transformer can be used when the works are first started, if it is so desired, in order to keep down the first cost or the hysteresis losses. In the lower compartment there are contained the high and low tension switchgear and fuses, which can be actuated when the door in front is opened. A similar door at the back gives access to a cable connection. On the low-tension side provision is made for four low-tension distributing circuits. To aid in getting the transformer into



The Wilkinson Transformer Pillar and Lamp Column as made by Messrs. John Fowler and Co.

and out of the case, a number of rollers are arranged in the support for the transformer. The pillars are efficiently ventilated and thoroughly protected against rain. In fact, these boxes contain every detail that is required for a permanent arrangement of a transforming station above ground at a much less cost than is necessitated by the ordinary sub-station.

Electric Cranes.

For operating travelling cranes the electric motor has no rival which can be at all seriously considered. This fact is clearly shown by glancing through the electric crane list of Messrs. Royce, Limited, of Manchester. The major portion of this is devoted to illustrations of cranes already at work, and to descriptions and specifications of the numerous different types of electric cranes manufactured by the firm. These vary from the large Goliath crane, illustrated herewith, which was erected by the company in the goods yard of the Great Central Railway at St. Marylebone, down to small jib cranes used for working in shops to facilitate the rapid handling of materials. The advantages which electricity has for this class of work are exceedingly numerous, and a travelling crane equipped with three motors, one for each motion, is a means of saving a huge sum per annum in establishment charges in large engineering works. Not only is the crane able to do this work quickly, but there is the

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resultant advantage that there is not the waiting for the use of the traveller. For large outdoor work, such as that of the Goliath in

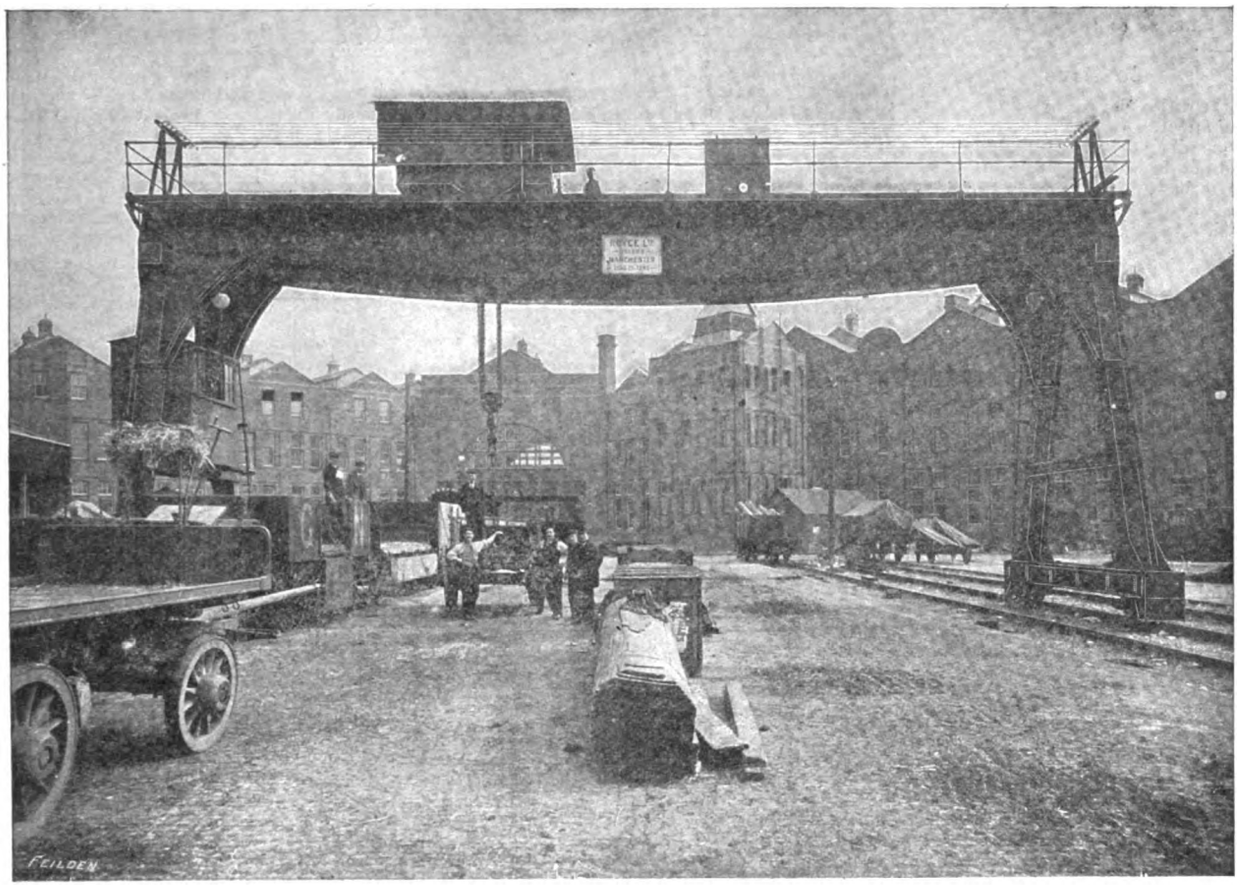

FIG. 1.—25-ton Goliath Crane, by Messrs. Royce, Limited.

Fig. 1, there is the great additional advantage that there is no interval required in starting up, as is the case with steam-driven cranes, in which a boiler fire has to be lighted and steam got up In Fig. 2 we give an illustration of a 20-ton electrical crab made by this firm. In connection with the brake on this, which is worked from the solenoid

Special Track Work.

Messrs. Askham Bros. and Wilson are noted for the excellency of the special track work for tramway purposes. The need for this class of goods in connection with tramways has been much more keenly felt since the introduction of electric traction, involving heavier cars

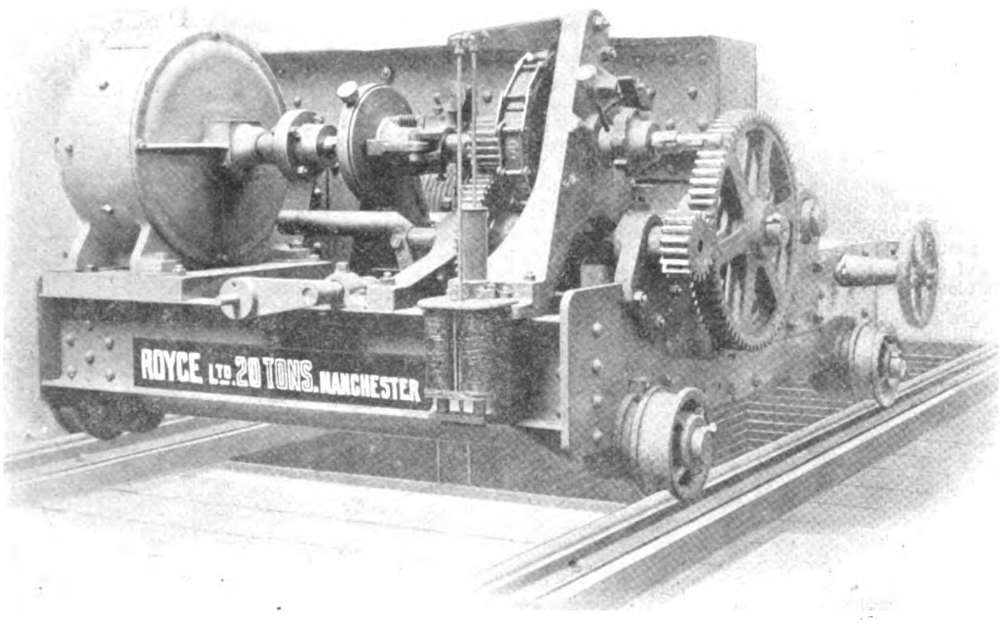

FIG. 2.—Electrical 20-ton Crab, made by Messrs. Royce, Limited.

seen in the foreground, a dashpot is provided to prevent the brake being too suddenly put on when the current is interrupted. This oil dashpot prevents the kinetic energy of the motor armature unduly straining the gearing, as would be the case were the brake jammed on while the motor was still going at full speed. From the specifications given elsewhere in the catalogue in question one sees that the firm take great care in selecting the most suitable materials for the various parts of their cranes.

moving at higher rates of speed. The firm in question have specialised in the department, and make a practice of erecting all the special work ordered from them in their own shops before delivery. The advantage of this course will be obvious to all engineers, as it avoids the costly alterations which otherwise may have to be carried out on the road. It also tends to reduce the time very largely during which

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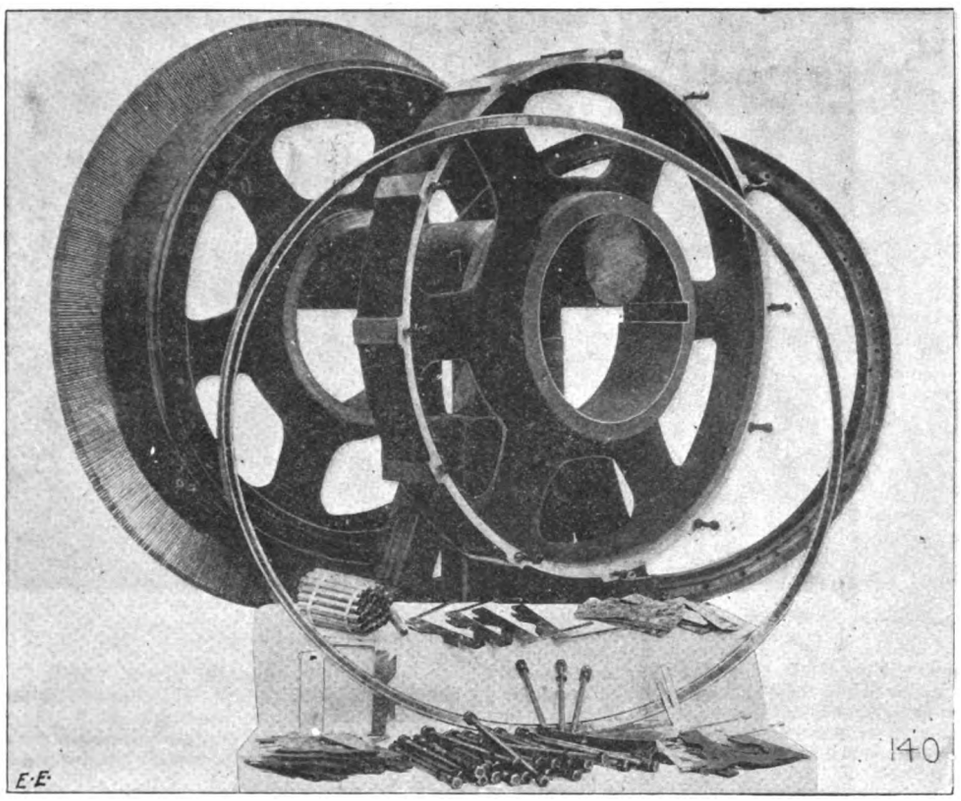
the streets have to be left opened out, and in this way saves great inconvenience to the public. The recent list issued by Messrs. Askham Bros. and Wilson of their special track work should find a place amongst the literature of all tramway engineers. It contains a number of illustrations of work previously carried out by the firm, from which useful hints as to the design of special work in other towns can be gleaned.

Continuous-Current Generators.

In the earlier days of electrical engineering the details of construction of armatures and commutators were looked upon as trade secrets to be guarded with the utmost care, in order that rivals in manufacture should not derive benefit from the same. In this respect times have changed, but it is not often that so much technical information is given away as appears in the illustrated book recently issued by the English Electric Manufacturing Company, of Preston. The book, which is entitled "Continuous-Current Generators," is exceedingly well illustrated, and discloses practically every detail in the manufacture of the machines in question. In this case there is no price-list or catalogue of sizes included, and the book deals only with the details of construction. We have recently published a short description of the two large dynamos made by the above firm, and supplied through their sole agents, Messrs. Dick, Kerr, and Co., to the Bolton Corporation. There is, therefore, no need to again give the details we then published, but through the courtesy of the firm we are able to give the accompanying block, illustrating the various parts which go to form a commutator of one of these direct-current generators. Although the block may not be quite so clear as the photograph from which we had it prepared, the method of construction can be clearly seen. For instance, in the commutator sections the design is such that the individual segments of copper are supported both against centrifugal force and against a blow which would tend to make one bar recede inwards. In the book before us the other items of construction, such as the armature windings, the brush gear, the building up of the armature core, are illustrated in much the same way. We presume that the object the firm have in circulating so much information is to bring the excellency of their manufactured articles to the notice of those engineers who have orders to place, and we know of no better way of influencing business.



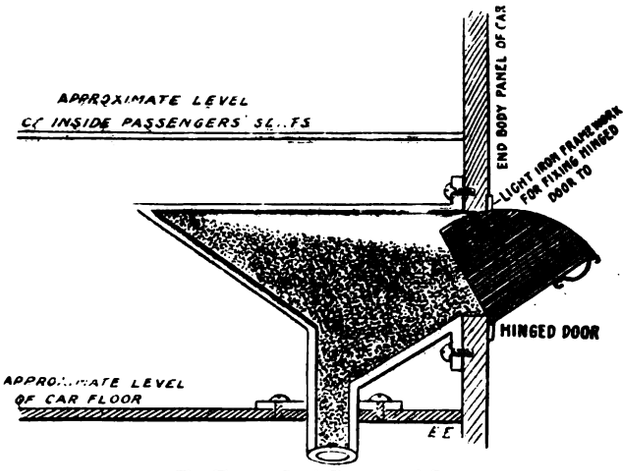
Complete Commutator and Commutator Parts as used by the English Electric Manufacturing Company.

Electroliers.

The Edison-Swan United Electric Lighting Company have recently issued a small list of their latest designs in electric light fittings. The main feature which a general perusal of the same gives is that the modern tendency is towards simple designs with an oxidised silver finish rather than the old florid brasswork. Hammered ironwork also figures prominently in the list in question, while a good number of the fittings have an armour-bright finish. From the illustration we should say that a visit to the showrooms of the company to see these new types would be well repaid.

The Thomas Sand-box for Tramcars.

We illustrate herewith an arrangement of a sand hopper or box on the tramcar which has been designed by Mr. H. N. Thomas, the engineer and manager of the Huddersfield tramways, and for which he has applied for patent protection. It is from Huddersfield that one would look for improvement in connection with the sanding gear in connection with tramcars owing to the exceedingly hilly nature of the tramway routes in that town. It is not in this case a question of heavy grades for a few yards only, but of long hills, which give rise to excessive speeds and disastrous accidents if once a tramcar gets out of control. As a consequence, a good deal more sand is required than is the case on ordinary lines, and the need arises of introducing more sand into the boxes in the course of the day's run. With the ordinary type of box this involves the lifting of the cushions or the seats of the car. In view of the accident which happened some years ago with a runaway steam tramcar in Huddersfield, a sudden request on the part of the conductor to the passengers to stand up so that he may refill an empty sand-box is not reassuring, and apt to cause a slight panic. It will be seen from the illustration that the hopper designed by Mr. H. N. Thomas avoids this risk, and at the same time renders the refilling operation much more simple. In this case the hopper sand-boxes are refilled through the panels at the ends of the car by either the conductor or the driver while standing on the end platforms. This construction has a number of indirect advantages quite apart from the details of design, which give great strength and rigidity to the sand-box. One of these advantages is that the sand is not spilt inside the car or over the motors, where it is likely to cause inconvenience to the passengers and damage to the running gear; also, there will be no sand spilt on the cables used to connect up the motors to the controllers. Mr. Thomas informs us that the first cost and maintenance of the new type of sand-box is low, and that they are more durable than the older types. The hinged door through which the sand is introduced is made to match the rest of the car, and secured in position with a fancy scroll brass handle. The door is, therefore, hardly noticed when inspecting the car, and yet is exceedingly handy to the driver or conductor. It may interest our readers to know that, with the increase of load on the tramways works at Huddersfield, Mr. Thomas has already got his cost of generation per unit down to ·345d., and that as the daily output will shortly be increased, this figure must not be looked upon as being at all final as far as lowness of cost is concerned.



The Thomas Sand Hopper and Box.

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BURTON-UPON-TRENT ELECTRICITY WORKS.

Herewith we give the electric lighting revenue account of Burton-upon-Trent for the year ended March 31, 2902, which we have received from Mr. F. L. Ramsden, the manager and engineer of the works:

Dr. Expenditure.	£	s.	d.	£	s.	d.
Coal and other fuel	£359	10	6			
Oils, waste, etc.	96	15	5			
Wages	1,168	3	9			
Repairs and maintenance	101	2	9			
				1,725	12	5
Repairs of mains and services	40	10	0			
Repairs of meters	6	12	10			
				47	2	10
Rents, rates, and taxes				78	11	7
Salaries				170	0	0
Establishment charges				49	4	5
Insurances				12	3	0
Bank interest and commission				686	14	2
Stock dividends				867	13	7
Stock contributions				1,015	8	11
				4,652	10	11
Balance—income over expenditure				545	6	8
				£5,197	17	7

Cr. Income.	£	s.	d.
Sale of energy	4,995	12	2
Meter rents	179	8	5
Fittings	22	17	0
	£5,197	17	7

Units consumed during year, 241,534.

TAUNTON ELECTRICITY ACCOUNTS.

In the accounts of the Taunton Corporation electricity works for the year ended Dec. 31, 1901, the total expenditure on capital account is given as £52,586. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are given below:

Dr. Revenue Account.	£	s.	d.
Generation of electricity	2,380	13	9
Repairs and maintenance	150	18	7
Distribution of electricity	89	13	8
Attending and repairs of public lamps	290	5	3
Royalties—free wiring	291	13	0
Rents, rates, and taxes	131	14	5
Management expenses, etc.	836	16	1
Special charges—insurance, etc.	820	7	4
Total expenditure	4,991	12	1
Carried to net revenue account	2,680	14	1
	£7,672	6	2

Cr.	£	s.	d.
Sale of current per meter	4,068	2	5
Tramways company for current	204	13	2
Public lighting	2,242	6	9
Rental of meters and other apparatus	209	3	3
Rents receivable	5	4	0
Sundry installations and sales	842	16	7
Sale of machinery displaced by arc rectifier plant	100	0	0
	£7,672	6	2

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount of redeemable debenture stock	27,066	15	9
Temporary loan	15,500	0	0
Sundry creditors	1,505	12	4
Balance at credit of net revenue account	75	15	8
Stock redemption fund account	4,466	3	0
Balance at credit of repayment of loans account	824	13	0
Balance at credit of reserve fund account	700	0	0
Amount due to treasurer	12,486	11	1
	£62,625	10	10

Cr. Assets.	£	s.	d.
Capital account—amount expended	52,585	19	10
Discount on stock issued	506	15	9
Stores on hand	357	8	2
Sundry debtors for current supplied	2,548	14	6
Other debtors	450	8	2
Stock redeemed and stock redemption fund	4,466	3	0
Suspense account	498	11	3
Balance at debit of motor purchase account	1,206	0	7
Cash in hand	5	9	7
	£62,625	10	10

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units			582,672
Quantity sold: Public lamps	137,040		
Quantity sold: By contracts	840		385,907
Quantity sold: Private consumers by meter	248,027		
Quantity used on works			98,202
Total quantity accounted for			484,109
Quantity lost in mains, transformers, etc.			98,563
Total maximum supply demanded (kilowatts)			435

Number of public lamps: arcs, 72; incandescent, 8 50-c.p., 17 32-c.p., 168 16-c.p., 32 8-c.p.

KINGSTON ELECTRICITY WORKS.

In his eighth annual report on the past year's working of the electricity undertaking, Mr. J. E. Edgcome, the borough electrical engineer, says: "I greatly regret I should again have to present to the committee an unsatisfactory balance-sheet. For three months of the period embraced by this report, owing to the contract then in force, the heavy price of coal was maintained, and as the economy effected by the chain grate stokers and condensing plant was only felt for a few months, it has not had a very appreciable effect on the coal consumption. The amount spent on fuel has been reduced by £680. 9s. 2d. (from £4,236. 6s. 8d. to £3,555. 17s. 6d.), whereas the total number of units sold has increased by 37,472 (from 308,860 to 346,332)—that is to say, the average cost per unit for fuel has been reduced from 3·291d. to 2·464d. The total works expenditure has been reduced by £551. 13s. 7d. (from £6,387. 17s. the previous year to £5,836. 3s. 5d.), whereas the total revenue has increased by £816. 5s. 9d. (from £6,562. 11s. 4d. to £7,378. 17s. 1d.). The profit on the works before payment of interest and repayment of capital has increased by £1,367. 19s. 4d. (from £174. 14s. 4d. to £1,542. 13s. 8d.). The amount for payment of interest has increased by £310. 1s. 4d. (from £1,434. 3s. 5d. to £1,744. 4s. 9d.), and the amount for repayment of capital has increased by £631. 14s. 8d. (from £1,461. 12s. 7d. to £2,093. 7s. 3d.), although as yet a portion of this capital expenditure has not earned any revenue. The result of the year's working, after payment of interest and repayment of capital, is a debit balance of £2,294. 18s. 4d., as against £2,721. 1s. 8d. during the previous year. As pointed out in previous reports, the heavy costs of repayment of principal, which have to be met before the plant has commenced to be remunerative, bears very heavily upon municipal electrical undertakings, and I am glad to say that very strong representations have now been made to the Government authorities, and it is hoped that such representation will be favourably considered at an early date, and that all provincial municipal electrical undertakings will be placed on the same footing as certain metropolitan municipal undertakings, which are allowed for two or three years to make their repayment of principal on new work out of capital. The number of consumers during the 12 months has increased from 376 to 458, an increase of 82, as compared with an increase of 65 during the preceding year. The number of 8-c.p. lamps connected has increased from 18,899 to 22,885, an increase of 3,986, as against 2,769 in the preceding year. By means of the deferred payment system of house wiring, which the committee have adopted, and have carried out in a few instances, I confidently hope that a very substantial increase in the number of consumers will be made, and I hope the committee will see their way to adopt in certain cases a system of prepayment slot meters, which I feel sure would prove very popular with a large class of inhabitants, and whilst being convenient to the consumer, would be remunerative to the Corporation, and tend to largely augment the number of lamps connected to the mains."

LEGAL INTELLIGENCE.

IS A TRAMWAY A RAILWAY?

A case in the Court of Appeal (consisting of the Master of the Rolls and Lords Justices Mathew and Cozens-Hardy) on Tuesday raised an important question under the Workmen's Compensation Act as to whether a tramway is a "railway" within the meaning of the statute. It was an appeal from the refusal of the late Judge Bagshawe to award the applicant compensation for personal injuries sustained while in the employ of the London United Tramways, Limited. Mr. J. A. Compton argued the case for the appellant, and Mr. Ruegg, K.C., for the respondent.

The **Master of the Rolls**, in giving judgment, said the workman met with the accident on a line which came to be constructed under different statutory provisions at different parts of its length. At one part it was a light railway, and at another an electric tramway; or, at all events, was not brought under the light railway regulations. The particular part where the accident happened was what was known as an electric tramway line. In his opinion, however, an electric tramway should be regarded as a "railway." The appeal, therefore, must be allowed with costs.

The Lords Justices concurred.

SPEED OF THE GLASGOW TRAMCARS.

At Glasgow last week Sheriff Fyfe heard a complaint at the instance of Thomas Simpson, coalmaster, of Pollokshields, setting forth that the Corporation of the city of Glasgow had contravened Article 6 of the regulations made by the Board of Trade, in so far as on the tramway in Albert-road on Feb. 17 and 18 last they drove and propelled six

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cars (none of the said cars having been fitted with speed indicators, in terms of the regulations) at a speed exceeding the maximum of eight miles an hour.

It was stated in evidence in support of the complainer's case that the speed of the cars varied from 10½ up to 19½ miles an hour.

The **Sheriff**, in giving judgment, said this case lacked two essential elements in order to bring the facts up to the contravention charged. The one was that it should be proved as a matter of fact that the cars in question were the property of the respondents, the Corporation of Glasgow, and at the time the speeds averred were being run by the servants of the Corporation. The other point was that it must be proved as a matter of fact that the cars in question were not fitted with speed indicators. While both were technicalities, they were dealing here with a criminal complaint under the Summary Jurisdiction Act, and, unless the facts proved were sufficient to support the averments, he had no alternative but to find the charge not proven, which he did.

COMPANIES' MEETINGS AND REPORTS.

MERTHYR ELECTRIC TRACTION AND LIGHTING.

The directors in their report for the year 1901 state that the total capital expenditure to Dec. 31, 1901, amounted to £86,850. 9s. 3d. The gross receipts on the tramways from April 6 (the date upon which the lines were opened for traffic) to Dec. 31, 1901, amounted to £9,587. 3s. 4d., and the gross receipts on account of electrical supply from July 22 amounted to £2,104. 17s. 8d., making, with £80. 3s. 9d. sundry receipts, a grand total of £11,772. 4s. 9d. After deducting expenses amounting to £7,129. 6s. 9d., and £1,434. 12s. 3d. for debenture and other interest, there remains a net profit of £3,208. 5s. 9d. The directors propose that this amount should be applied as follows—viz.: to pay dividend on the cumulative preference shares to Dec. 31, 1901, £862. 10s.; to be placed to reserve and depreciation fund, £1,000; to dividend on the ordinary shares at the rate of 4s. per share, equal 5½ per cent. per annum, £1,200; to be carried forward to next account, £145. 15s. 9d. The number of private consumers now connected with the mains represent a demand equivalent to 4,313 lamps of 8 c.p. This department of the business continues to make satisfactory progress.

ABSTRACT OF WORKING ACCOUNT (Lighting Section).

Dr.	£	s.	d.
Generation of electricity	1,278	15	11
Repairs and maintenance	48	3	0
Distribution of electricity	14	17	0
Balance carried to profit and loss account	763	1	9
	£2,104	17	8

Cr.	£	s.	d.
Sale of current per meter	631	12	0
Current supplied to traction section	1,451	8	2
Rental of meters and other apparatus	12	12	6
Sale and repairs of other apparatus	9	5	0
	£2,104	17	8

Dr. WORKING ACCOUNT (Traction Section).	£	s.	d.
Power and running expenses	3,847	6	5
Repairs and maintenance	732	2	10
Balance carried to profit and loss account	5,007	14	1
	£9,587	3	4

Cr.	£	s.	d.
Traffic receipts	9,493	2	1
Advertising receipts	94	1	3
	£9,587	3	4

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Administration and general expenses	1,208	1	7
Debenture and other interest	1,434	12	3
Balance carried to balance-sheet	3,208	5	9
	£5,850	19	7

Cr.	£	s.	d.
Balances from working accounts	5,770	15	10
Sundry receipts	80	3	9
	£5,850	19	7

MEXICO ELECTRIC TRAMWAYS.

The report of the directors states that from Jan. 1, 1901, the system has been worked by this Company under the terms of the lease entered into with the Compania de Ferrocarriles del Distrito Federal de Mexico. The result of the operations for the year, after charging the interest on the debentures of the Compania de Ferrocarriles del Distrito Federal de Mexico, and the 3½ per cent. guaranteed on the share capital under the terms of the lease, shows a net profit of 9,284·34dol., which at the rate of exchange of 22½d., gives £870 to be carried to the credit of the London profit and loss account. The interest received on the debentures of the Compania de Ferrocarriles del Distrito Federal de Mexico held by this Company, and the dividend declared by that company on its share capital is then added, and, after charging the various expenses and obligations against same, a net balance is shown to the credit of profit and loss account of £16,662. After paying the preference dividend there is £4,306 available, which, together with £2,227 brought forward, makes £6,533 to be carried forward. During the year a further 200,000 6 per cent. cumulative preference shares of £1 each has been issued at par, in order to provide the necessary funds for construction purposes, leaving 112,987 shares still unissued, the proceeds of which will be devoted to construction and further extensions. The Company's service now extends over 251 km. of track, The number of passengers carried during the past 12 months was 26,709,225, being an increase of 39,165, and the receipts amounted to £209,136, an increase of £5,259, which was partly made up of increased freight returns. The operations during the year did not, from perfectly unavoidable causes, realise the anticipations of the directors. The past year has been one of the worst in the commercial history of Mexico. The outlook, however, is distinctly encouraging.

BELLISS AND MORCOM.

The report of the directors for the year ended March 31 states that the profit for the year, after making ample provision for depreciation, etc., and after payment of the preference dividend, amounts to £32,853. The directors have already distributed an interim dividend on the ordinary shares at the rate of 5 per cent. per annum. They now propose to pay a further dividend, making 12½ per cent. for the year, to place £10,000 to the general reserve fund, and to carry forward the balance, together with the amount brought forward from the preceding year. The directors have made a further issue of preference shares; these have been placed at a premium, which has been added to the reserve fund.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Falkirk.—The Town Council will shortly advertise for tenders for piping and cables.

Nuneaton.—The Urban District Council invite tenders for a water-tube boiler and pipework. Tenders by 18th inst.

Shanghai.—The last day for receiving tenders for the proposed municipal tramway and motor 'bus service is June 30.

Sophia (Bulgaria).—The General Post Office require tenders for £2,000 worth of telephone and telegraph material. Tenders by June 9.

West Ham.—The Council invite tenders for 50 double-deck electric tramcars, complete with electrical equipment. Tenders by July 8. See advertisement.

Manchester.—The Tramways Committee invite tenders for the supply of line materials, trolley wire, etc., for overhead equipment. Tenders by June 14. See advertisement.

Bristol.—The Electrical Committee invite tenders for feed and general service pumps, water-softener, and tank coke filters and pipework. Tenders by June 20. See advertisement.

Valparaiso.—The Municipality are inviting tenders for electric lighting and tramways. We understand that particulars may be obtained from the Chilian Consul. Tenders by Sept. 1.

Bury.—The Tramways Committee invite tenders for the supply and delivery of rails and fishplates, fishbolts and nuts, tiebars, points and crossings, and sole or anchor plates. Tenders by June 24.

Walsall.—The Corporation invite tenders for the supply and erection of a reversible booster and switches, to work in series with a battery on a tramway circuit. Tenders by June 27. See advertisement.

Brighton.—The Town Council invite tenders for the supply of 300 tons of steel girder tramrails. Specifications, etc., may be obtained from Mr. Thos. B. Holliday, tramways engineer, Lewes-road, Brighton. Tenders by June 9.

West Ham.—The Corporation invite tenders for the construction of about eight miles of route length of tramways. Specifications, etc., may be obtained from the offices of Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster. Tenders by June 10.

Brighton.—The Town Council invite tenders for the supply of points, crossings, tiebars, bolts, and other fittings. Specifications, etc., may be obtained on application at the office of Mr. Thos. B. Holliday, tramways engineer, Lewes-road, Brighton. Tenders by June 9.

Warrington.—The Corporation invite tenders for the following: (Section 11) tramcars, with motors and electrical equipment complete. Specification, etc., may be obtained at the offices of Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W. Tenders by June 18.

Launceston (Tasmania).—The Corporation invite tenders for polyphase generating, transmitting, and distributing plant and apparatus, transforming apparatus, reconstruction of existing plant, and enclosed arc lamps and accessories. Tenders by Sept. 15. See advertisement.

Kirkcaldy.—The Corporation invite tenders for wiring the central station. Specification, etc., can be obtained from Mr. Wm. L. Macindoe, town clerk, or seen at (but not obtained from) the office of Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. Tenders by 21st inst.

Manchester.—The Tramways Committee invite tenders for: (a) chilled cast-iron car wheels and axles; (b) lamp glasses for cars. Specifications may be obtained from Mr. J. M. McElroy, general manager tramways department, 55, Piccadilly, Manchester. Tenders by 1 p.m. on 14th inst.

Stretford.—The District Council invite tenders for the following in connection with its scheme for supply of electrical energy: Steam-raising plant, comprising boilers, superheaters, economisers, etc.;

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generators, comprising engines, dynamos, condensers, pumps, etc.; and mains. Tenders by June 18. See advertisement.

Tonbridge (Kent).—The Urban District Council invite tenders for the fitting-up of an electric light installation in their electricity works. Specification, etc., may be obtained at the offices of Mr. Robert Hammond, M.I.C.E., consulting engineer to the Council, 64, Victoria-street, Westminster, London, S.W. Tenders by June 9.

Astrachan.—Erection of electric generating station and installation of public and private lighting, commencing with 150 arc and 6,000 incandescent lamps. Manufacturers who will undertake to finish the work within two years can obtain particulars from the Municipality. Agents will not be able to tender. Tenders by June 7-20.

Ipswich.—The Corporation invite tenders for the supply, delivery, and erection at the generating station, Constantine-road, Ipswich, of engines and dynamos, storage battery, overhead hand travelling crane, feeders, mains, and road work, permanent-way construction of tramways, and arc lamps. Tenders by July 5. See advertisement.

Little Woolton.—The Urban District Council invite tenders for (1) supply, laying, and jointing of cables and the supply and fixing of junction boxes and lamp connections: and (2) supply of lamp fittings. Specification, etc., may be obtained from the surveyor, Mr. Richard Simmons, Grange-lane, Gateacre, near Liverpool. Tenders by 20th inst.

Stockton-on-Tees.—The Corporation invite tenders for the supply, delivery, and erection of one 300-kw. steam generator, two Lancashire type boilers, one switchboard panel and instruments, surface condenser and cooling plant, pipework and valves, extension feeders, and mechanical stokers, economiser, and feed pump. Tenders by June 17. See advertisement.

Rotherham.—The Corporation invite tenders as follows: (Specification No. 12) tramway and lighting feeders, mains, and other cables, with roadwork; (13) boilers—first extension, consisting of three Lancashire boilers, with mountings, erected complete; (14) additional steam dynamo, with normal output of 320 kw., erected complete. Tenders by June 17.

Bury.—The Tramways Committee invite tenders for the work required in the construction of the permanent way in several parts of the borough—viz.: Fairfield section, Bolton-road section, Heywood-street and Knowsley-street sections. Specifications, etc., can be obtained on application at the office of Mr. Arthur W. Bradley, borough engineer and surveyor. Tenders by June 24.

York.—The North-Eastern Railway Company invite tenders for the following articles in such quantities as they may require during six months ending Dec. 31, 1902, delivered (carriage paid) at the telegraph stores at York: telegraph apparatus and telegraph wire and line stores. Particulars may be obtained on application to Mr. Graves, Telegraph Department, York. Tenders by noon on June 9.

Worthing.—The Corporation invite tenders for the erection of a circular brick chimney shaft for their electric generating station, High-street, Worthing, 140ft. high from the ground level and 7ft. 6in. inside diameter at the top (the Corporation will construct the foundations and other brickwork to the ground level). Full particulars can be obtained on application to the Borough Surveyor, Municipal Offices, Liverpool-road, Worthing. Tenders by June 16.

Rotherham.—The Corporation invite tenders for the following materials: 2 pairs of cable jacks; 1 hand cart; 1 watchman's box; 200 yards of fencing chain with spikes; 1 tar boiler; 1 portable Weston voltmeter, with case, ranging from 0 to 300 and 0 to 600 volts; set of 6 Crosby indicators complete, with accessories and case; set of stocks and dies: 300 yards of ·1 - ·05 - ·1 triple-concentric Callender's vulcanised-bitumen sheathed cable; 250 yards of ·035 concentric cable, as above; 500 yards of ·022 ditto; 500 yards of ·012 ditto; 50 service boxes; 50 fuse boxes; 10 tons of bitumen. Tenders by 14th inst.

RESULTS OF TENDERS.

Southampton.—The tender of Butler and Co. has been accepted for an 18in. shaping machine, at £142, less 2½ per cent. discount.

Ilkeston.—The Tramways Committee have accepted the tender of Moss and Sons, of Loughborough, for the construction of car-sheds at £6,950.

Eccles.—The tender of Chapman, Hollinworth, and Son to erect a wall 9in. in thickness at the generating station, at £100, has been accepted.

Worcester.—Messrs. Fownes Bros. have accepted the tender of Willans and Robinson, of Rugby, for one of their standard compound engines for mill-driving.

Colchester.—The tender of the Oak Building Company, Cambridge, at £2,242, has been accepted for the works in connection with the extension of the electricity station.

Birmingham.—Messrs. Dunlop and Co. have accepted the tender of Willans and Robinson, of Rugby, for two 250-h.p. engines for direct coupling to dynamos for electrical power purposes.

The Underground. — The Metropolitan and District Electric Traction Company, Limited, have placed the order for the storage battery for their electric traction scheme with the Electrical Power Storage Company, of 4, Great Winchester-street, London, E.C.

Manchester.—The Chamber Colliery Company, of Hollinwood, have accepted the tender of Willans and Robinson, of Rugby, for one of their standard compound engines for direct coupling to a dynamo for supplying power for electrical coal-cutters and other motors about their colliery.

Shipley.—The tender of the Westinghouse Company for the supply of 30 carrier lamps of the Bremer type has been accepted, and arrangements made with the Anchor Cable Company to send an expert to superintend the cable-laying, a two years' guarantee to be given on the completion of the work.

Hull.—The tenders of Belliss and Morcom, Birmingham, for an additional engine for the power station, at £1,774, and the tender of Siemens Bros. for additions to the switchboard, at £184, have been accepted. The clothing for the tramway drivers and conductors is to be supplied by R. S. Burn, and that of the inspectors by Clarke and Son.

Mansfield.—The tender of Crompton and Co., Limited, Salisbury House, London wall, E.C., at £2,486, has been accepted for the construction and erection of the following plant for the municipal electricity works: (Section I.) pipework, valves, and tanks—steam, exhaust, water, and other pipes, valves, tanks, footplates, and accessories.

Poplar.—The following tenders have been received for the electric wiring and fittings at the Guardians' offices: A. H. Marshall and Co., £289. 10s. (accepted); F. Cramer and Co., £407. 8s.; W. Simmonds and Co., £407. 18s.; C. H. Cathcart and Co., £585; E. Ryan and Co., £679. 13s.; Jackson Bros., £507; London Electrical Engineering Company, £998; Geipel and Lange, £756; Laurence and Co., £514; Pitford and Estall, £463. 15s.

Hammersmith.—The Council have accepted the following tenders: Pain and Son, Walworth-road, for decorating the Broadway and Shepherd's Bush-green, and for illuminating such decorations on Coronation Day and the following day, £257; J. E. Spagnoletti and Co., Goldhawk Works, Goldhawk-road, for electrically illuminating the town hall and Shepherd's Bush library, £212. The illumination of the Starch Green Pond enclosure is to be carried out by the borough electrical engineer at a cost not exceeding £35.

Fulham.—The Borough Council have received the following tenders for the supply and erection of a 600-kw. steam alternator:

			A.
Allgemeine Electric Company, Allen engine, A.E.G. dynamo	£3,885	...	22·5
Bruce Peebles and Co., Allen, P.P.P	3,915	...	27·0
Witting Bros., Allen, Belgian	3,940	...	26·7
British Westinghouse Co., Allen, Westinghouse	3,942	...	27·31
W. H. Allen, Son, and Co., Allen, Westinghouse	3,955	...	27·0
Ditto, Allen, Witting	4,011	...	27·0
Ditto, Allen, B.T.-H.	4,013	...	27·0
Johnson and Phillips, Allen, J. and P.	4,021	...	27·4
Dick, Kerr, and Co., Allen, E. E. M. Co.	4,024	...	26·2
W. H. Allen, Son, and Co., Allen, Ferranti	4,028	...	27·0
Ferranti, Allen, Ferranti	4,063	...	27·0
Geipel and Lange, Allen, Brown-Boveri	4,076	...	28·0
British Thomson-Houston Company, Allen, B.T.-H.	4,083	...	26·75
Mather and Platt, Allen, M. and P.	4,110	...	27·25
General Electric Company, Willans, G. E. Co.	4,125	...	25·9
Rosling and Fynn, Allen, R. and F.	4,125	...	27·5
Richardsons, Westgarth, and Co., Allen, Brown-Boverie	4,140	...	27·0
Lahmeyer Electrical Company, Allen, Lahmeyer	4,160	...	27·5
Lancashire Dynamo Co., Allen, L. D. and M. Co.	4,200	...	26·4
General Electric Company, Allen, G. E. Co.	4,280	...	26·8
Rosling and Fynn, Allen, R. and F.	4,375	...	27·75
Siemens Bros. and Co., Allen, Siemens	4,395	...	26·6
C. A. Parsons and Co., Parsons, Parsons	4,779	...	25·0
British Westinghouse Co., Willans, Westinghouse	4,894	...	26·36
Electric Construction Company, Allen, E. C. Co.	4,935	...	27·0
Geipel and Lange, Willans, Brown-Boveri	5,036	...	27·0
Johnson and Phillips, Willans, J. and P.	5,062	...	26·4
Mather and Platt, Willans, M. and P.	5,109	...	26·25
British Thomson-Houston Co., Willans, B.T.-H.	5,109	...	25·9
Dick, Kerr, and Co., Willans, E. E. M. Co.	5,110	...	25·3
Ferranti, Willans, Ferranti	5,123	...	26·0
Lancashire Dynamo Company, Willans, L. D. and M. Co.	5,150	...	25·5
Richardsons, Westgarth, and Co., Willans, Brown-Boveri	5,165	...	26·0
Johnson and Phillips, Willans, J. and P.	5,242	...	23·4
Dick, Kerr, and Co., Belliss, E. E. M. Co.	5,290	...	22·3
British Thomson-Houston Company, Belliss, B.T.-H.	5,335	...	23·0
Richardsons, Westgarth, and Co., Belliss, Brown-Boveri	5,385	...	23·0
Ferranti, Belliss, Ferranti	5,400	...	23·0
British Westinghouse Co., Belliss, Westinghouse	5,343	...	23·3
Belliss and Morcom, Belliss, B. T.-H.	5,484	...	22·8
Mather and Platt, Belliss, M. and P.	5,485	...	23·5
Dick, Kerr, and Co., Belliss, E. E. M. Co.	5,490	...	22·3
Lahmeyer Electrical Company, Belliss, Lahmeyer	5,520	...	23·25
Geipel and Lange, Belliss, Brown-Boveri	5,535	...	24·0
General Electric Company, Belliss, G. E. Co.	5,535	...	22·8
British Thomson-Houston Co., Belliss, B.T.-H.	5,541	...	23·0
Lancashire Dynamo Co., Belliss, L. D. and M. Co.	5,550	...	22·6
Siemens Bros., and Co., Willans, Siemens	5,575	...	—
Richardsons, Westgarth, and Co., Belliss, Brown-Boveri	5,575	...	23·0
Belliss and Morcom, Belliss, Brown-Boveri (?)	5,592	...	22·5
Siemens Bros., and Co., Belliss, Siemens	5,615	...	—
Mather and Platt, Belliss, M. and P.	5,665	...	23·5
Rosling and Fynn, Belliss, R. and F.	5,675	...	23·25
Geipel and Lange, Belliss, Brown-Boveri	5,711	...	24·0
Siemens Bros. and Co., Belliss, Siemens	5,909	...	—
Rosling and Fynn, Belliss, R. and F.	5,950	...	23·5
Brush Electrical Engineering Co., Allen, Brush	5,961	...	27·5
Electric Construction Company, Willans, E.C.C.	6,000	...	25·8
Ditto, Belliss, E.C.C.	6,120	...	23·0
Brush Electrical Engineering Co., Belliss, Brush	7,503	...	23·5

The following recommendation has been made by the committee: (*a*) that the tender of Dick, Kerr, and Co. for the sum of £5,290. 4s. be accepted, subject to their undertaking to complete the contract within six months; (*b*) that in the event of Dick, Kerr, and Co.

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declining the contract on the above condition, the tender of the General Electric Company, with the Willans engine, at £4,125, be accepted, subject to the completion of the contract within the period of six months. The consulting engineer in his report points out that taking £600 per lb. of steam as representing the true capital value of the steam consumption, the lowest tenders work out considerably higher than (some of them more than double the amount of the tender) those recommended for acceptance. A. Consumption full load.

Aberdeen.—The Corporation have received the following tenders for a 20-ton electrical crane: J. Carrick and Sons, Dalry Ironworks, Edinburgh £1,288 (accepted); Royce, Limited, Hulme, Manchester; S. H. Heywood, 37A, Fountain-street, Manchester; Mavor and Coulson, 47, King-street, Mile End, Glasgow; Carrick and Ritchie, Waverley Engineering Works, Edinburgh; Crompton and Co., Salisbury House, London-wall, E.C.; C. and A. Musker (1901), Limited, Liverpool; International Electrical Engineering Company, Strand, W.C.; T. Broadbent and Sons, Central Ironworks, Huddersfield; Craven Bros., Osborne-street, Manchester; Higginbottom and Mannoch, West Gorton, Manchester; J. Booth and Bros., Rodley, Leeds; J. Spencer and Co., Chamber Ironworks, Hollinwood; Wimhurst, Hollick, and Co., London; J. M. Henderson and Co., King-street Engineering Works, Aberdeen; Verenigte Maschinenfabrik Augsburg und Maschinenbaugesellschaft, Nurnberg, Germany.

Devonport.—The following tenders have been received for supply of all materials in connection with and the execution complete of the following works, for the Corporation: (Contract A) permanent way, road bed, paving, and bonding of 3 miles 1 furlong 2·08 chains of double tramway track, and all incidental and special works:

W. C. Shaddock, Plymouth	£35,127	15	1
Matcham and Co., Plymouth	37,287	0	0
W. Griffiths and Co., Limited, Bishopsgate-street Without, London, E.C. (accepted)	38,157	7	1
J. C. Lang, Liskeard, Cornwall	39,378	13	6
A. N. Coles, Plymouth	39,515	8	4
J. and T. Binns, Croydon	41,117	6	3
Macartney, McElroy, and Co., Limited, London	41,745	18	10
Harrod and Co., Plymouth	42,556	14	11
Mayoh and Haley, London	43,115	7	4
C. L. Duke, Plymouth	43,224	6	8
Pethick Bros., Plymouth	44,952	16	8
W. Winnard, Wigan	46,146	11	0

BUSINESS NOTES.

TRACTION.

Rotherham.—A site for car-sheds has been acquired in Rawmarsh-road.

Blackburn.—It is reported that the loss on the tramways for the past year is about £6,000.

Bolton.—Complaints are being made of the slow progress in relaying the tramway in Chorley New-road.

Dudley.—The British Electric Traction Company are proposing a tramway from Ocker Hill to Great Bridge.

Lancaster.—Satisfactory progress is being made with the work of constructing the electric tramways in the town.

Shoreham.—A draft of the Bill proposed to be promoted by the tramway company will shortly be considered in committee.

An Abandoned Tube.—The City and Brixton Electric Railway Abandonment Bill has passed a Select Committee of the House of Commons.

Dundee.—The Tramways Committee have decided to set aside £500 as a beginning to meet claims for compensation in respect of accidents on the tramways.

Ilkeston.—The Tramways Committee have appointed Mr. O. A. Pilcher, of Blackburn, electrical engineer and manager of the proposed tramways at a salary of £250 per annum.

Twickenham.—The overhead equipment of the tramway from Busch Corner to Twickenham is progressing rapidly, and the opening of the line will probably take place about June 20.

Hammersmith.—At the Borough Council meeting on Wednesday the Parliamentary Committee recommended that the draft agreement with the London United Tramways Company be sealed.

Wrexham.—The Borough Council and the Wrexham and District Electric Tramways Company have now come to terms with reference to the supply of current for the tramways, and other matters.

Batley.—The statement that the construction of electric tramways here is to be indefinitely delayed is entirely devoid of foundation. The work of laying the lines will shortly be proceeded with.

Garston.—The Council have confirmed a recommendation of the Works Committee to petition against the Bill transferring the electric light and tramways undertaking to the Liverpool Corporation.

Manchester.—On Sunday the inauguration took place of the tramway to Stockport, along Stockport-road, and to Denton, by way of Hyde-road, under the electric system of the Manchester Corporation.

Chatham.—The electric cars were expected to commence running one day this week over the entire system of tramways which has been laid down by the British Thomson-Houston Company in Chatham, Brompton, and Gillingham.

Gloucester.—The light railway scheme proposed by the County Council provides for the construction of a line from Gloucester city boundary to Brockworth, a distance of between three and four miles, at an estimated cost of £40,000.

Speed of Motorcars.—At a meeting of the council of the Central and Associated Chambers of Agriculture in London on Tuesday, a resolution was adopted demanding that all motorcars should carry a distinctive number in front and rear.

Clydebank.—The Clydebank and Glasgow Corporations have now practically settled their differences on the tramway question. The Glasgow Corporation have virtually agreed to take over in its entirety the burgh's tramway provisional order.

Elland.—At their meeting on Wednesday night the District Council passed a resolution regretting that the Halifax Corporation have not taken any steps to provide a service of tramways for Elland, and asking when the line will be commenced to Elland.

Devonport.—While descending a steep hill on Tuesday an electric car left the rails and, colliding with a lurry, turned over on its side. The conductor was seriously injured, and many of the inside passengers were cut about the hands and face by broken glass.

Maidens and Dunure Light Railway.—The Ayrshire County Council have granted the application of the promoters of the above scheme for leave to construct a level crossing for a 3ft. gauge light railway in Longhill-avenue, near Burns Monument.

Wakefield.—Much disappointment is felt in the town at the delay in the tramway scheme. At a meeting of the City Tradesmen's Association on Tuesday night it was resolved to write the promoters, through their local agents, and enquire how matters stand.

Sheffield.—A public meeting convened in the Crookesmoor district of the city has passed a resolution protesting against the decision of the Tramways Committee to discontinue the Harcourt terminus, and a deputation has been appointed to wait upon the committee.

Nidd Valley Light Railway.—Under the Light Railways Act an order has been granted by the Commissioners, and confirmed by the Board of Trade, authorising the construction of a light railway in the rural district of Pateley Bridge from Pateley Bridge to Lofthouse.

Surrey and Sussex Light Railway.—Formal notice has been given that application will be made to the Light Railway Commissioners for an order authorising the construction of a system of light railways between Ockley, in Surrey, and Selham, in Sussex.

Gillingham.—The Council have determined to call upon the tramway company to carry out work of repairing and altering levels of roads and paths in various parts of the district. The Board of Trade inspection of the new lines took place on Wednesday week.

Southend-on-Sea.—Formal notice is given that application is intended to be made to the Light Railway Commissioners by the Corporation for an order authorising them to lay down light railways in the borough of Southend and the urban district of Shoeburyness.

Pontypridd.—Two petitions on behalf of the Taff Vale Railway Company and frontagers praying to be heard by counsel against the Urban District Council's Tramways Bill when the committee stage is reached, have been deposited in the Private Bill Office of the House of Lords.

Woodbridge and Bawdsey Light Railway.—Notice is given that application is intended to be made to the Light Railway Commissioners by Sir William Cuthbert Quilter, Bart., and Major Algernon Waller Cobbold for an order authorising the construction of the above railway.

Leeds.—An illuminated tramcar has been making the round of the city the last two or three nights in celebration of the successful result of the peace negotiations with the Boers. For the purposes of the rates the tramway profits for the past financial year have been taken at £47,000.

Kidderminster.—The directors of the Kidderminster Electric Tramway Company have passed the estimates for the construction of a tramway from Kidderminster to Bewdley, and the plans are now being prepared. It is intended to lay down the line in the autumn of the present year.

Newcastle.—In accordance with a suggestion of the city engineer a number of tramway poles are to be fitted with guards at the bottom, particularly those on Byker Bridge. The Tramways Committee have ordered that 25 cars be fitted with magnetic track brakes at a cost of somewhere from £40 to £50 per car.

St. Helens.—Negotiations between the Corporation and the tramway company have culminated in an agreement under which the company will have the right to use the tramcars for the carriage of goods on certain terms. The Corporation are applying for leave to borrow £23,000 for tramway purposes.

London County Council Tramways.—Good progress is being made with the work of electrifying the London County Council tramways from the Tooting terminus to Westminster. About 1½ miles in all of the down track of the permanent way has been taken up, of which less than a mile is now complete.

Eccles.—The Council have confirmed the action of the Parliamentary Special Committee with regard to the agreement made with the Salford Tramways Committee for the appointment of agents and arbitrators in acquiring land in Eccles and Patricroft for the widening of the main roadways for electrical tramway purposes.

Huddersfield.—Major Druitt, R.E., on Wednesday inspected the electrically equipped tramway from Northumberland-street to Sheepridge. It is expected that within the next 10 days the Birkby, Honley, and Almondbury sections will be ready for electric traction. The permanent way of the Honley section is already completed.

Yarmouth.—A successful trial trip of one of the new Corporation electric tramcars was made last week. The tramways—now very near completion—have been laid with great rapidity, and had it not been for the delay in supplying points, progress would have been even more marked. The work of laying the lines was commenced in October last.

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Ainsdale.—A request of the Parish Council that the Birkdale District Council should receive a deputation in reference to the extension of the Southport Tramways Company's system to Ainsdale, has been complied with in so far that it has been resolved to accede to the suggestion after the tramways now in progress in the district have een completed.

Heywood.—A special meeting of the Town Council was held on Saturday to seal an agreement with regard to the purchase of the Bury, Rochdale, and Heywood tramways. The agreement related to a joint contract being entered into between Heywood, Bury, Rochdale, Littleborough, Royton, and Unsworth for the acquisition of tramways on a common date.

Private Bills.—In the House of Commons the Croydon and District Electric Tramways Bill, the North Metropolitan Tramways Bill have been read a third time. In the House of Lords the following Bills have been read a third time: Wrexham District Tramways Bill, Edgware and Hampstead Railway Bill, and Manchester Corporation Tramways Btll.

Dewsbury.—Petitions are being received by the directors of the Yorkshire (Woollen District) Electric Tramways, Limited, asking that certain places may be fixed upon at which cars shall stop to take up and put down passengers on the line of route, which, when completed, will extend from Cleckheaton, through Heckmondwike and Dewsbury, to Ravensthorpe and Thornhill.

Stockport.—A runaway car on the electric lines of the municipal tramway system on Wednesday jumped the lines at some points, and, rushing at a tangent across the road, crashed into an extensive shop front, badly wrecking it, and buckling up the front of the car. Though much damage was done nobody was injured. A similar accident happened near the same spot a few months ago.

Burnley.—The Corporation have received an intimation from the promoters of the proposed tramway from Accrington to Burnley that they have abandoned for this year their application, though they may renew it next year in the form of a Bill. The company intended to construct a tramway from Accrington to Burnley, passing through Huncoat and Hapton, and the Burnley Corporation had given their support to the scheme.

Ayr.—Colonel Yorke has made an inspection of the Burns Monument section of the electric tramways. Among other appliances, Colonel Yorke inspected a new signalling apparatus in connection with the block system over the single line which has been invented and manufactured in the Corporation workshops. He expressed himself as satisfied with it, and with everything he had seen. The line is now open for public traffic.

Colchester.—The borough electrical engineer and borough surveyor have been instructed to jointly prepare a report setting forth in particular their views and recommendations relative to (1) the merits of the several Continental tramway systems; (2) the hills in Colchester, some of which are of steep gradient; (3) the suggested widening of North Bridge; and (4) the proposal for erection and use of a refuse destructor in connection with the tramway system.

Salford.—Arising out of some recent fatal accidents on the electric tramways, a question was asked the deputy-chairman of the Tramways Committee at the meeting of the Town Council on Wednesday as to whether these were not due to the excessive rate of speed at which the cars travelled. In reply, it was stated that the speed of the tramcars was well within the Board of Trade limits, and none of the accidents had really been caused by excessive speeds.

Levenshulme.—The application of the Council to borrow £8,064 for the purpose of electrical equipment for tramways in the district has been granted. The electric cars have already commenced running. Notice has been given to the Council that the Manchester Corporation are desirous of placing a loop line in the village to enable return cars to stand and receive passengers, as Levenshulme is for certain cars a terminus, and also of erecting a temporary structure on land adjoining the road.

Doncaster.—On Monday those portions of the tramways laid between Station-road and Balby and Hexthorpe and from Station-road to the sheds in Greyfriars-road were formally inaugurated, comprising 3 miles 1 furlong and 5 chains of the nine miles the Corporation are empowered to lay. The other portions are to the racecourse and to the head of Avenue-road. The total estimated cost is £77,500. After the formal opening the cars were run to Balby and Hexthorpe, and were well patronised.

Crewe.—It was stated at a meeting of the Town Council on Wednesday that the Electricity Committee are in negotiation with a private company with a view to the provision of a scheme of electric light railways for the borough. The committee were originally desirous of promoting a light railway scheme of their own, and taking any profits which might have been derived from it. But the ratepayers, at a recent poll, declined to allow them to proceed with it as a municipal concern.

Bath.—An announcement was made at the last meeting of the Town Council to the effect that a clause in the agreement with the tramway company provides for the completion of the undertaking within three years of the date of the order, which was last December. The surveyor has already prepared plans showing the present routes, and also those abandoned or suspended. It was further stated that Sir Henry Bramwell has inspected the existing tramway area, and will commence his arbitration on the 13th inst.

Deptford.—The Works Committee having considered a letter from the chief engineer of the London County Council stating that in connection with the equipment of the tramways along New Cross-road with the electrical conduit system it would be necessary to alter the bridges conveying the road over the lines of the London, Brighton, and South Coast and South-Eastern and Chatham Railways, a reply has been sent that, provided that no alteration is made in the present level of the road, the Borough Council are prepared to acquiesce in the arrangement suggested.

Blackpool.—The Tramways Committee have decided to revert to the former 2d. stages on the promenade system. A short time ago there was an agitation for 1d. fares, and in consequence 1d. stages were substituted. The real test of their success was in Whitweek. On the first four or five days the receipts decreased to the extent of between £700 and £800. On the Friday, Saturday, and Sunday at the end of the week, although there were 13,000 more passengers carried, the returns were down £70 as compared with the same period last year.

Nottingham.—At the meeting of the City Council on Monday a member asked the chairman of the Tramways Committee whether there was any objection to the publication of a weekly return of the tramway receipts for the information of the public. The Chairman of the committee replied that he did not think any good result would accrue from the publication of these returns. If they had a good week there would be someone to propose a reduction of the fares by one-half, which they were not prepared to agree to. Still, as a matter of courtesy, he would bring the matter before the committee.

Aberdeen.—The electric cars are now running to Bridge of Don on the King-street section of the bridges route, and to Abergeldie-road on the Holburn section. The electric service on the Bayview and Queen's Cross route has also been started. The work of equipment of the Rosemount branch is being pushed on as speedily as possible, and it is expected that it will be completed in the course of a fortnight. When this is done the whole system will have been finished. One of the electric car drivers has been fined 20s., with the option of 10 days' imprisonment, for having driven a car recklessly in George-street and collided with and damaged a brake.

Stockton.—At the last meeting of the Chamber of Commerce a discussion was raised on the speed of motorcars. A resolution was passed: "That this Chamber deems it absolutely necessary for the regulations to be enforced in reference to the speed of motorcars, in the interests of the public safety, and resolves that the speed should not exceed 12 miles per hour, and on the approach of any horse or horses the man in charge of the motor should be required to decrease the speed or stop altogether on a signal being given by the person in charge of the horse; also that all motorcars and bicycles be numbered with a large and distinctive number."

Liverpool.—An inquest has been held by the city coroner into the circumstances of the death of a child, who was killed by being run over by an electric tramcar. Mr. Sanders, for the Corporation, said that the question of guards was under consideration by all the electric tramway authorities. Other authorities thought the net or shelf guard was the best, but in Liverpool they thought the plough-shaped guard was better, and they were adopting it as rapidly as possible. It was the wish of the Tramways Committee to have the most efficacious guard possible. The jury found that the death was accidental, and exonerated the driver from all blame.

Gateshead.—At a meeting of the Tramways Committee on Friday the question of the proposed change in fares was considered. Hitherto ½d. stages have been in operation in the centre of the town, while 1d. fares were charged in the outlying districts. The tramways company offered to abandon the halfpenny stages and to charge 1d. for any distance on each of the sections The committee, by a substantial majority, agreed to recommend the Town Council to accede to the company's requests, provided that necessary safeguards were adopted, so that if the new system did not prove remunerative the company would revert back to the present system of fares.

Glasgow.—The Tramway Department report a record year's operations up to and including Saturday last. The drawings amounted to £612,794, as compared with £484,872 for the previous year, while no fewer than 163,600,000 passengers were carried, being an increase of a little over 31,000,000. On Sunday the reduction of fares came into operation. The ½d. stations remain unaltered, but four consecutive ½d. stages are covered by the 1d. fare. This, of course, means that many passengers who at present pay 1½d. will in future ride the same distance for 1d. The Lower Ward District Committee of the Lanark County Council have approved the plans of the tramways proposed to be laid by the Glasgow Corporation on Kirkintilloch-road.

Halifax.—The Tramways Committee have resolved to commence a system of parcel traffic on the tramcars. Town offices for the receipt of parcels to be conveyed by the cars are to be opened, and arrangements are being made to have an agent at, or as near as possible, the end of each 1d. stage on the outward journey to receive parcels. The construction of the tramways to Sowerby Bridge has now been commenced. At present the work at King's Cross will only be continued to the top of Pye Nest Park-road, but when the Corporation Bill has been passed by Parliament, the line will be continued down the new road through Pye Nest Park. In the meantime, the making of the line from Bolton Brow Board School to Wakefield-road end will be pushed forward.

Rawtenstall.—Colonel Boughey and Mr. H. A. Steward have held an enquiry into an application for powers to construct a light railway from Holcombe Brook to Rawtenstall, by way of Ramsbottom and Edenfield. The scheme was opposed by the Lancashire and Yorkshire Railway Company on the ground of competition. After hearing some of the evidence Colonel Boughey said the Commissioners had carefully considered the arguments put before them with regard to competition, and although they were quite satisfied that the line in the district, especially the one to serve Edenfield, was very greatly desired, they still felt that, in view of the decision of the Board of Trade in the Staines and Egham case, it was useless to carry this application further.

Alexandra Park.—The trustees of Alexandra Palace are prosecuting their scheme for running an electric tramway through the grounds

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up to the entrance of the building. There can be no question as to the great convenience of the intended line, but it is strongly opposed in the district on the ground that it would spoil the park. As a matter of fact, however, the tramway would not go through the park proper, but merely along the valley in the lower grounds. In the same way, great objection is taken to permitting the tramway company to erect a generating station against the palace, though this will be a valuable source of revenue, and will certainly be no more of an eyesore than many similar buildings incidental to the management of the Crystal Palace at Sydenham.

Waterlooville Light Railway.—Great progress is being made with the new light railway, which is calculated to vastly improve Portsmouth's means of communication with Waterlooville and Horndean. The line, which is being built by the Provincial Tramways Company, has already reached the top of Portsdown Hill, and it is not expected to take long to complete the remaining five miles to Horndean. In fact, under the provisional order, the company are called upon to complete by July 1. The current will be supplied by the Portsmouth Corporation from their Fratton power station. Nine cars are on order, and are to be stored at a car shed now being completed at Waterlooville. The cost of the line will be between £60,000 and £70,000, or £10,000 a mile. A penny a mile will be the ordinary fare.

Metropolitan Railway Bill.—The Court of Referees of the House of Commons yesterday week considered the application of the London County Council to be heard against the Metropolitan Railway Bill. The Bill authorises the Metropolitan Railway Company and the Harrow and Uxbridge Railway Company to execute further works and acquire additional lands for the enlargement and improvement of the Baker-street Station. The land sought to be taken for this purpose, and for the making of platforms, sidings, approaches, and other works, is situate in the parish of St. Marylebone, and it was the contention of the London County Council that the company should be placed under statutory obligation to widen Marylebone-road and Allsopp-place, and to construct the frontage of and entrance to the station according to plans to be approved by them. It was to preserve their powers under the Management and Building Acts in this respect that the County Council asked for a *locus* to appear. The court, without calling upon the promoters, disallowed the application.

Paddington.—With respect to the proposed widening of Ladbroke-grove and the construction of a tramway from Uxbridge-road to Harrow-road, the Works Committee at the last meeting of the Borough Council reported having received a letter from the London County Council communicating the total cost of the suggested street widening in Ladbroke-grove (exclusive of laying down and paving the tramway track), amounting to £58,500, the cost of the portion within Paddington amounting to £38,040. The London County Council asked the Borough Council to consent to the tramway and to contribute one-third of the cost of the street widenings. A similar letter had reference to the proposed widening of Cornwall-road, Carlton-terrace, and Walterton-road, and the construction of a tramway from Ladbroke-grove to Edgware-road, the total cost of the suggested widenings being £90,700, and the cost of the portion within Paddington amounting to £69,200. In both cases the Council decided that they were prepared to consider as to giving their consent, but were not prepared to contribute anything to the cost.

Trafford Park Light Railways.—Colonel Boughey and Mr. H. A. Steward, Light Railway Commissioners, at the end of last week held an enquiry into the application of the West Manchester Light Railway Company to extend the time limit for the compulsory purchase of lands and property, and for powers to construct a short branch connecting their present system with the Cheshire Lines, near their engine sheds, and to make various other alterations in their system in Trafford Park. By an order of 1899 they had permission to join with the Cheshire Lines at Water Meetings, but owing to the purchase of a plot of land by the British Westinghouse Company the line sanctioned in 1899 had to be abandoned. There are 2¾ miles of the West Manchester Light Railways made, and last year these showed an excellent traffic return. Colonel Boughey said the Commissioners would frame a draft order and submit it to the Board of Trade. Of the great many points raised, the best way of dealing with them would have to be considered by him and his colleague, and a copy of the order as framed by them would be sent to all the parties concerned, whose observations thereon would be invited.

Cardiff.—The electric cars are now running on Sundays. Last Sunday's takings from 17 cars amounted to £104. 17s. The number of cars now delivered by Messrs. Dick, Kerr, and Co. is 41 out of the first order of 54, but 10 of these are not yet ready for service. All the double-deckers have arrived, and one out of 14 of the single-deckers Of the latter, about half a dozen will be required for the Cathays section, and the others will be used where necessary, according to circumstances which may arise. In addition to the 54, there are now on order another 40 cars, which will complete the complement for the present. With regard to the uncompleted work on some of the sections, it is expected that Bute-street will be electrically equipped within a week, High-street to the workhouse in a fortnight, and the Cathays route in three weeks. This means that in three weeks' time, if sufficient cars are delivered, the whole of the original scheme will be in working order. The proposal of the Glamorgan County Council for the extension of the city tramway system outside the borough boundaries was considered by a joint meeting of the Parliamentary and Tramways Committee on Monday. Eventually a committee was appointed to meet the representatives of the County Council.

Wolverhampton.—Up to the present there is still no probability of an arrangement being come to between the Corporation and the British Electric Traction Company whereby tramway communication with the outlying districts may be completed. We understand that the Corporation have now made the company the following offers: (1) either that the company shall at their own expense lay down and electrically equip on the overhead system the lines which shall connect Bilston and Willenhall with the borough; or (2) that the Corporation shall be responsible for one-half of the short length on the Lorain system, and that the traction company shall be responsible for the other half on the overhead system. The latter proposal is, of course, absurd on the face of it. It really means that two entirely different systems should be worked on a length of line of considerably under a mile—an arrangement which has no advantages, but, on the contrary, has many difficulties in its way. The proposal of the traction company, on the other hand, is that the Corporation shall at their own expense construct and electrically equip the short length, the traction company giving them every facility so to do. This would enable the cars of the Corporation and the traction company to meet and exchange passengers.

Maritzburg.—By the last mail we received a copy of the *Natal Witness*, in whose columns we find a most interesting report by Mr. F. W. Jameson, borough engineer, and Mr. W. F. Skidmore Ashley, borough electrical engineer, on electric tramways for the city of Maritzburg. The scheme which these engineers propose appears to us to be extremely well thought out, and one which, on the face of the figures given, the Municipality would do well to adopt, not only as the best means of efficiently opening up the townlands, but as a thoroughly good investment. The present scheme provides for one mile of double and 4½ miles of single track on a 4ft. 8½in. gauge. The total cost of the system is estimated at £74,580, with a probable annual expenditure of £16,673. 10s. Against this the engineers estimate the receipts based on the assumption that the average number of passengers carried per car mile will be eight, and that the fare will be 3d. per car mile, at £20,592, so that there is a good margin left for profit. Up to this point the scheme seems to have met with the general approval of the city, but there is one matter mentioned in the engineers' report which is the subject of much controversy. Deciding in favour of the single-deck car as more suitable for the needs of the city than the double-deck car, the report goes on to recommend that the "sliding bow" should be adopted in place of the ordinary "trolley" in practice in Great Britain, in America, on the Continent, and in other parts of the Globe. Now, the "sliding bow," as our readers know, is a German system, and the proposal that this should be employed in a loyal British colony like Natal has come upon the local Press as a shock. With few exceptions, all the papers in the colony condemn the policy favoured by the borough officials of "having their tramways made in Germany," and it is argued in favour of the trolley system that all the best American and British engineers have adopted it, as well as other towns in South Africa, Australia, and New Zealand. The further plea is put forward that foreign articles should not be encouraged in a British colony. The point urged by Messrs. Jameson and Ashley in favour of the sliding bow may be shortly summarised as follows: less wear on the overhead wire, especially when rounding curves; more silence in action than the trolley; less complication in overhead wires at curves and turn-outs; ears and frogs of more substantial design; no soldering of overhead wires necessary; no trailing rope from back of trolley arm required; no possibility of jumping off the trolley wire, as "bow" is reversible, so that in changing direction of car the lights would not be put out; and, finally, "sparking" possibilities are greatly reduced. Thus the controversy proceeds, and if the voice of the local Press is allowed to prevail, the Maritzburg tramways will be truly British, and nothing of foreign make is likely to gain a footing in that city. The whole matter was to be discussed in open council about the middle of last month, and we wait with interest to see with what favour the "sliding bow" will be received by the City Fathers themselves.

London United Tramways.—On the 29th ult. the House of Commons Committee of which Mr. Compton Rickett is chairman, commenced the hearing of evidence in support of the London United Tramways Bill. In his opening statement Mr. Balfour Browne, K.C., described the proposals of the promoters for extending their existing system of electric tramways in the counties of London, Middlesex, and Surrey. The total length of the company's lines in operation was 16 miles, and, in addition, there were 46 miles authorised. The system was partly worked by electricity. The proposed extensions had a length of 15 miles, and included short lengths in the Hammersmith district to connect the parts of the existing system, the one running from Hammersmith-broadway to Isleworth, with authorised extensions westwards, and the other running from Shepherd's Bush to Southall; a line connecting Hammersmith with Barnes, Mortlake, and Richmond, a line from Wimbledon to Malden, and a line northwards from Wimbledon to Hammersmith along the road on the east side of Wimbledon Common. From Richmond to Kew there was in operation a horse tramway, but it had long been the view of the company, now shared by the local authority, that this should be reconstructed and equipped for electric traction. In connection with this part of the proposals, important road widenings would have to be carried out. Between Mortlake and Barnes the riverside route would be followed, and there the company undertook to construct an embankment and a wall at a cost of about £30,000 at the instance of the Barnes local authority, which would be a great public benefit, preventing the flooding that often occurred. An understanding was arrived at last year with the London County Council in respect to so much of the line as came within the area of their jurisdiction, by which the short spur line at Hammersmith should be included in the purchase powers to come into operation in 1909, and a protective clause should be inserted for the crossing of Hammersmith Bridge. These arrangements were proposed to be carried out in the present Bill. On this portion of the extensions it was proposed to expend £158,752 in road widenings and improvements. Besides this, arrangements have been made with various local authorities, payments being made for extensions of the time of purchase. From the

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terminus of the authorised line at Malden, on the south of the Thames, the proposed line would be carried in a north-easterley direction, and connect with Tooting and Clapham Junction. The line connecting North and South Wimbledon would serve as a much-needed access to Wimbledon Common, and the objection of frontagers on the route would not, he thought, weigh with the committee against this public advantage. On the Wimbledon portion of the present scheme it was proposed to expend £180,056 in road widenings and improvements. The various local authorities were friendly to the proposals, and he hoped that an arrangement would be arrived at with the London County Council. The opposition of frontagers was of the usual character, and the petition of the London and South-Western Railway Company was grounded on apprehension of competition, which no doubt would arise, for the railway service was not satisfactory. With the completion of the system it would be possible to travel at a tramway fare of 5d. between points for which the third-class railway fare was 1s. 3d. Evidence having been given by the chairman of the Surrey County Council in support of the proposals, Mr. J. Clifton Robinson, engineer to the company, gave the engineering details of the different sections of the scheme, and described the connections which would be effected. He stated that at the present time construction was proceeding at the rate of 1½ miles per month, and every week £10,000 was paid in wages. The line from Isleworth to Twickenham and well on towards Hampton would, he hoped, be opened next month. His earlier estimate of traffic had been amply justified, and over the 16 miles of lines in operation 243,000 passengers had been carried in a day. The population of the districts traversed was 412,000 at the last census, and was rapidly increasing. The Chairman said the committee were agreed that they could not consider that part of No. 14 line which was proposed from the cap of Wimbledon-hill to the point where it was assumed it would connect with the line to Putney, which, though shown on the plan, was not yet authorised. It would take some time to make this announcement, but it would be open to the promoters to submit evidence and arguments in favour of carrying the line to a point on the top of the hill for passengers for the common. The continuance beyond the committee was not disposed to allow. At Monday's proceedings Sir Douglas Fox stated that the proposed tramway extensions were necessary additions to the existing system of the London United Company. The line between Richmond and Hammersmith was greatly needed. The line from Mortlake to Barnes would form an excellent means of communication between London and Richmond, and would prove valuable to Mortlake. Hammersmith Bridge was quite strong enough to admit of the passage of electric cars over it. A protective clause should be inserted in the Bill for the benefit of the County Council. Line No. 10 would be an important connection between Wimbledon and Lower Tooting in a thickly-populated working-class district. Further evidence in support of the scheme was taken on Wednesday, and the committee adjourned.

LIGHTING AND GENERAL.

Greenhill.—The new public hall is to be lighted by electricity.

Stockton.—The charge for current for motive power has been reduced.

Taunton.—The extension of the electricity works will be opened on June 23.

Nelson.—Three pupils have been selected for the electrical engineer, Mr. A. Fraser.

Bootle.—A scheme of street-lighting, estimated to cost £7,500, is in preparation.

Stafford.—Mr. Jas. H. Clothier, who has been appointed to St. Annes, has resigned.

Cromer.—Application is to be made for sanction to a loan of £25,000 for electric lighting.

Coppenhall.—The parish church is now lighted by electricity. The fittings have cost about £200.

St. Annes.—The Urban Council have elected Mr. Jas. H. Clothier to the post of electrical engineer.

Newhaven.—The Board of Trade has revoked the Newhaven electric lighting order as from May 2, 1902.

Barnstaple.—The Town Council have agreed to fit up consumers' premises on the deferred payment system.

Rotherham.—It is proposed that the salary of Mr. E. Cross, the engineer, be increased to £250 per annum.

Redruth.—The Urban District Council have postponed the date of commencing the electric lighting to Aug. 1.

Gloucester.—The Electricity Committee have decided to supply electricity at 2d. per unit on Coronation Day.

North Metropolitan Electric Power Supply Bill.—This Bill has been read a third time in the House of Commons.

Shipley.—A scheme of electric arc lighting is to be carried out in Bradford-road by utilising tramway traction pillars.

Loughborough.—An extension of 12 months has been granted for the Town Council's electricity order, which expires next August.

Crewe.—The electrical engineer's report for the past year shows a total income of £4,690, and total expenditure £3,741, a surplus of £948.

Newark.—We understand that a draft agreement is being prepared between the Urban District Council and the Derby and Notts Electric Power Company.

Mansfield.—Electricity works at Mansfield, the foundation stones of which have just been laid, are being built for the Corporation at a cost of about £60,000.

Redditch.—The Urban District Council have agreed to supply a manufacturing firm in the town with electrical energy for motor purposes at a cost of 1½d. per unit.

Removal.—The Brush Electrical Engineering Company are removing their London offices to their previous address, Victoria Works, Belvedere-road, Lambeth, S.E.

Middlesbrough.—The question of erecting arc lights, for which the mains have already been laid and a loan of £1,350 obtained, has been referred to the Watch Committee.

Wellington.—The Urban District Council invite applications for a lease of their power under their provisional electricity supply order. Full details will be found in another column.

Aberdeen.—A number of extensions of electric mains at Torry have been approved of. The Town Council are making trials with Bremer arc lamps for the lighting in Albyn-place.

Stretford.—The District Council have decided to apply for sanction to borrow money for electricity purposes, and expect to be able to supply electricity in nine months from getting authority.

Provisional Orders.—Electric Lighting Provisional Orders (No. 7) Bill has been reported for second reading in the House of Commons. No. 4 Bill has been reported for second reading in the House of Lords.

Western Telegraph Co.—The directors have declared an interim dividend, payable on June 24, of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax. for the quarter ended March 31, 1902.

Wormit.—With regard to the proposed lighting of Wormit and Woodhaven, we learn that 50 of the most modern incandescent lamps will be distributed throughout the roads and streets of Wormit at a cost of £2,000.

Kingston.—At the last Town Council meeting it was proposed to appoint a committee to enquire generally into the electric lighting work, but an amendment was passed to call a special meeting to discuss the question.

Epsom.—The Council have agreed that Messrs. Laurence, Scott, and Co. should substitute two efficient engines for the two Alley and Maclellan engines erected by them, such engines to be of the standard of efficiency fixed by the contract.

Erdington.—At their last meeting the District Council postponed for three months certain street-lighting proposals because it was thought not unlikely that shortly a scheme for lighting the district with electricity might come about.

Batley.—It is proposed to appoint a clerk of works at the new electricity generating station, and the successful candidate, providing he fills the post to the satisfaction of his employers, will afterwards be appointed resident electrical engineer.

St. Pancras.—The Borough Council have instructed the Electricity and Public Lighting Committee to carry out the illumination of the town hall and the Prince of Wales-road baths in a manner befitting the occasion on Coronation Day.

Stock Exchange.—The Stock Exchange Committee have ordered Edmundson's Electricity Corporation's further issue of 10,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 20,001 to 30,000, to be quoted in the official list.

Eccles.—The electrical engineer has been authorised to sell incandescent lamps to any consumer of electric light. The chairman and vice-chairman are about to deal with the applications for the two vacant positions of switchboard attendants.

Callender's Cable Construction Co.—Negotiations for a fusion with Henley's Telegraph Company having taken a longer time than was originally anticipated, the directors have decided to pay another dividend of 10s., making 15s. for the year.

Camberwell.—The County of London and Brush Provincial Electric Lighting Company, Limited, are about to lay electrical conduits along the east side of Martin's-road and along both sides of Burbage-road in 2in. low-tension cast-iron pipes.

Sheffield.—The Council have received a report from Mr. R. Hammond on the site for the proposed power station at Neepsend, agreeing generally with the scheme of Mr. Fedden, and the order given to Messrs. C. A. Parsons and Co. for plant.

Dover.—Electric lighting will be very largely used on Coronation Day. The municipal buildings, the monument on the parade, the clock tower, and the Prince of Wales Pier will be outlined, and the castle will probably be decorated in a similar way.

Charing Cross and Strand Electricity Supply Co.—With regard to the recent issue of 40,000 £4½ per cent. (City undertaking) preference shares, 1902, of £5 each at par, we are informed that letters of allotment have been posted to the applicants.

Eastbourne.—The Electric Lighting Committee during the last year made a net profit of £3,262, which, added to the profit made last year up to March 31, made a total net profit of £5,078. It is expected that the price of current will be reduced from next September.

Gravesend.—The work of laying the electric lighting cables along the streets of the town is proceeding, but we understand that in consequence of differences between the Corporation's engineer and the building contractor the work at the generating station has been greatly impeded.

Broughty Ferry.—The Town Council will start on Sept. 27, 1902, to supply electricity for lighting purposes within the burgh at the rate of 6d. per unit, as measured by meters placed on consumers' premises. The pressure of supply at consumers' terminals will be 230 volts.

Coventry.—The Local Government Board has instructed Major C. E. Norton to hold an enquiry in regard to the application of the

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Coventry Corporation for sanction to borrow £20,485 for the purpose of electric lighting and £2,000 for the purchase of motors for letting out on hire.

Hamilton.—The Council are about to dispose of a portion of Almada-hill ground for electric lighting works, at a cost of £1,300. The total cost of the works has been reduced to £31,494, and the agreement between the Corporation and Messrs. Edmundson, London, lessees of the burgh's provisional order, signed.

Tunbridge Wells.—At Wednesday's meeting of the Town Council a heated debate took place upon the refusal of the Watch Committee to allow the National Telephone Company to put up a free instrument at the town hall for police and fire brigade purposes. Finally, the report of the Watch Committee was carried by 17 votes to 3.

New Agency.—The Union Electric Company, Limited, have appointed Mr. James Gray, of 19, Waterloo-street, Glasgow, agent for the sale of their arc lamps for all industrial purposes. Mr. Gray is to arrange a showroom to exhibit the latest types of both open and enclosed, direct and alternating current, flame, and triplex lamps at work.

Bolton.—The motor department of the Corporation is making rapid progress. In the first year the department coupled up 148 h.p. and in the second year 200 h.p. Since the prices for current were reduced, in two months 90 h.p. has been added, thus showing that the lower rates are having a decisive effect. Many new applications for power are coming in.

Frome.—At the next monthly meeting of the Council it will be proposed that application be made for sanction to the borrowing by the Council of the sum of £16,400, for the purpose of the installation of works for the supply of electricity for power and lighting purposes within the Frome urban sanitary district, and that Mr. Medhurst be engaged as consulting engineer.

Sale of Plant.—A number of electric motors, nearly new, in most cases fitted with raw-hide and steel double reducing gear, are for sale by the Era Press, Leyton, where plant may be seen at any time by appointment. Particulars appear in another column. Some second-hand dynamos and motors are also on sale at Messrs. Claude Carter and Co.'s, 215, St. Vincent-street, Glasgow.

Kent Electric Power Co.—The authorised capital of this Company is £750,000, with borrowing power to the extent of £250,000. Their scheme includes the whole of the county of Kent, with the exception of the Isle of Thanet. The company has an agreement to acquire by arbitration the Chatham and Rochester Company's undertaking, where current will be required for tramways and power.

Islington.—The Council will be asked to-night to approve of the following estimates: decoration and illumination of the town hall, electric lighting station, and public baths during the Coronation festivities, £400; provision and laying of public and private supply mains, etc., in Green-lanes, £2,100; low-tension distributing mains in Camden-road and Hornsey-road, £114; and in Cloudesley-square, £100.

Jandus Patents.—We are given to understand that the litigation which has been conducted between the Jandus Company and the Davy Construction Company for some years past with reference to the alleged infringement of the Jandus Company's master patents has been brought to a close. The Davy Construction Company have now recognised the Jandus patents, and have taken a license on the ordinary terms.

Aldeburgh.—In order to provide Aldeburgh with the Post Office telephone service, it would be necessary to erect a circuit from Ipswich. The contractors for the East Anglian Telephone Company have applied for a license to provide a service for the district of Southwold, Halesworth, Leiston, and Saxmundham, and it is suggested that the company would probably be willing to connect Aldeburgh with their service.

Colchester.—The borough electrical engineer's last report states: output of electricity in units during April, 1902, 12,849; 1901, 7,853; 1900, 4,299; number of consumers at end of April, 266; (171); (96); total number of 8-c.p. lamps connected at end of April, 15,949; (10,626); (5,064). The price of electric current used for illuminating and decorative purposes on June 26 and 27 will be reduced to 3d. per unit.

Patents.—The Comptroller-General of Patents, in his report for 1901, says there was an increase in the receipts for patents fees, designs fees, and trade marks fees as compared with 1900. There were 26,777 applications for patents, against 23,924 in 1900. The number of inventions connected with cycles and cycle accessories is lower than for many years past, but all classes relating to electricity show a marked increase.

Southampton.—The Electricity Committee's last report states that applications for the supply of electric current to the extent of 3,000 8-c.p. lamps for purposes of illuminations for the Coronation have been received, and the borough electrical engineer having reported upon the capacity of the plant under his charge, and to his being able to supply current up to 5,000 8-c.p. lamps, the applications will be granted, subject to the usual terms.

Nottingham.—The Electricity Committee are about to raise £35,000 additional capital for a generating station in the Eastcroft and for the extension of mains. The committee are desirous of proceeding with the construction of the generating station in connection with the destructor at the Eastcroft, estimated at £15,500, and £20,000 is required towards the completion of the St. Ann's power station, which will cost £85,000.

Exeter.—The total payments to local firms for necessaries during the past year amounted to £2,942, while those to outside firms came to £1,966. The latter included £1,801 for materials which were all special manufactures out of the ordinary business line of local contractors, and mostly covered by patents. The electrical engineer has been asked to schedule the articles which are from time to time required, so that tenders might be invited.

Luton.—The resident electrical engineer's last report states that during the past month 3,275 units had been generated, that about 250 8-c.p. lamps were being wired, and that two motors of nearly 13 h.p. were to be connected very shortly. The report was considered as very satisfactory. The revision of the scale of charges has been deferred until the next meeting, when the committee hope to be prepared to submit a scheme to the Council.

Salford.—After a somewhat heated discussion with regard to the electricity enquiry, the Council have decided to positively decline to pay for counsel for any of the complainants. The Council have adopted an alternative system of charges for electricity - viz., a rental of 1s. per 8-c.p. lamp per quarter and a charge of 1½d. per unit. This alternative method of charging, it was explained, would affect only a score of long-hour consumers, such as hospitals.

Motherwell.—The report of the Lighting Committee of their first year's experience with electric light is most satisfactory. There has been an income of £3,036, while the total cost of working amounted to £1,000. For public and private purposes 189,000 units were produced at a cost of 1·44d. per unit. The charge for illuminating purposes will now be reduced from 5d. to 4d. per unit, and to 1½d. for over 500 units, and to consumers of under that quantity to 2d. per unit, for power.

Coronation.—We are informed that the directors of the Robertson Lamp Company have offered their workpeople's large dining hall for the use of the King's Dinner Committee for Hammersmith, the use of which the committee have been very pleased to avail themselves of, as the dining hall is the largest in the district. The directors have also decided to pay their workpeople two days' full wages for the two Coronation holidays, in commemoration of the Coronation of King Edward VII. and as a recognition of the efforts of the workpeople during an excessively busy and trying period.

Peace Illuminations.—As an example showing how rapidly electricity can be applied as compared with the installation of gas devices, we notice that the E.L.B. Company fixed up between 4 and 8 p.m. last Monday a number of illuminating devices in Regent-street, Bond-street, Pall-mall, etc. Most notable were an elaborate device at the United Service Club, and a very characteristic decoration at the P. and O. Offices, Northumberland-avenue. We are informed that a record was made by two men and one boy, who placed 280 8-c.p. lights, including six principal connections, in 1 hour 20 minutes during the evening, which, taking into consideration the difficulty of working in view of a large and demonstrative crowd, comes very close to the company's French and American time records for rapid illuminations on the E.L.B. system.

Londonderry.—At the meeting of the Council on June 3 the following motion was discussed and negatived by 20 to 12: "To rescind the following resolution, passed at a special meeting of the Council on April 26, 1901—viz.: 'That we adopt the report of Sir William Preece of Feb. 1, 1900, and proceed immediately with the carrying out of the scheme advised by him for the supply of electric light and power to the whole city, and that an application be made for a loan of £35,000'; and that in lieu thereof the following be adopted: 'That the Corporation, instead of undertaking themselves the supplying of the city with electric light and power, consider the question of entering into negotiations with some of the leading electric lighting companies, and of handing over to the company selected the supplying of light and power to the whole city for a limited number of years upon such terms as may be agreed."

Aberystwyth.—Representatives of the municipalities of Welshpool, Montgomery, Newtown, Llanidloes, Machynlleth, Aberystwyth, Towyn, and Aberdovey met in conference at the Queen's Hotel, Aberystwyth, on Thursday, with a view to agreeing on some course of united action with a view to securing an extension of the telephone to each of the places named. Mr. C. S. Dunniss, general manager of the Cambrian Railways, presided. A resolution was passed approving the proposed extension of the telephone system from Shrewsbury to the towns represented and Aberdovey, and recommending the respective councils and railway company to enter into the necessary agreement and guarantee with the Postmaster-General. A deputation from the districts concerned is to wait upon the Postmaster-General with a view to getting a reduction in the amount of the guarantee required—namely, £605—and of the period of seven years to three years. It was also agreed that the amount payable by each of the guaranteeing authorities be in the ratio which each guarantee bore to the total amount guaranteed for the whole extension.

St. Helens.—At the last meeting of the Town Council a statement was made as to the work of the electricity undertaking. Last year's profit was £260 net, which is a reduction on the previous year. There are two causes for the reduction. In the first place, the capital charges were high, owing to the extension of plant. The second cause was the reduced price charged for current to the tramways company. Last year the number of units sold to the company was 600,000, which brought in £5,773, while this year, although 8 8,000 units were thus sold, the amount received was only £6,094, the increase of current sold being 38 per cent. and the increase of receipts 5 per cent. The current supplied for lighting had risen from 211.000 units to 267,000, the revenue had increased by 30 per cent., and the increase of revenue for current supplied for motors was 83 per cent. The Chairman said last year the cost of production established a record for the country, and that cost had now been still further reduced. The total cost was 1·04d. per unit. The average price received was 2·12d. per unit, which was very low. The street-lighting was now much improved, and they had obtained the sanction of the Board of Trade to use overhead wires for the transmission of power to various works. This would mean a great saving. The minutes were passed.

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West Hartlepool.—The Electric Lighting Committee have obtained £22 in settlement of claim for an arc lamp-post in Lynn-street recently knocked down by a wagon. A supply main for the supply of current is to be laid to St. Oswald's Church and other property. The request of the Corporation of Hartlepool for terms for the supply of current is being considered. The extension of the buildings to accommodate additional plant has been referred to the Management Sub-Committee.

Hull Telephones.—The Corporation Telephone Committee have not been able to come to an agreement with the National Telephone Company. The committee strongly urged a reduction of the rate to £7 for business premises and £6 for private houses, as against the company's offer of £8 and £7. The company, however, would not fix lower rates for an unlimited service than £8 and £7. The committee have now decided to oppose the Telephone Company's Bill in Parliament.

Epsom.—The Urban District Council have adopted the resident engineer's suggestion that, in order to meet the requirements of those who wished to adopt the electric light for illumination or decoration at the Coronation, a fixed sum of 1d. per lamp per night should be charged up to 50 16-c.p. lamps (equivalent to 5d. a unit for four hours), the consumers already wired to be permitted to take the current from the cut-out side of the meter, and so get the benefit of the reduced rate for the occasion.

Dartmouth.—The electric lighting company has undertaken to supply electricity for public lighting by Aug. 15. Provided the company cannot do this, and cannot make terms with the gas company for a continuance of gas lighting, the electric lighting company is to be allowed to substitute oil lamps for gas. The Council have decided not to engage the services of a consulting engineer in connection with the electric lighting works. Mr. Philip and the surveyor are to advise the Council in the matter.

Accrington.—A maximum price for current at 4d. per unit, and the minimum price of 1·25d. per unit, has been adopted. The engineer's last report states that the plant and mains are generally in good order. Main cables had been laid during the past month in Edgar-street and King-street to the extent of 435 yards run of street. Cable-laying was now being continued until all that sanctioned had been laid. Units delivered to mains for week ended May 19 numbered 1,326; units for corresponding period last year, 830; increase, 496, or 59 per cent.

Bridlington.—As indicated in our last issue, the Town Council have decided to retain Mr. F. H. Medhurst to carry out the works in connection with the electric lighting order, exclusive of the buildings. The central station will be at the Portland-place depôt, on the following alternative lines: (1) private and street lighting in the compulsory area only; (2) private lighting in the compulsory area and street-lighting in the whole of the borough now lighted with gas, with provision for the lamps to be lighted and extinguished from the central station.

Belfast.—From a statement of the electric light account for year ended March 31 last, we gather that a gross profit for the year of £9,054 has been made. After charging interest and redemption there is a deficiency of £346, which will be carried forward to the next year's accounts. The application of Messrs. Harland and Wolff, Limited, for supply of electric energy for light and power to their premises at Queen's-road, already noted by us, has been granted, and application will be made for sanction to the borrowing of £20,000 for the extension of the mains for the purpose of supply.

Electricity in Mines.—There was a fair representation of mining engineers from the North of England at the annual conference of the Institute of Mining Engineers in London last Thursday. The presidential address of Mr. James Dixon, a Scottish engineer, said coal-cutting by machinery was making considerable progress. Last year there were 48 such machines at work; most of them were driven by electricity, and did the work four times as fast as by the old methods. Electricity was also becoming popular for illuminating purposes, and would eventually be utilised for winding and pumping.

Nuneaton.—The Urban District Council have adopted a report of the Electric Committee recommending that the Council should instruct the electrical engineer (Mr. Gibson) to prepare the specifications and invite tenders for one new boiler with connecting pipework, cable required for extensions and street-lighting scheme. The report further stated that it was the intention of the committee to charge the Council the same amount for lighting the streets with electric light as was paid to the Nuneaton Gas Company for a period of 12 months, when the matter would be further considered, the number of arc lamps to be erected being 20 and the number of lamps displaced being 42. The committee are fully satisfied that a proper return would be forthcoming for the extensions of the cables about to be laid.

Dundee.—The accounts of the electricity department show that the expenditure during the past year was £18,398, which was £1,132 less than the estimate. The income was £18,616, against an estimate of £20,382. For the current year the expenditure is estimated at £25,667. 10s., and the income (including a balance brought forward of £217. 11s. 9d.) at £25,914. 15s. 9d., leaving an estimated surplus of £247. 5s. 9d. At a recent meeting of the Finance Committee the Town Clerk stated that he had had some correspondence with the Secretary for Scotland regarding the borrowing powers for electricity purposes. He explained that the Scotch Office wished to include the borrowing powers for the electricity department under the gas department borrowing powers, but the clerk replied that hitherto both departments had been treated separately. He added that the Scotch Office was still considering the matter.

Hammersmith.—The last report of the Electricity and Lighting Committee states that since the last Council meeting 14 additional consumers have been connected, representing a maximum of 383 8-c.p. lamps, the present number of consumers now taking current from the mains being 1,022. Three additional lamps are to be erected on the western side of St. Ann's-road. A set of rules and regulations prepared by the borough electrical engineer for the supply of electricity to premises for the purpose of the Coronation illuminations has been approved. The surveyor has reported that Messrs. Wimpey and Co. have satisfactorily completed their contract in connection with the condensing scheme at a total cost of £5,775. 7s. 8d., the amount of the contract being £5,823. 4s. 6d., and that the difference is accounted for by the deductions from the work included in the specification, thereby reducing the cost by £47. 16s. 10d.

Bristol.—The Electrical Committee contemplate an expenditure of £61,000 on extensions of the Avonbank works, in consequence of the rapid growth of the undertaking. The foundations are to be constructed this summer at a cost of about £10,000. Plans and estimates will be prepared by the staff, and will be submitted to Sir Benjamin Baker. The Electrical Committee in their report adopted at the last Council meeting also stated that the water-softening plant (which has not been enlarged since the initial installation in 1893) was now inadequate for the demands made upon it. The committee had received from the electrical engineer a scheme for the erection of additional plant capable of softening 8,000 gallons per hour, and for the provision and erection of additional feed-water filters, feed and general service pumps, which with the plant already laid down will meet all demands likely to arise from the present works, at an estimated total cost of £2,915, and were authorised to apply for sanction to the borrowing of the money.

Blackburn.—In his last report on the electricity department, Mr. Giles, electrical engineer, states that the cost of generating in the works has been reduced from 1·32d. per unit last year to 1·01d., and the total costs, including management and distribution to the consumers, from 1·78d. per unit to 1·48d. There is the equivalent of 82,109 lamps of 8-c.p. connected to the mains—an increase of 25,585 over last year. During the year applications were received for supply to additional motors, which now total 100, or an aggregate of 350 b.h.p. The number of consumers taking the supply for all purposes is 783, an increase of 113 over last year. The average price obtained per unit sold is 3·93d. for lighting purposes, 1·65d. for private power purposes, 1·5d. for tramway purposes. The total output from the works for the year is 2,002,141 Board of Trade units, an increase of about 72 per cent. over last year's production. During the year one additional generator has been put down and two boilers. The total capacity of the works is 3,720 h.p. The maximum load on the works at any one time was 1,406 kw. on Dec. 21, 1901. The total cost works out at £5,970 3s. 9d.—·71d. per unit sold.

Worthing.—The Electric Lighting Committee have decided to invite tenders for the supply and erection of a circular chimney shaft, 104ft. high from the ground level, the Corporation constructing the necessary foundations up to the ground level. In the course of a detailed report upon the expenditure incurred and liabilities outstanding in connection with the installation of the original scheme, the consulting engineers pointed out that the actual cost of the scheme amounted to £34,333. 12s. 4d., or £1,833. 12s. 4d. beyond the amount of £32,500 originally sanctioned by the Local Government Board, but that on the machinery and plant contract a saving of £1,602 had been effected, the tenders for the work having been less than the amount allowed in their estimates. The excess was stated by the engineers to have arisen through (1) the materials for the buildings being higher in price at the time the work was done than when the estimates were prepared; (2) extra cost incurred by the substitution of 40 arc lamps in place of 76 incandescent lamps, as originally arranged, £768; (3) arc lamp spares and spare cable taken over by the Corporation, £120; (4) alterations to arc lamp-posts, £41; (5) extra cost of manhole covers owing to greater number of manholes being required than estimated for, £153; (6) to the price of cables being much higher at the time the tenders were received than at the time when the estimates were prepared, to the excavations for the laying of the ducts costing more than was allowed, owing to the ducts having to be laid deeper than was anticipated, and to additional manholes being constructed; and (7) to the inclusion of the fee for their original report, and resident engineer's salary during the erection of installation, neither of which was included in their estimates, and to their fees having been increased owing to the greater cost of the installation. The engineers added that much of the discrepancy in cost between their estimates and the tenders as accepted was to be accounted for by the fact that their estimates were given some 16 or 17 months before tenders were invited, and in the interval prices had in most cases risen considerably.

Wellingborough.—Colonel Durnford has held an enquiry into the application of the Urban Council for sanction to a loan of £1,320 for the purpose of carrying out their scheme of lighting the streets by electricity. A refuse destructor has been placed on land which the Council own in the centre of the town, and it is proposed to utilise the surplus steam for providing light in the public lamps. Before the order applied for by the Council was granted, the Electrical Power Distribution Company obtained an order from the Board of Trade enabling them to supply electricity for all purposes, and the Council entered into an agreement with that company under which the Council might purchase their undertaking, and in the meantime would be allowed to transmit their energy along the company's mains to the bottom of the street lamps free of charge. That order has been transferred from the Electrical Power Distribution Company to the County of Northampton Electrical Power Distribution Company, who will carry out the provisions of the agreement. The Council at first intended to erect a generating plant, but arrangements have been made whereby the company will put down on the Council land certain buildings and a generating plant, and take the Council's surplus energy. This will save the Council a considerable sum, so that instead of the Council requiring a loan of £3,000, they only ask for £1,320 to carry out their part of the scheme. The building will cost £250, and the cost

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of altering 287 street lamps £990, legal expenses and contingencies taking it to £1,320. The average cost of lighting those 287 lamps at present is £1. 3s. 0½d., or £330 a year. If £1,320 are borrowed, repayable in 20 years at 3½ per cent., the charge would be £90. 16s. per annum, thus effecting a saving of £240 a year. If the loan is repaid in 15 years there would be a saving in the cost of lighting of £218 per annum. In each public lamp there will be placed two lights of 16 c.p. each, and the maximum cost of adapting the lamps, from start to finish, is estimated at £3. 9s. 6d. each. It was also stated that at the present time rather more than a ton of refuse per hour was being burned, and in actual practice, without any special test, they were evaporating a pound of water to a pound of unscreened refuse.

Cornwall Electric Power Co.—The Cornwall Electric Power Company's Bill for the generation, distribution, and supply of electrical energy in bulk throughout the greater part of the mainland of the county has passed its third reading in the House of Lords. The area of supply comprises the whole of the mainland of the county except the northern outlying districts of Stratton and Holsworthy, the area being 1,100 square miles. Amongst the hindrances to the proper development of mineral wealth in Cornwall are the want of coal in the county and the high cost of internal transport. Owing to the economies effected by the use of electric power, especially in the case of machinery worked intermittently, and the advantage gained by "averaging" the working load over a large area with varying demands, the amount of horse-power—*i.e.*, 32,000 used for transport out of 460,000 tons forwarded to Cornish ports during the year—would be considerably reduced. Generating stations capable of an output of 24,000 h.p. will be provided. By placing the generating stations at the ports where the coal is delivered, the high cost of internal carriage is avoided, the loss by transmission of electricity through cables being trifling for the distances involved in comparison with the cost of transport of coal. It is proposed to make the capital of the Company £450,000, which, with £150,000 obtained, if necessary, on debentures, makes a total of £600,000. The average cost of the cables would be about £800 per mile, and the engineers consider that there should be 240 miles of such. It has been decided to provide two power generating stations—viz., one at Hayle, for 14,000 h.p., situated on the north of the harbour, on land belonging to Messrs. Harvey and Co., and adjoining their wharves and sidings, and the other at Par Harbour, for 10,000 h.p., on land belonging to Mr. C. E. Treffry. A 20-mile radius from the Hayle station embraces the important mining districts of Camborne, Redruth, and Helston, and the important centres of Truro, Penryn, Falmouth, Penzance, St. Just, and St. Ives. It extends north to within a mile of Newquay, and covers, in short, all the south-western half of the area of supply. The Par station embraces within a similar radius the china clay districts of St. Austell and Bodmin, with their tin and other mines, Newquay, Padstow, and Wadebridge, extends north to Tintagel, and east to within a couple of miles of Saltash, and overlaps the Hayle circle about four miles west of Truro. The engineers for the scheme are Messrs. C. A. Baker, of London, and J. Sturgeon, of Leeds.

PROVISIONAL PATENTS, 1902.

MAY 24.

11809. An improved electrical indicator. Archibald Denny and James Archibald Robertson, 121, West George-street, Glasgow.

11814. Improvements in means for preventing commutator sparking in dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11815. Improvements in electric railway systems. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11816. Improvements in or relating to variable-speed electromotors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11817. Improvements relating to electric railways. Henry Harris Lake. 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11818. Improvements in electric switches. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11819. Improvements relating to the insulation of the conductors or windings of electrical apparatus. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11820. Improvements in or relating to systems of electrical connections for current-measuring instruments. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11821. Improvements in electrical brush-holders. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11822. Improvements relating to the control of electromotor and other electric circuits. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11823. Improvements in and relating to regenerative apparatus for railway and similar purposes. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11824. Improvements relating to dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11825. Improvements in electric transformers. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11826. Improvements in rheostats. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11827. Improvements in magnetic clutches. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11828. Improvements relating to the regulation of dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11829. Improvements in starting devices for electromotors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11830. Improvements in brush-holders for dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11831. Improvements relating to the field magnets of dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11832. Improvements in oil guards for the commutators of dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11833. Improvements in electric switches. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11834. Improvements in electric condensers. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11835. Improvements in electric speed regulators. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11836. Improvements in commutator brushes for dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11837. Improvements relating to electric railways. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11838. Improvements relating to controllers for electric motors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11839. Improvements in or relating to controlling devices for electric arcs. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11840. Improvements in cleats or holders for electric conductors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11841. Improvements in apparatus for measuring the potential or strength of electric currents. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11842. Improvements in electric meters. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11843. Improvements in fuses for electrical purposes. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11844. Improvements in or relating to devices for controlling electric motors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11845. Improvements in electric plug fuses. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11846. Improvements relating to railway signal apparatus. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11847. Improvements relating to variable-speed driving mechanism. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11848. Improvements relating to variable-speed driving mechanism. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11849. Improvements in devices for controlling motors from a distance. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11850. Improvements relating to volt-ampere meters or direct-current wattmeters. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

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11851. Improvements relating to the windings of electric transformers and other high-potential windings. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

11881. Improvements in electric fire-alarms. Louis John Abrahams, 6, Breams-buildings, Chancery-lane, London.

11889. Improvements in electric devices for igniting mines. Wilhelm Norres, 6, Lord-street, Liverpool. (Complete specification.)

11914. Improvements in electricity maximum demand indicators. Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

MAY 26.

11919. Maximum demand indicator cut-out or switch. Frank Camillo Norman Bergh and Frank Farrer, 17, Albert-road, Brighton.

11922. Hillhouse's electric night gun sight corrector. Guy Hillhouse, 30, Charles-street, London.

11940. Improved "frog" for overhead conductors or lines of electric tramways or railways. The Palatine Engineering Company, Limited, and Ralph Blakiston, 15, Water-street, Liverpool. (Complete specification.)

11956. Improved brush-holder for dynamo-electric generators and motors and the like. Clifford Mitchell, Victoria Works, Ossett, Yorkshire. (Complete specification.)

11971. Improvements in and connected with electric incandescent lamps. John Otley Rhodes, 6, Lord-street, Liverpool.

11972. Improvements in electric accumulator plates. Alexander Fischer, 60, Queen Victoria-street, London.

11973. Improvements in negative plates for electric accumulators. Alexander Fischer, 60, Queen Victoria-street, London.

11994. Improvements in circuit-closing devices for the line selectors of telephones. Otto Graetzer, 18, Buckingham-street, Strand, London. (Complete specification.)

MAY 27.

12003. An improved feeder pillar for electric tramway and power distribution. Charles Beckingsale, 25, Clarence-square, Cheltenham.

12030. An improved electric autocar for conveying heavy articles in factories and the like. Charles Heuze, 18, Fulham-place, Paddington, London.

12075. An improved method of waterproofing electrical insulating or other materials. William Alfred Phillips, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

12078. Improvements in electrical transformers. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

12079. Improvements relating to the laminated cores of dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

12080. Improvements relating to the field magnets of dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

12081. Improvements relating to lubricating devices for the trolley wheels of electric railway cars and the like. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

12083. Improvements in or relating to electric arc lamps. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

12106. Improvements in pull-down devices for the trolley poles of electric cars and the like. Joseph Ignatius Soudet and John Turri, 6, Lord-street, Liverpool.

12110. Improved means and apparatus for effecting telephonic intercommunication. John Young, 21, Finsbury-pavement, London. (Complete specification.)

12120. Improvements in electromagnetic brakes. William Thomas Pember, 4, South-street, Finsbury, London.

12121. Improvements in and relating to telegraphic apparatus. Antoine Damaskinos, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MAY 28.

12129. Improvements in electric arc lamps. Frank Michael Lewis and Henry Stafford Hatfield, 2, Prestonville-terrace, Brighton.

12156. Improvements in electric incandescence lamps. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

12157. An improvement in the manufacture of filaments or the like for electrical incandescence lamps. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

12158. Improvements in the manufacture of filaments or the like for electrical incandescence lamps. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

12159. Improvements in the manufacture of filaments or the like for electrical incandescence lamps. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

12160. Improvements in the manufacture of filaments or the like for electrical incandescence lamps. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

12161. Improvements in electrical incandescence lamps. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

12162. Improvements in the manufacture of filaments or the like for electrical incandescence lamps. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

12182. Improved manufacture of electrical glow lamps with osmium filaments. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Oesterreichische Gasglühlicht und Electricitäts Gesellschaft, Austria.)

12201. Improvements in and relating to controlling devices for electric motors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Compagnie de l'Industrie Electrique, Switzerland.)

12205. Improvements in means for securing cords to fittings; more especially intended for securing flexible electrical conductors with electric light fittings. Joseph Henry Golding, 47, Lincoln's-inn-fields, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published June 19.

1901.

6454. Grid or electrode for retaining plumbic oxides in accumulators to prevent disintegration during charging and discharging. Clark.

11254. Fittings for electric incandescent lights. Stead.

11257. Electrolytic incandescence lamps. Quain and Turnbull.

12382. Portable electrically-driven drilling apparatus. Campbell and Isherwood.

13468. Electrical interlocking apparatus for railway signalling. Westinghouse Brake Company, Limited, and Malan.

13665. Holders for Nernst lamps. Sheppard, Ram, and Nernst Electric Light, Limited.

14813. Trolleys and like current collectors for electric railways and tramways. Menlove.

14826. Apparatus for exhausting electric glow lamps. Imray. (Scharf.)

14930. Means for holding and working trolley poles on electric railway and tramway vehicles. Parsons.

15045. Electric arc lamps and means for stopping heat radiation in optical apparatus. Evans.

15195. Supporting conductors in conduit systems of electric railways. Chapman.

15239. Electrical cut-outs, and partly applicable to electrical switches. Bartlett.

15258. Means for raising, lowering, and suspending arc lamps. Irwin and Willans and Robinson, Limited.

15290. Method of electrically igniting the explosive mixture in hydro-carbon engines. Smith.

15371. Electric switches. Hodges.

15524. Electrically-driven blast-fans. Grüll.

16122. Working zinc and substances containing silicic acid in electric furnaces. Dorsemagen.

18530. Electric dynamos and motors. Marshall.

26203. Electromagnetic motors. Schneider.

1902.

1417. Electric meter. Wyatt.

2084. Joints and joint-boxes for electrical conductors. Wilkinson.

5592. Electric self-registering target. Williams and Edwards. (Date applied for under International Convention, Aug. 20, 1901.)

6481. Wireless telegraph systems. Shoemaker.

8488. Method of and means for producing synchronous motion. Justice. (Rowland Telegraphic Company.)

8717. Luminous-gas electric lamps. Fairburn-Hart. (General Electric Company.)

8784. Rail bonds or connections for electric railways. Lake. (Thomas.)

8872. Switches for electric lighting. Bach.

8969. Dynamo-electric generators. Haddan. (Peck.)

9229. Audible electric telegraphy. Oxlade and Richardson.

9504. Electric lamp sockets. Norden.

9704. Electric switches and wall plugs and bases for the same. Vandam and Marsh.

9788. Electric switches and applications of same to electrically-propelled vehicles. Brown.

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TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	May 24	769	687	+ 81	36,120	33,930
Birmingham Tramways	,, 31	5,017	5,646	− 629	103,212	99,300
Blackburn Corporation	,, 30	841	846	− 5	14,644	12,897
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 31	671	1,163	− 1,192	6,898	6,993
Bolton Corporation	June 1	1,819	1,852	− 32	31,064	30,391
Bradford Corporation	May 18	2,828	995	+ 1,833	44,468	16,276
Bristol Tramways Company	,, 30	4,676	6,597	− 1,920	—	—
Carlisle Tramways Company	—	—	—	—	—	—
Central London Railway	,, 31	6,815	6,368	+ 447	147,483	136,471
City and South London Railway	June 1	2,952	1,822	+ 1,130	65,422	43,434
Cork E. T. and L. Company	May 29	631	585	+ 46	9,056	8,800
Darwen Corporation	—	—	—	—	—	—
Darwen-Hoddlesden	—	—	—	—	—	—
Dover Corporation	,, 31	247	289	− 42	4,166	3,950
Dublin & Lucan Electric Railway	June 1	88	173	− 85	2,080	2,029
Dublin U. T., electric cars	May 30	3,861	4,108	− 247	—	—
Dublin S. District, Electric	,, 30	909	1,011	− 102	—	—
Dundee Tramways Company	,, 14	647	678	− 31	—	—
Glasgow Corporation	,, 31	11,761	11,381	+ 380	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 31	1,703	1,965	− 262	14,947	14,897
Liverpool Corporation	,, 17	9,131	9,495	− 364	179,303	164,587
Liverpool Overhead Railway	June 1	1,481	2,079	− 598	31,368	34,455
Newcastle-on-Tyne Corporation	May 24	2,964	—	—	—	—
Portsmouth Corporation	,, 17	1,296	542	+ 754	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	June 1	3,864	—	—	—	—
Southampton Corporation	—	—	—	—	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £267 decrease.
Barcelona Ensanche y Gracia, £112 decrease. Barcelona £133 increase.
Brisbane, £318 increase (month of March, £10,934; increase, £1,789).
Buenos Ayres and Belgrano Electric (month of April, receipts £11,872; decrease £613), £294 increase.
Calcutta, £246 increase.
Cape Town (month of March), receipts, £17,888; expenditure, £7,343.
Isle of Thanet Electric, £432 decrease
Mexico Electric (month of April), receipts, £19,350; expenditure, £10,620.
Perth Electric, £221 increase.
Port Elizabeth (month of March), receipts, £3,818; expenditure, £1,947.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	⅝-¾
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¾-⅞
—— Ordinary, 1-125,000	1 ..	⅜-½
British Insulated Wire, Ord., 1-70,000	5 ..	7½-8½
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-5⅝
—— 5 per cent. Mortgage Debentures	100 ..	101-104
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5⅞-6
Brush Electrical Engineering, Ordinary, Nos. 1-105,751	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1⅞-2¼
—— 4½ per cent. 1st Debenture Stock	100 ..	101-104
—— 4½ per cent. 2nd Debenture Stock	100 ..	95-100
Callender's Cable, Debentures	100 ..	111-115
—— Ordinary	5 ..	17-18
—— 5 per cent. Pref.	5 ..	5¼-6
Crompton and Co.	3 ..	3-3¼
—— 5 per cent. Debentures	100 ..	103-106 p.c
Edison and Swan United, Ordinary	3 ..	1⅞
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	75-80
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-1⅜
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	97-101
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	10-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	98-101
W. T. Henley's Telegraph Works, Ordinary	5 ..	16¼-17¼
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	99-102
Parker, Thos., Limited, Ordinary	10 ..	15¼-16¼
Telegraph Construction and Maintenance	12 ..	34-37
—— 5 per cent. Bonds	100 ..	103-106
Telegraph Manufacturing, Ordinary	5 ..	9½-10½
—— 5 per cent. Cum. Pref.	5 ..	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	8¼-9¼
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6⅜
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107
Electric Railways.—		
Central London, Ordinary	100 ..	104-107
—— 4 per cent. Pref.	100 ..	103-106
—— ,, ,, deferred	100 ..	100-103
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-118
City and South London, Consolidated Ordinary	100 ..	71-74
—— 4 per cent. Debenture Stock	100 ..	113-118
—— 5 per cent. Pref. Stock '91	100 ..	128-133
—— ,, ,, ,, '96	100 ..	125-128
—— ,, ,, ,, '01	100 ..	121-125
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
—— Ordinary, 1-50,000	— ..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	92-96

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	¼-¼
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	100-104
Bournemouth and Poole, Ordinary	10 ..	11-12
—— 4½ per cent. Cum. Pref.	10 ..	9½-10½
—— Debenture Stock, Red.	100 ..	103-106
Brompton and Kensington, Ordinary	5 ..	8⅞-9¼
—— 7 per cent. Preference	5 ..	8⅞-9¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	8-9
—— Nos. 50,001-70,000	5 ..	8-9
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½
—— ,, ,, £10 Ord.	5 ..	10⅜
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	106-107 xd
Charing Cross and Strand	5 ..	9-10
—— Nos. 50,001-70,000	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5-5¼
—— 4½ per cent. Debentures	100 ..	110-113
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	11¼-12¼
—— 5 per cent. Debenture Stock	100 ..	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	103-106
County of London and Brush Provincial, Ordinary	10 ..	7¼-8¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	108-111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6¼-6⅜
—— 6 per cent. Cum. Pref.	5 ..	5⅞-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	108-111
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4-4¼
—— 5 per cent. Debenture Stock, Red.	100 ..	101-104
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¼-6¼
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10-11
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¼-10¼
London Electric, Ordinary	3 ..	1½-1⅝
—— 6 per cent. Pref.	5 ..	4-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	95-100
Metropolitan, Ordinary	10 ..	16¼-17¼
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	8-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	14-15
Oriental, 1879	1 ..	1¼-1⅜ xd
—— £5 Shares	5 ..	7-7½ xd
—— £4½ Shares, New	4½ ..	6-6½ xd
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	98-101
River Plate Electric Light and Traction, Deb.	100 ..	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1⅜-2⅛
—— 4 per cent. Debenture Stock	100 ..	89-90
South London, Ordinary	5 ..	3-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8¼-9¼
—— 3½ per cent. Deb.	100 ..	98-101
Westminster, Ordinary	5 ..	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	2½ ..	3½-4
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4-4¼
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	127-132
Blackpool and Fleetwood Tramroad	10 ..	13¼-14¼
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	3-3¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	104-107
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	7-7½
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¾-10⅛
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	102-104 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13¼-14¼
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12¼-12⅝
—— 5 per cent. Perpetual Debenture Stock	100 ..	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1¼-1⅜
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4⅜-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4⅜-5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	104-107
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2⅜-2⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11¼-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	96-99
Imperial Tramways, Ordinary	all ..	22-22½
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	4¼-5
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within	10 ..	10¼-11¼
—— ,, ,, ,, 1-82,500	5 ..	5¼-6
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	105-108
—— ,, Prov. Crts.	50 ..	55-57
New General Traction, Ordinary	5 ..	2-3
—— 6 per cent. Cum. Pref.	10 ..	3-4
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10¼-10⅝
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	100-103
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	9¼-10¼
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	107-110
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £251,132 6 per cent. Preference	12s. ..	¼
—— £50,000 ,, ,,	1 ..	¼
—— £500,000 4½ per cent. Debenture Stock	60 p.c. ..	60 p.c.
Telephones.—		
National Telephone, Preferred	100 ..	96-99
—— Preferred, 590,001-790,000	3½ ..	3½-3⅝
—— Deferred Stock	100 ..	53-57
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5-5¼
—— 3½ per cent. Deb. Stock, Red.	100 ..	94-97
—— 4 per cent. Deb. Stock, Red.	100 ..	103-107
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

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NOTES.

The Deputation to Mr. Balfour.—We are informed that Mr. G. Balfour has appointed the hour of 12 noon on Wednesday, the 18th inst., for receiving the deputation from the Institution of Electrical Engineers on the subject of electrical enterprise.

Semi-Solid Petroleum Fuel.—News from the Continent states that some French naval experts have evolved a process whereby petroleum is made semi-solid, mixed with coal-dust, and pressed into briquettes It is claimed that a splendid fuel is thus produced, and among its advantages are economy and the absence of dust or ashes. One brick, it is said, generates the heat of four times its weight of anthracite coal.

Wireless Telegraphy.—It is reported that Mr. Marconi will on the 22nd of this month make his first attempt at Transatlantic work from his new station at Nova Scotia. This is well within the time promised by him for establishing a commercial system of wireless telegraphy between this country and America. The latest public body to adopt Mr. Marconi's system is the Belgian Railways Department, which has decided to employ wireless telegraphy on its steamers after a three months' trial.

Owens College, Manchester.—It is announced that the governors of the above college have decided to apply for a charter for an independent university, to be called the Victoria University of Manchester. In coming to this decision a few days ago the governors expressed the opinion that any powers and advantages possessed by the Victoria University and its graduates, including the use of the name Victoria, should be equally continued, if they desire, to the proposed universities of Leeds, Liverpool, and Manchester and their graduates.

Fire Losses and Causes.—A contemporary publishes some data as to fire losses and causes in the United States during 1900, which are particularly interesting, as showing the very small proportion of fires attributable to electricity as compared with those due to other causes. The number of fires registered in the United States as the result of the use of coal fuel in that year was 20,297, as compared with 5,861 with oil, 1,981 with gasoline, 1,605 with gas, and 1,054 with electricity. Thus, out of a total of close upon 31,000 fires which were found to be due to some specific cause, only about 1 in 30 was attributable to electrical causes, which should be a striking lesson to those alarmists who are ever ready to saddle electricity with the responsibility for fires the real cause of which cannot at the time be located.

Cable Rates in the West.—Several important reductions in the cable rates to Alaska, British Columbia, and the North-West Territories came into force with the 1st of this month under a decree of the Dominion Government of Canada. Taking the dollar at 4s. 2d., the new rates to British Columbia has been fixed at a minimum of 1s. 8d. a word and a maximum of 3s. 5d. a word, according to the locality which the message has to reach. In the same way the new tariff to the North-West Territories provides for a minimum charge of 2s. 9d. and a maximum of 3s. 5d. It is understood that this series of reductions is tentative, and that the experiment is to be of three months' duration. The lower rates will, of course, become permanent should an increase in the volume of traffic passing over the lines justify them.

Electrolytic Estimation of Copper in Iron.—Mr. H. Koch, describing the electrolytic estimation of copper in iron, says that not less than 100 grammes of the iron are dissolved in dilute sulphuric acid (400 cubic centimetres of 30deg. Bé) and the insoluble residual collected on a filter. If the substance is an iron rich in carbon, it is well to wash back the residue into the beaker and boil it with 200 cubic centimetres of fresh sulphuric acid to ensure the solution of the last traces of iron, then return it to the same filter, wash, dry, and ignite. It is then dissolved in hydrochloric acid, the solution evaporated to dryness with sulphuric acid, redissolved in 20 cubic centimetres of water and 20 cubic centimetres of nitric acid of sp. gr. 1·2, and after diluting to 120 cubic centimetres and adding a few drops of oxalic acid, it is electrolysed for 9 to 10 hours with a current density of 0·094 ampere per square centimetre.

An Electric Incline.—There is now in operation at Genoa an electric incline with a length measured on the horizontal of 3,520ft. and a difference of level of 615ft., giving a mean grade of 17 per cent. The system adopted is known as the rack and binding system, the rack being in the middle of the single track. The ties are supported on a strong masonry bed to prevent slipping. The cars, which are self-propelling, are so arranged that the platforms are horizontal when on the incline. The wheels are loose on the main axles, and each axle carries in the centre a large gear wheel, which engages with the track. The overhead trolley system is used, and each car is equipped with a direct-current motor of 30 h.p., working at 500 volts, which drives it by a set of reduction gears. The car descends the incline from the Piazza Principe by its own weight, and the motor acts as a brake by varying the resistance and regulating the descent at will.

Receiver for Wireless Telegraphy.—One of the principal difficulties in the way of successful wireless telegraphy has been in connection with the coherer, the problem being to get an instrument which would enable wireless messages to be read at long distances. Mr. Marconi claims to have now overcome this difficulty, and another inventor, Mr. T. Tomasina, of Geneva, has come into the field with a device, which he calls the "coherer telephone," having the same object in view. The arrangement consists of a coherer in connection with the diaphragm of a telephone receiver, the terminals of the coherer being connected respectively to the antennæ and to ground. The terminals also serve to connect a relay circuit. When the circuit is closed through the coherer by the Hertzian waves passing through the same from the antennæ to ground, the second circuit is closed in turn by the relay to operate the recording apparatus and energise the diaphragm magnet, thus producing a sound, and at the same time decohering the material of the coherer. It is claimed that the sound produced by the receiving instrument is of sufficient loudness to be heard distinctly without placing the instrument to the ear, and hence in use it is not necessary to remove the instrument from its support.

Electric Combustion Furnace.—An electrically-heated combustion tube for carbon determinations is the invention of Mr. Wm. M. Carr, which thus adds to the growing list of laboratory appliances controlled by electricity. In this arrangement the usual combustion tube, carrying at one end a roll of copper gauze and at the other a body of granular copper oxide held in place by perforated discs, is surrounded by a porcelain or other tube, upon which the coils of the heating circuit are wound. A suitable non-conducting jacket, such as magnesia, encloses the whole, and the material for analysis is placed in the usual platinum boat in the centre of the combustion tube. The heating circuit is divided, the ends of the tube being surrounded by two coils connected in series, and the central section by an independent coil; a switch and con-

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tacts are so arranged that the current may be sent firs through the end coils to bring the copper and oxide to the necessary temperature, and then through all coils in series to provide an evenly distributed heat. During the entire operation a current of oxygen passes through the tube, and the products of combustion are led through the usual collecting train. The advantages of cleanliness, ease of control, and quick application of heat, all tending to rapidity and accuracy in the determination, are claimed for this device.

Paris Moving Platform.—As we recently announced in these columns, Mr. Casalonga, a French engineer, has made a proposal for providing Paris with a moving platform, running from the Place de la Concorde to the Place de la Bastille, under the Grand Boulevard, a total length of about six miles. Further particulars to hand show that the plan has been well thought out. Stairs would be installed every 650ft., one set for going in and another for going out of the shallow tunnel of the running platform. The platform itself would consist of three parallel parts, running with speeds of 2·4, 5, and 7 miles per hour respectively. A passenger walking on the third platform could thus attain a speed of from 9 to 10 miles, and it is even in contemplation to increase this to 12 or 14 miles an hour by introducing a quadruple platform. The cost is estimated by the promoters of the scheme at £340,000 per mile of double track, and the running expenses, calculated from experience gained with the moving platform of the Paris Exhibition, are put down at £80,000 a year. The present 'bus service between the places named above is far from satisfactory, and the traffic, owing to the crowded nature of the locality, is congested and slow. It is, therefore, thought that the proposed route is the most favourable that could be chosen in Paris for the experiment. The promoters propose to charge a uniform fare of 1d. Electricity would naturally be employed as the motive power.

Faraday's Law and its Range of Validity — From a consideration of the accurate measurements which have been made with the copper and with the silver voltameter, Mr. Emile Bose has come to the conclusion that the slight deviations from Faraday's law are only apparent. In the paper, abstracted in the current number of the *Journal* of the Chemical Society, in which this conclusion is expressed the author states that to test the accuracy of the law, a salt may not be used the cathion of which is capable of existing in two forms, for then there enters a possible disturbing factor due to the reaction $M^{\cdot\cdot} + M = 2M^{\cdot}$. The deviations found in the electrolysis of silver salts ($\frac{1}{10000}$ of the total weight of silver) are due to secondary reactions, an important one of which is attributed to oxygen occluded by the platinum electrode. Faraday's law, so far as the weight of substance deposited by a given amount of electricity is concerned, may be regarded as an absolutely exact law of nature. From the work of Otswald and Nernst, it is shown that we may rightly conclude that the current which passes through an electrolyte is entirely conducted by transport of material, and there is no evidence of "metallic conduction." The author regards Faraday's law as comparable with Dalton's law of multiple proportions as far as exactitude is concerned, and views it as an extension of Dalton's atomic laws.

Civil Engineers' Conversazione. — About 1,500 guests attended the conversazione of the Institution of Civil Engineers at Great George-street on Wednesday and Thursday last week. They were received by Mr. Chas. Hawksley (the president) and Mrs. Hawksley, supported by Sir John Wolfe-Barry, Sir Fredck. Bramwell, Sir Benjamin Baker, Sir Wm. Preece, Sir Douglas Fox, Sir Alexander Binnie, and Sir G. Molesworth. Included in the company were Lord Alverstone, Sir Ed. Carbutt, Lieut.-Colonel Crompton, R.E., Sir John Darston, and Sir David Hunter. In the course of the evening the guests were entertained with some very interesting scientific experiments. In the reading-room Mr. A. P. Trotter demonstrated some of the conditions under which electric shocks at 500 volts are harmless, practically repeating the experiments which he made at the Institution of Electrical Engineers a short time ago. Mr. W. N. Shaw performed several successful experiments in the library in cloud formation. The larger rooms were utilised for the purpose of displaying collections of engineering models and scientific apparatus. The exhibits included a series of models and pictures illustrating the development of transport by road, canal, and railway. A lighter form of entertainment was provided by the string band of the Royal Artillery, which played a selection of music in the hall. Vocal performances were also given in the lecture theatre and in the main library. The conversazione was quite as successful and entertaining as any of its predecessors.

Electrically-Operated Gold Dredge.—The vast superiority of gold dredgers operated by electric motors over the earlier forms of dredges is being put to good advantage in California in reclaiming some of the enormous wealth of gold lost by the wasteful methods of early mining. Some of our American contemporaries illustrate an electrically-operated gold dredger which is worthy the attention of mining engineers in our Colonies, where up to the present, owing in some instances, no doubt, to the absence of electrical power, comparatively little has been done in the use of electrical machinery in gold-mining operations. The chief point of activity in California to-day is on the Feather River at Aroville, where one company is working over an area of about 10,000 acres with electrically-operated gold dredges with the greatest success. The profits of operation, it is said, have frequently been £200 per dredge daily. Each dredger costs from £8,000 to £15,000 depending on its capacity. The working of the dredge is accomplished entirely by electric motors, the current for which is obtained from the long-distance transmission companies operating in the district. Transformers are usually placed upon the bank to lower the voltage of long-distance lines and flexible cables run from the bank to the top of the dredge, and from there to the motors. These motors, as a rule, have an aggregate capacity of 75 h.p. to 200 h.p. on each dredge. The photograph above referred to shows a variable-speed induction motor driving a counter-shaft, from which the main dredging buckets are operated. These buckets raise the material from the bed of the river to the shaking screens at the top of the dredge.

Compounding Generators in Parallel.—It is generally recognised that the operation of compound-wound machines in parallel is not usually accomplished satisfactorily unless the machines are of exactly the same type, for the reason that it is impossible to adjust the compounding of any one machine independently of the others. A system of compounding which is said to obviate this objection is proposed to be used by Mr. F. G. Baum, and is described in the current number of the *American Electrician*. He employs an exciter for the generators, which has a series field winding connected in the main circuit, so that the field strength of the exciter will vary directly with the load supplied by the generators. The exciter delivers current to the field windings of the generators in parallel, exactly as is done in the case

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of alternating-current generators, and it is obviously possible by this arrangement to obtain any desired degree of compounding on all the generators, and also to vary the compounding of the machines individually in order to compensate for varying characteristics. The exciter is provided with a self-exciting shunt field winding, compounded by the windings in series with the main supply. A modification of this is also shown, in which the windings of the generators are connected in parallel with each other and in series with the exciter armature across the main line. In this case the generators would, of course, be self-exciting, and the exciter dynamo would serve merely as a booster to increase the field excitation of the generators upon an increase in load. By providing adjustable resistance in series with the generator windings, the degree of compounding may be adjusted for individual machines.

Manchester Section.—The second annual report of the committee of the above section of the Institution of Electrical Engineers shows that 12 ordinary meetings have been held in the past session, the average attendance being about 100. At the suggestion of the chairman, the committee appointed a sub-committee to call a meeting of representatives of the various Manchester societies to discuss the question of acquiring central premises in Manchester for meetings and library. The meeting was held in the Lord Mayor's Parlour on April 3, and a joint committee was then appointed to consider the question and formulate a definite scheme. It is hoped that some practical result will follow. If sufficient students come forward next session, it is proposed to form a students' sub-section. The first annual dinner was held at the Grand Hotel on Friday, Feb. 28, and proved a successful gathering, about 100 members and guests being present. The total roll of the section comprises 415 members of all grades, as against 354 last year. The committee consider that they may congratulate the members upon a successful session, and they hope that members will contribute, as far as possible, to the success of the coming session by hearty co-operation in offering papers and taking part in the proceedings. The following is the list of officers for this year: Past chairmen—Dr. Edw. Hopkinson and Mr. C. H. Wordingham; chairman—Mr. Hardman A. Earle; vice-chairman—Mr. Edw. W. Cowan; members—Dr. F. H. Bowman, Messrs. S. V. Clirehugh, A. A. Day, C. M. Dorman, W. P. J. Fawcus, A. S. Giles, J. S. Highfield, H. Lindley, G. F. Metzger, A. B. Mountain, Dr. C. H. Lees, and Mr. C. D. Taite; hon. secretary and treasurer—Mr. P. A. Ramage, Salford Ironworks, Manchester.

Tests of 220-Volt Lamps.—Interesting data are available from some lengthy tests of the performance of 220-volt lamps made by Mr. F. W. C. Bailey, and explained before the members of the American National Electric Light Association last month. Lamps of all makes were obtained, and from these 50 were selected at random and set aside for test purposes. It appears that with respect to candle-power, out of 14 lots of lamps tested one lot did not give a single lamp that came within a margin limiting the candle-power to 1½ candles above or below the normal rating. Only five lots showed a percentage above 50 per cent., and three lots a percentage of 80 or above. It is stated that at least 80 per cent. of all the selected lamps should have come within such a margin. With respect to economy, those coming within a margin limiting the lamp to one-half watt per candle above and below the rating, none of the lamps of two lots were within the margin; only four lots were above 50 per cent., and three lots reached 80 per cent. or higher. In the life tests 12 lamps of each lot were operated upon, being selected as closely as possible to the rated candle-power efficiency. The results are tabulated in terms of arbitrary candle-power areas, and no general discussion of the test is given. A final table shows that the average initial watts per horizontal candle-power varied in 14 lots from 3·36 to 5·30; that the average watts per horizontal candle-power during the useful life varied from 3·73 to 5·88 watts; that the average watts per horizontal candle-power during 1,500 hours varied from 4·38 to 6·08; and that the estimated period of useful life varied from 467 hours to 3,502 hours. Measurements made of mean spherical candle-power showed that the ratio of mean spherical to mean horizontal candle-power was quite uniform, averaging about 82 per cent. for "double oval" filaments.

A Unique Power Scheme.—When Lord Kelvin was in America a short time ago he visited Rochester, in the State of New York, and while there formulated a novel scheme of electrical transmission in connection with the utilisation of the water power of the Genesse River. The problem is one which has long claimed the attention of electrical engineers in the States, and Lord Kelvin is said to have evolved a solution of the question which is considered quite practical. According to the *Western Electrician*, the plan is to construct small and comparatively cheap dams on the Genesse River at various points between its source and the Alleghany Mountains of Pennsylvania and its mouth in Lake Ontario, wherever sufficient poundage can be obtained to give a supply of water for several months in the year. At these dams Lord Kelvin suggests turbines should be installed and connected to 2,000-volt direct-current generators. All the generators would be connected in series on a single copper or aluminium wire of not more than ½in. diameter. The single wire would form one continuous closed circuit, going back to the place of beginning by perhaps a shorter route. Lord Kelvin is reported as saying that by this method power could be economically and profitably transmitted 300 miles at a pressure of 80,000 volts. Motors would be connected in series in the circuit, and, where advisable, would be used to drive alternating-current generators. Many of the details of the scheme have also been thought out by Lord Kelvin, such as insulation devices, line construction, and provisions for automatically short-circuiting a generator in case of trouble. The doubt will, however, still remain as to the advantage of this series system over a three-phase parallel system. The fact that 80,000 volts is to be the pressure at some consumers' motors is a serious drawback to Lord Kelvin's proposal.

The Telegraphone in Multiplex.—A method of using the Poulsen telegraphone in such a manner as to record a number of messages on a single steel strip without interference with each other, is the subject of a patent recently granted to Mr. P. O. Pedersen, of Copenhagen. One of the advantages claimed for the improvement is that the size of the drum in the Poulsen invention, or the length of the wire or ribbon used, may be materially lessened, so that a long speech or a number of speeches or messages may be stored upon a comparatively short or small magnetic body. From a description of the arrangement in our American contemporary the *Electrical World* we gather that the essence of the invention is the use of two or more recording magnets, the connections of which are varied for each message, with a corresponding variation in the combined action of the magnets on the recording strip. To reproduce each message the connections of the magnets must be adjusted to the same combination that was used in impressing it. A couple of diagrammatical figures are given showing how two messages may be recorded on and reproduced from the same portions of two adjacent steel strips. These strips are drawn past the poles of two

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magnets connected in series with the secondary of the telephone circuit. By means of four plugs the connections of the magnets in the circuit may be varied. A message spoken into the transmitter will be recorded magnetically on the steel strips, and may be reproduced on substituting a receiver for one of the coils, according to the well-known action of the telegraphone. By changing the connections of the magnets the polarity of one is reversed, and in this state of the magnets the original message cannot be reproduced, but while the magnets are thus connected, it is possible to fix on the steel strips an entirely new message, which will not in any way obliterate the first message, and which can be reproduced, while the connections remains the same and will not prevent the reproduction of the first message when the connections of the magnets are changed back to their original conditions. It is not necessary to use separate recording strips for each magnet, as the desired results can be obtained by using a single strip, it being necessary only that the magnets shall act at different parts of the strip. In using a drum carrying a spirally-wound steel wire, the magnets should be arranged to bear on two different convolutions of the spiral. Our contemporary also gives diagrams showing the extension of the method to four magnets, and the application of the same principle of varying combinations of magnets to the simultaneous transmission of several messages along the same wire.

Electrical Logislation in India.—For the first time in nearly 20 years an effort is being made to introduce a complete legislative system for granting licenses and for regulating the supply and use of electrical energy in the Empire of India. It is a remarkable fact that the only general Act relating to electricity now in the Indian statute-book is that dated 1887, and which merely gives power to the Governor-General in Council to formulate rules for the protection of person and property and for the prevention of injury to telegraph lines. During the past few years the matter of fresh legislation has been dealt with tentatively, but this is the first time that a comprehensive scheme in the form of a Bill has been prepared. From our contemporary, *Indian Engineering*, we learn that the Bill is entitled "The Indian Electricity Bill," and is based upon the Electric Lighting Acts and rules in force in this country. The scope of action extends to the whole of British Baluchistan, the Santhal Parganas, and the Pargana of Spiti. The ostensible intention of the present measure is to secure continuity of principle and uniformity, leading eventually to standardisation of machinery and methods, but perhaps the greatest advantage in favour of the Bill is that it will give assurance to investors and encourage them to use their capital in promoting electrical enterprise in India. We complain in this country of the evils of over-legislation in regard to the industry, but it is far better so than that there should be no legislation at all, which is practically the position in India to-day. In the old Act of 1887 no provision was made for the issue of licenses to companies, or for control by the Government of monopolies. When, therefore, in 1891, the Indian Electricity Supply Company applied to establish works at Calcutta, the Bengal Legislative Council were obliged to make a provision to enable the local government to extend its powers to any municipality in the province. The formation of the electric tramway company of Madras raised a similar difficulty as regards the breaking-up of the streets; so also did the Calcutta Electric Supply Corporation in 1896 with reference to the extension of the license from 21 to 42 years. The proposed Bill in the first instance relates to the supply of electrical energy to the public or for the purposes of traction—*i.e.*, to those undertakings which it is expedient to control by license. The next part deals with restrictions to be imposed on the use of electrical energy not supplied under the first part of the Bill, the object being to reserve to the Government power of control over unlicensed undertakings. The fourth section of the measure provides for the making of rules, the reference of disputes to arbitration, the requisite penal sanctions, and the repeal of the old Act of 1897. There is also appended a schedule setting forth certain provisions which are to be considered as incorporated with every license granted under the first part of the measure, with some exceptions.

Royal Institution.—According to arrangement, the Prince of Wales, as vice-patron of the institution, and the Princess of Wales were present last Friday night at the Royal Institution to hear Sir Benjamin Baker deliver his lecture on "The Nile Dams and Reservoir." Their Royal Highnesses were received shortly before nine o'clock by the president of the institution (the Duke of Northumberland), Sir James Crichton Browne, Sir Wm. Crookes, and Lord Rayleigh, and before proceeding to the theatre spent a short time in the library, where arrangements had been made for a few interesting experiments in electrical science. A sensitive flame taking the place of the ear in a telephone circuit and responding to every sound passing over the wires was shown by Lord Rayleigh, while Sir Wm. Crookes displayed some of the phenomena of the electric discharge in high vacua. Prof. Dewar repeated some of his experiments in the condensation of rarefied gases by extreme cold, and showed the almost instantaneous production of a very high vacuum in a tube through which the electric current was passing by the application of liquid air to the exterior. He also exhibited air in the solid state. Perhaps the most strikingly beautiful experiment was the production of a fountain of liquid air, rising to a height of about 6ft. and illuminated from above. The jet broke into spray, and the falling drops produced the most perfect condensation effects, in part evaporating and producing the phenomena of cloud formation at high altitudes, and in part falling back upon the table, and giving the effect of the rolling masses of cloud in an Alpine valley. Finally, the spray was allowed to fall into water, where it produced miniature icebergs and the general aspect of a Polar sea. At the lecture the Prince of Wales occupied the chair, with the Princess seated on his right hand. Sir Benjamin Baker, in a few words, expressed the pleasure it gave the managers of the Royal Institution to see their Royal Highnesses present at one of their Friday evening lectures, and their gratification at the Prince of Wales's acceptance of the post of vice-patron. Sir Benjamin then proceeded with his lecture, in the course of which he mentioned that the Nile reservoir at Aswân would contain over 1,000 millions tons of water. By far the most important of the works constructed to enable the water stored up to be utilised to the greatest advantage was the barrage across the Nile at Asyût, about 250 miles above Cairo, which was begun by Sir John Aird and Co. in the winter of 1898 and completed this spring. The total length of the structure was 2,750ft., or rather more than half a mile, and it included 111 arched openings of 16ft. 4in. span, capable of being closed by steel sluice gates 16ft. in height. The object of the work was to improve the present perennial irrigation of lands in Middle Egypt, and to bring an additional area of about 300,000 acres under such irrigation. After the lecture, which was illustrated in many instances by photographic lantern slides, the Prince and Princess of Wales held a reception of some of the more distinguished members of the audience and the officers of the institution.

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Lamp Efficiency. — The National Electric Light Association of America held their twenty fifth convention at Cincinnati on the 20th of last month, and the *Electrical World* for the 24th ult. publishes as a supplement a very full account of the proceedings, together with a number of abstracts of papers read on this occasion. One of the most interesting subjects discussed was as to what efficiency lamp should be used, and how may this efficiency be determined, and no less than five papers were presented dealing with the subject. In the first of these, Mr. Doherty considered that the efficiency of the incandescent lamp, assuming that 16-c.p. lamps are used, should be placed at that point where the cost to the central station for the supply of current just balances the cost of lamp renewals, and that when this point has been determined for a 16-c.p. lamp, then lamps of other ratings should have an efficiency that would bring the cost of lamp renewals to the same point per kilowatt-hour consumed. In other words, when lamp renewals for lamps of a given efficiency cost more than it would cost the central station to supply additional current to yield the same amount of light from a lamp of lower efficiency, this lower efficiency lamp should be adopted. Mr. Doane, in the course of another paper, gave a table comparing the economy of using lamps of several efficiencies. If, for example, the ultimate life of a four-watt lamp is represented by 375, that of a 3·5-watt lamp is 210, and that of a 3·1-watt lamp is 130. That is to say, it is as economical to use a 3·1-watt lamp for 130 hours as it is to use a four-watt lamp for 375 hours. The next paper was by Mr. L. G. Van Ness, who considered that the life of 16-c.p. lamps on perfect regulation is 420 hours for 3·1-watt lamps, 750 hours for 3·5-watt lamps, and 1,500 for four-watt lamps, and that lamps should be changed periodically by the company On this basis the most desirable efficiency will be determined by five factors—viz., the average regulation of the circuit, the generating costs that are strictly proportional to the output, investment per kilowatt capacity of the station, the average consumption per lamp per year, and the charge per kilowatt-hour to the consumer. In the fourth paper Mr. F. W. Willcox discussed the question under a number of heads, his general conclusions being as follows: The best available economy in central-station service for the 16-c.p. lamp is 3·1 per candle. The 3·1-watt lamp can be used to advantage even when the voltage is kept 4 per cent. high, with fluctuations going still higher. No central station, therefore, which supplies current by meter should use lamps of lower economy than 3·1 watts. The best economy in smaller candle-power units is that which keeps the cost of renewals per kilowatt-hour about the same as the 16 c.p. costs. This basis gives a 3·6 watt per candle economy, or, better, for 8-c.p. and 10-c.p. lamps. An economy of four watts per candle-power is desirable for 4-c.p. and 5-c p. units, this being reduced to five watts per candle-power for 3-c.p. and 2-c.p. lamps, owing to the extreme tenuity of filament used in the same. The fifth paper was by Mr. C. D. Marsh, who considers that from a strictly engineering standpoint it would seem a simple matter for the members of the association to arrive at a proper conclusion if a table were given them, fixed factors being entered and blanks left for the variables, which each manager could insert for himself. Business policy, however, should be ever kept in mind in considering the technical branch of central-station operation.

Theory of the Electrolytic Extraction of Copper.—In the issue of the *Journal* of the Chemical Society for June will be found an excellent abstract of a paper by J. Egli containing an historical account of the methods which have been proposed for the electrolytic extraction of copper from its ores, and the disadvantages which are the causes of the non-success of these are pointed out. In connection with the Marchese process, the electrolytic extraction of copper sulphides by various solvents has been investigated, and in connection with the Höpfner process the electrolysis of cupric chloride solutions has been studied. An artificial cuprous sulphide containing some cupric sulphide was electrolytically extracted with sulphuric acid of sp. gr. 1·225 (acid of maximum conductivity). On electrolysis, the ore being made the anode, a slime is deposited on it, which soon stops the current. This slime contains free sulphur, but it is shown from the analysis of the slime progressively deposited that the solution of the copper takes place in the two phases: (*a*) $Cu_2S + SO_4'' = CuSO_4 + CuS$, and (*b*) $CuS + SO_4'' = CuSO_4 + S$. Using current densities up to 30 amperes per square decimetre the sulphur could not be oxidised. Rise of temperature favours the passage of the current. The same cuprous sulphide was electrolytically extracted with 4·5 N sodium hydroxide, the sulphide in this case being the cathode. The sulphur passes into solution, leaving metallic copper in the residual slime. Since the slime in this case has not a high resistance, the potential remains nearly constant throughout the electrolysis. The current yield is at first good, but falls off, and it has further been observed that the current yield decreases as the current density rises. The cathode slime can then be easily dissolved electrolytically in sulphuric acid, and as it contains little sulphur the previous disturbing factor is removed. The electrolysis of cupric chloride was carried out with a solution of this substance, using a platinum cathode and a carbon anode in a porous cell. When the solution is stirred, it is found that rapid stirring diminishes the yield for a given current, but the copper deposited is purer because the cuprous chloride formed by the dissolving of separated copper by the cupric chloride is washed away from the deposit. In a series of experiments, the solution circulated through the electrolytic cell and passed into another vessel containing a copper plate, and the rate at which the copper dissolved was measured. To obtain constant results, the liquid must always circulate at the same rate. Addition of hydrochloric acid diminishes the current yield, but leads to a pure copper, because the cuprous chloride formed is retained in solution. When the concentration of acid is very great, the current yield begins to increase slightly. Sodium chloride added to the solution also diminishes the current yield, but not to anything like the same extent as hydrochloric acid; the deposited copper is very pure. The current yield diminishes as the concentration of cupric chloride increases, and the copper deposited becomes more impure, for more cuprous chloride is formed, and it may even happen that cuprous chloride alone is deposited. It is not advisable, however to diminish the concentration too much, for then the copper is deposited in a very spongy form. At a temperature of about 12deg., the deposited copper is spongy; a coherent deposit is obtained at about 25deg., but as the temperature rises above this, the current yield diminishes and the deposit is not so pure. Increase of current density slightly increases the current yield, because the solubility of the copper in the electrolyte is almost independent of this density. At very high current densities, however, the current yield falls on account of the separation of hydrogen at the cathode. A deposit containing up to 99·98 per cent. of copper can be obtained from a solution containing 0·1 gramme-molecule of cupric chloride, 0·1 gramme-molecule of hydrochloric acid, and 0·4 gramme-molecule of sodium chloride per litre.

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THE THEORY OF EQUALISING CONNECTIONS ON CONTINUOUS-CURRENT ARMATURES.

The following is an abstract of a lengthy article on the above subject by Prof. E. Arnold, of Karlsruhe, in the *Elektrotechnische Zeitschrift* for March 13 and 20, 1902 :

If we assume that a machine is perfectly symmetrical, magnetically and electrically, we can connect those points of the winding together which maintain the same potential relatively to one another at all points of the revolution. Under these conditions the equipotential connections would carry no current, and would consequently be valueless As soon, however, as a want of symmetry occurs—*i.e.*, as soon as E.M.F.'s of different amount are induced in the different branches of the armature—the resulting equalising currents will pass along the equipotential connections instead of passing through the brushes. In this way the load on the brushes will be reduced, and one cause of sparking will be avoided.

To ensure the correct arrangement of the equipotential connections, every circuit formed by two of these connections and the intermediate armature coils should contain equal numbers of symmetrically-situated coils connected in opposition so that their E.M.F.'s may cancel out. This condition is obviously complied with if the number of commutator segments, k, is divisible by the number of segments having the same potential.

We will first consider how the connections should be carried out with the different windings.

1. *Gramme Ring Windings and Lap Windings.*

Equipotential connections were first employed by Mordey, in the Brush Company's Victoria machines, in order to reduce the number of sets of brushes with multipolar parallel-coupled armatures to two, independently of the number of poles. In all parallel-coupled armatures the number of tapping points on the winding, or the number of commutator plates of equal potential, is equal to the number of pairs of poles, p, and the distance between two such points is equal to twice the pole pitch, or equal to the distance between two brushes of similar sign. If we call the number of commutator segments (or of tapping points on the winding) lying between the two ends of an equipotential connection, the potential step $= y_p$, then

$$y_p = \frac{k}{p};$$

p segments may be connected together, and $\frac{k}{p}$ must be a whole number.

When dealing with a multiple-parallel winding $a = m\,p$, where m is a whole number and m neighbouring segments, have practically the same potential. $\frac{k}{m\,p}$ must now be a whole number. The winding becomes multiply closed, and the potential step is, as before, $y_p = \frac{k}{p}$. In this case it is also permissible to connect neighbouring segments directly. This should, however, only be done at a few points, so that the currents in the short-circuited coils may be independent of one another. These connections will then act as equipotential connections.

2. *Series-Parallel Windings.*

In the case of the author's type of series-parallel armatures equipotential commutator segments also exist, and the determination of the potential step for these is next considered by the aid of a simplified diagram of connections devised by the writer. A distinction must be drawn between symmetrical and unsymmetrical series-parallel windings.

(*a*) *Symmetrical Windings.*—A series-parallel winding is symmetrical when $\frac{k}{a}$ is a whole number. This condition may be restated rather differently :

$$y_k = \frac{k \pm a}{p},$$

where y_k is the average span of an armature coil (front and back connections). Multiplying both sides by $\frac{p}{a}$, we get $y_k \frac{p}{a} = \frac{k}{a} \pm 1$. To make the winding symmetrical, $\frac{k}{a}$ must be a whole number; therefore, $y_k \frac{p}{a}$ must also be a whole number. But in order to make $y_k \frac{p}{a}$ a whole number, $\frac{p}{a}$ must be a whole number, so that an ordinary closed wave winding is symmetrical only when $\frac{p}{a}$ is a whole number.

(*b*) *Unsymmetrical Windings.*—When k is not divisible by a, it indicates that the a segments are not at exactly the same potential, because they are rather displaced in the field. These inequalities are, however, generally small, so that a segments can still be connected together. With unsymmetrical windings $\frac{p}{a}$ is not a whole number, so that the potential steps can no longer be equal, as they must be whole numbers.

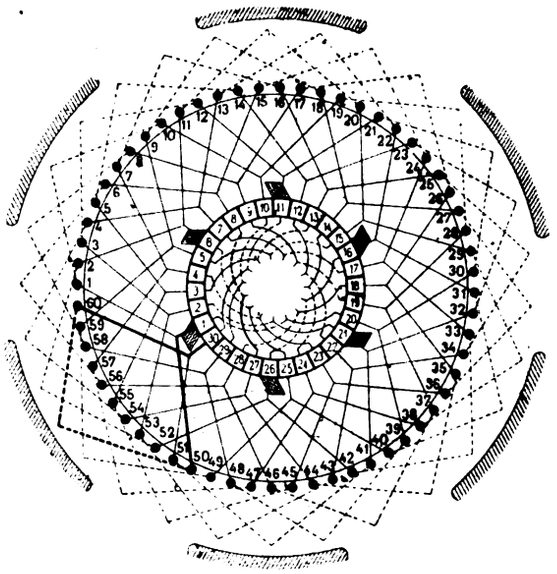

FIG. 1.

The writer suggests two methods of avoiding this want of symmetry :

1. Make $p \times y_k$ divisible by a, so that $\frac{k}{a} = \frac{p \times y_k}{a}$ is a whole number. This results in a number of separately closed circuits in parallel, the number of such circuits being equal to the common divisor of y_k and a.

2. Insert a number of sections of a lap winding sufficient to make k divisible by a. In this case $y_k = \frac{k \pm a - z}{p}$, and $\frac{p \times y_k \mp a + z}{a}$ must be a whole number. As an example, Fig. 1 shows the connections for the case when $p = 3$, $a = 2$, $z = 1$, $y_k = 9$, $k = 30$.

The rules given naturally hold good for rotary converters, and also for machines fitted with Dolivo Dobrovolsky's voltage sub-dividers. Points connected to the same collector ring must be equipotential points—*i.e.*, each collector ring must be connected to a system of a equipotential connections conforming to the conditions given.

3. *Current Strength and Loss of Power with Equipotential Connections.*

(*A*) *Parallel-Wound Armatures* (*Gramme Ring and Lap Windings*).—We will first consider a four-pole armature with an ordinary lap winding (Fig. 2), and will assume that it is set eccentrically in the field. Unequal E.M.F.'s will then be induced in the four branches, but their algebraic sum will be zero, as the winding is symmetrical and the power entering must be equal to that leaving the armature. The average value of these four E.M.F.'s will be equal to the E.M.F. which would be induced in each branch if the armature were situated centrally in the field.

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By subtracting this average value from each of the four actual values we get four E.M.F.'s as remainders, of which two are additive in each half of the armature, whilst two E.M.F.'s, each equal to the average E.M.F., cancel out. Suppose, first, that the different E.M.F.'s are equally distributed over the windings, and tend in the directions, B D A, B C A, which corresponds to the case of greater E.M.F.'s being induced in the lower than in the upper branches. These different E.M.F.'s (e) give rise to currents which, in the absence of equalising connections, must pass through the positive brushes and the external connectors, and are, therefore, liable to cause sparking. If the brushes are raised and the points A and B connected by means of a wire of negligible resistance, an equalising current will flow in the wire of such amount that the drop in each armature branch will equal e. Since the armature rotates numerous cross-connections like A B must be fitted to enable the equalising current to flow continually. At the same time, if the resistance of the cross-connections is taken as zero, current will only flow in that connection (A B) which is under the brush, because, as can be seen from Fig. 2, the currents from neighbouring sections mutually cancel out as far as the other cross-connections are concerned. The losses due to the equalising currents are a maximum in this case, and $= \frac{4e^2}{R}$, where R is the resistance of one armature branch. The equalising current in one-half of the armature is $\frac{e}{R}$. If the resistance of the cross-connections is increased, the potential difference between A and B will no longer be zero, and therefore currents occur in all the cross-connections, though the total loss in the armature winding is reduced. If the brushes are now put on again, an equalising current will flow through them and their outside connector due to the difference of potential between A and B. It follows, therefore, that the greater the resistance of the equalising connections the less will the internal armature copper losses be, but at the same time the less perfect will the equalising be.

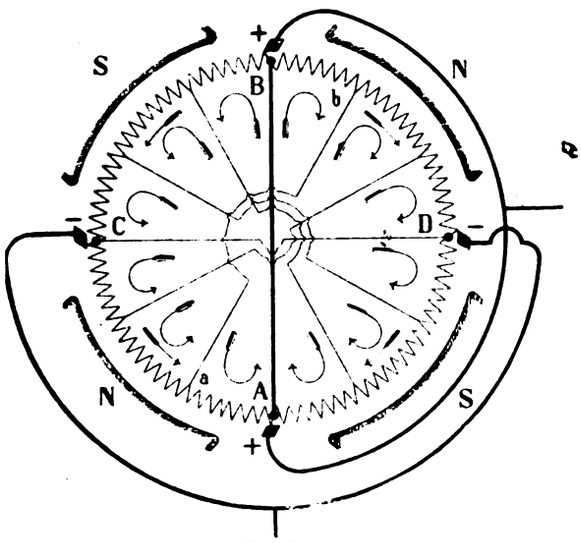

FIG. 2.

Up to the present we have neglected the effect of the armature reaction upon the field. This is incorrect. The reaction is such that the weaker poles become strengthened and *vice versâ*. The effect may become very considerable, and on this account lap windings are more or less self-regulating in respect to equal current distribution in the different branches. This self-regulation is improved by the equipotential connections. The calculation of the loss due to the equalising currents would be very involved; it depends not only on the differences in E.M.F., the reaction of the currents, the resistance of the windings and the equipotential connections, but also on the contact resistances of the different brushes.

According to recent tests carried out at the Technical High School, Karlsruhe, this contact resistance is made up of a part inversely proportional to the current density and a part which remains constant—*i.e.*, the voltage difference between a brush and the commutator is made up of a constant part of about one volt and a part proportional to the current. Since the equalising current flows in the direction of the main current at one brush, and in the opposite direction at the other, those parts of the voltage difference which are proportional to the current cancel out, so that only the constant part of the contact resistance can affect the question of equalising currents. As this latter part is very small, the equalising current will depend principally on the E.M.F.'s, the reaction, and the resistances of the windings. It is also clear that the resistances of the equipotential connections must not be made greater than the constant part of the brush contact resistance, if satisfactory equalising is to be obtained.

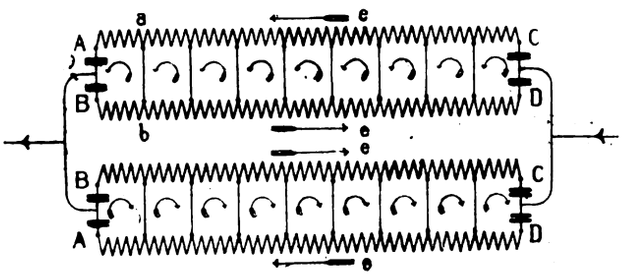

FIG. 3.

The effects of equipotential connections on lap windings are then as follows: (1) The equalising currents due to want of symmetry in the field, which previously passed through the brushes and their external connections, now pass principally through the equipotential connections. (2) The equipotential connections offer several paths of low resistance to the equalising currents, and these currents and their reaction on the field are therefore increased, and the magnetic pull on the armature is reduced. (3) As the equalising currents tend to equalise the fields, the voltage differences in the armature become less, and also the currents do not attain such large values as those due to the original voltage differences. On this account the loss in the armature is only slightly increased by the equipotential connections. (4) The connections exert an equalising effect on the commutating currents under the different brushes of like sign.

We will next consider the case in which the E.M.F.'s are no longer equally distributed over the armature branches, but have a sinusoidal distribution, which is more in accordance with the actual conditions. The arrangement in Fig. 2 may be converted into that of Fig. 3, which is more convenient in considering the directions of the equalising currents. The sign = in Fig. 3 represents the brushes. Branches A C and D B are cross-connected as well as branches B C and A D. The directions of the differences of E.M.F. are shown in Fig. 3. Neglecting the resistances of the equalising connections and of the brush contacts, the current distribution in the connections and in the armature winding will be sinusoidal. In this case the conditions are more favourable than in the first case, both as to loss and as to voltage differences between brushes of similar sign. When the machine has six or more poles the conditions become more complicated, but the general working is much the same as in the four-pole machine, so that the above statements hold good generally. In order to study the action in a multipolar machine, it is best to draw a diagram

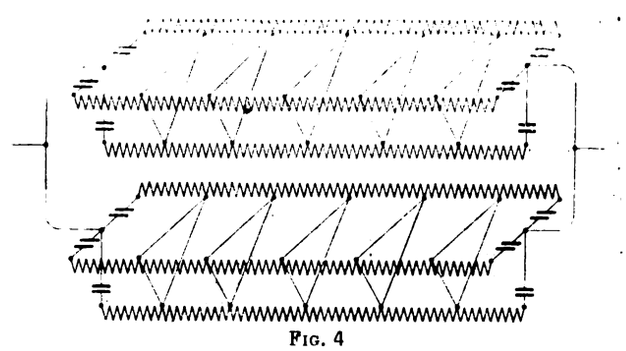
FIG. 4

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as in Fig. 4, which represents a six-pole lap winding. Such a diagram, considered as a picture in space, enables the flow of the equalising currents to be readily followed.

It is worth enquiring whether it be permissible, instead of fitting every segment with an equalising connection, only to fit every third, fourth, or fifth segment with one. This question may be answered by a consideration of Fig. 2. At the moment when no connection between A and B exists under the brushes and the next one is *a b*, a voltage difference is developed between A and B, tending to produce a current through the brushes and the outside connector. This can, however, never be large, as the sum of the differences of the E.M.F.'s in the portions *a* A and *b* B is small even when only every fifth section is fitted with an equalising connection. In this case the voltage difference existing between A and B is only that due to five coils lying in the neutral zone.

(*B*) *Wave-Wound Series-Parallel Armatures.* — It is a characteristic of wave windings that they progress continuously round the armature, so that each armature path contains coils under all the poles. On this account it is hardly possible for a want of symmetry in the field to set up internal currents. On the other hand, greater differences of potential may be expected and are found to occur between neighbouring commutator segments. When the winding is symmetrical, equalising currents in the cross-connections can only occur due to want of symmetry in the fields, and are difficult to calculate. They will, however, all flow in such directions as to tend to equalise the fields, and on this account cross-connections are of service in reducing the voltage differences between neighbouring segments and in better balancing of the armature in the field. When the winding is unsymmetrical the voltage differences become greater, and may lead to small sparks between neighbouring segments all round the commutator circumference at every *a*-th segment unless equalising connections are fitted. If the contact resistances of certain brushes is too large, the current will divide unequally amongst the different brushes of like sign, and the cross-connections will act as a convenient inductionless path for the equalising currents so set up.

These connections, therefore, have the following effects: (1) the voltage differences between neighbouring segments will be equalised and more evenly divided up; (2) the unequal field strengths will be equalised, and the armature consequently better balanced in the field; (3) in case of unequal contact resistances occurring at brushes of like sign, part of the consequent equalising current can pass along the inductionless equipotential connections; (4) a more satisfactory passage of the short-circuit current is ensured.

The writer next proceeds to consider the effect of equalising connections on one or two types of unsymmetrical wave windings.

(*C*) *Application of Equipotential Connections.*—Experience has shown that it is very difficult, and in any case uncertain, to build multipolar machines so as to be magneti cally and electrically absolutely symmetrical. The same type of machine may work well in one case, and may spark and heat excessively in another. Laminated poles are decidedly conducive to magnetic symmetry. Wave windings are far less sensitive to magnetic want of symmetry than Gramme and lap windings, and yet it has been repeatedly noticed, especially with unsymmetrical multipolar wave windings, that they are inclined to spark and make good running impossible. The application of equipotential connections may, therefore, be decidedly recommended both for lap and wave windings. The Elektricitäts Aktien-Gesellschaft vorm. Lahmeyer und Co. makes use of equipotential connections on all the larger machines, especially on the flywheel type of dynamo, with excellent results.

It is not necessary to fit all segments with such a connection. Three, four, five, six, or more segments may be omitted without impairing the advantages of the equalising connections. These connections can be carried out inside the commutator, behind the commutator, on the back or front end of the armature, or on the armature circumference. In the latter case the binding bands may be employed as the equipotential connections. Equipotential connections for wave windings have been patented in Germany (No. 126,872) and other countries.

FORMERS AND FORMER-WINDING.

BY F. W. DAVIES.

(*Continued from page 805.*)

VI. Merits and Demerits of the Various Windings and Formers.

The various formers and former-windings having been described, it is now possible to make a comparison of them, with a view to discovering their relative advantages and disadvantages. As there is but one method of former-winding for field magnets, and practically but one design of former suitable for use with it, there is no need to discuss this winding. The same remark applies also to the former-winding of ring armatures. Thus, the comparison resolves itself into a comparison of the various *drum* windings and formers. It will be convenient to consider first the windings, and afterwards the construction of the formers used for those windings.

The question as to the relative merits of the three types of former-winding, the evolute, bastard, and barrel, presents itself from two points of view: firstly, from the point of view of economy of space; secondly, from the point of view of efficient ventilation.

In asking the question: What type of winding is most economical with regard to the space required at the ends? it should be remembered that the answer to the question depends to some extent upon the type of field magnet used—whether it is of the bipolar or multipolar type. Consider, first, the case of an armature for a bipolar magnet. Which winding will require the minimum of space? Manifestly, not the barrel winding; for the end winding, being carried out in a line with the active winding—that is, the conductors on the face of the armature core—projects to a comparatively great distance. The fact of the ends of the evolute winding being carried down the ends of the armature core renders this winding the more economical in this respect. In fact, it may be regarded as a barrel winding, the ends of which, instead of being carried out straight, have been bent down towards the shaft. The bastard winding requires less room than the barrel winding, but rather more than the evolute winding. For a two-pole machine the evolute winding is, undoubtedly, the most compact.

When a four-pole field magnet is used, the case is somewhat different. Owing to the angular distance between the pole centres being one-half of what it would be in a two-pole field, the arc embraced by each coil is proportionately less, consequently the end windings are not so bulky. With a barrel winding only about half the length is required for the ends that would be required in the case of a two-pole winding. In the evolute winding this economy is not fully realised, for the corresponding reduction of end-winding space with this winding would be by a reduction of the *radial depth* of the end windings. But a reduction of the radial depth of the end windings of an evolute-wound armature would obviously be of little advantage as far as the first cost and over-all dimensions of a machine are concerned. With a four-pole winding, owing to the end connectors being shorter than with a two-pole winding, they are not packed together so closely. In consequence of this it is possible to make them thicker than when a two-pole winding is used. A corresponding reduction in their width can then be made, but care must, of course, be taken that the cross-sectional area of each connector is sufficiently great. By this means the room required for the evolute end windings, also, may be reduced when a four-pole winding is used; though this reduction is only a slight one, as the space between the right-handed and left-handed groups of spirals at each end must necessarily remain the same. To summarise: the barrel, bastard, and evolute windings are practically on a par as regards the end space required for a four-pole winding, there being very little to choose between them. Whatever advantage there may be in this respect

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accrues to the latter type of winding. For the armature windings of machines having more than four poles, the barrel winding, undoubtedly, occupies the least space.

The question of ventilation is a simpler one to decide. Obviously, in ordinary cases—no matter what the number of magnet poles may be—there is but little difference in the amount of cooling surface presented by the three windings. The advantage, if any, lies with the barrel type of winding. Next to this comes the bastard winding; and, although this does not *seem* to present a large superficial area at the ends, yet, owing to the interstices among the different coils at the ends, it presents a larger cooling surface than it appears to do. Sometimes the barrel end plates are dispensed with on a bar-wound armature with barrel winding. When this is done, the ventilation is excellent, for both the inside and the outside of the end windings can radiate heat freely.

It is now possible, in the light of what has been said, to decide when each particular type of winding should be used. Each winding has its distinctive sphere of application, and it is of importance that it shall be clearly understood what this is. The evolute winding, when used on a two-pole machine, has been shown to require rather less room at the ends than the bastard winding, and considerably less than the barrel winding. This means, of course, that the length of the whole machine will be less than if a bastard or barrel winding were used, which is obviously a great advantage. Therefore, the evolute winding should be used, wherever practicable, for the armatures of two-pole machines, notwithstanding the fact that the cooling surface presented by such a winding may be slightly less.

The bastard winding is unsuitable for armatures in which a large gauge of wire is used, owing to the difficulty there is in interlacing the coils with one another on the core in such a case. As regards compactness, it is inferior to the evolute winding for two-pole machines, and inferior to the barrel winding for machines having six or more poles. Its true sphere of application is for very small armatures, and for these it is generally preferable to either the evolute or the barrel winding. The chief feature in its favour is the simplicity of the coils, the winding of which is a matter requiring very little skill. With this winding it is almost impossible for any fault to occur through inexperience or carelessness on the part of the winder of the coils. On a small armature, wound with a large number of turns of fine wire, the bastard winding is the cheapest to employ.

The barrel type of winding should be used for all multipolar machines, wherever practicable, for it is safer than an evolute winding, both electrically and mechanically; and for machines having six or more poles is decidedly more compact.

With regard to the type of former to be used for the armature winding, there is not much to be said. Formers have been classified as the block and the frame types of formers. It may, perhaps, appear to be a matter of indifference which type is used for any given winding; but it will be found in most cases that there is some slight advantage attending the use of one or other of these types. As previously pointed out, each coil has usually to be made in two operations when the block type of former is used. For this reason, it would appear advisable always to use a frame former; and, indeed, this would be so, were it practicable. When a coil consists of a large number of turns of fine wire, it is an expensive method to wind it on a frame former, as with an increase in the number of turns there is an increased difficulty in keeping the wires in their places at the bends at the ends of the coils. These bends occur on the jigs in the case of a frame former for evolute winding, and on the edges of the frame in the case of the frame former for barrel winding. Therefore, for small armatures, and all those having a large number of turns in each coil, the block type of former is preferable. When there are but a few turns of thick wire per coil, a frame former should be used.

(To be continued.)

American Pacific Cable.—The House of Representatives on June 11 rejected the Bill enabling the Government to construct the proposed trans-Pacific cable.

THE SCHMIDT SYSTEM OF SUPERHEATING STEAM.

The advantage of having the steam used for driving engines superheated before it reaches the high-pressure cylinder, is recognised by all engineers who have looked into the theory of the steam-engine and know the large losses which result from condensation in the cylinders. The other advantages in using superheated steam need hardly be gone into here, but the disadvantages are also numerous unless the details of the superheater and of the lubrication of the engine are well thought out. In this last respect the Schmidt system has the great advantage of being the outcome of years of experience, and we may add that commercial success of the system has been proved again and again on a large scale on the Continent. This is so in spite of the fact that with this system the superheating is carried much higher than with the ordinary types, in which the superheat is obtained from tubes placed in behind the boiler. In fact, with an ordinary system as usually employed, most of the superheat is lost by the time the steam enters the cylinder.

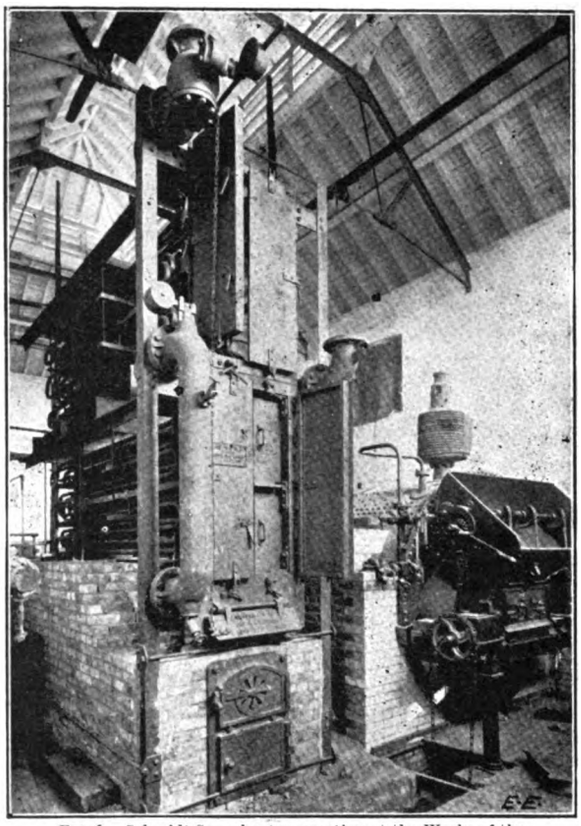

FIG. 1.—Schmidt Superheater, erecting at the Works of the British Xylonite Company.

Messrs. Easton and Co., of Erith, have taken up the license for this Schmidt system in the United Kingdom, and have already secured a number of important orders for equipments. On Tuesday last we were invited, with others, to inspect one of these superheaters at work at Erith, and to see the component parts of a large number of others in course of construction. The steam dynamo which is used to supply a large number of electric motors throughout the works is supplied with superheated steam on the Schmidt system, with wonderful results as regards both steam and coal consumption. Prof. J. A. Ewing, F.R.S., of Cambridge, has carried out a series of trials on this engine, and his report on the same is given at the end of this article, so that we need hardly describe it in detail.

In Fig. 1 is shown a superheater in course of erection at the works of the British Xylonite Company at Manningtree, Essex. It will be seen that this superheater is independently fired, which enables the degree of superheat to be conveniently regulated. In connection with this the firm are supplying two engines, each of 300 i.h.p., which will run at 140 revolutions per minute and drive three-phase alternators. The steam pressure is to be 140lb. per square inch, and with a steam temperature of 660deg. F.

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the firm have guaranteed a steam consumption of 10lb. per indicated horse-power hour. The engines in this case are of the horizontal, tandem, compound condensing type, with the reheater arranged below the floor level. In this instance also the superheated steam, on its way to the high-pressure cylinder, passes round the reheater and heats up the exhaust steam from the high-pressure cylinder on its way to the low-pressure cylinder. Fig. 2 gives a cross-section of a superheater of the type used for independent firing for land purposes. The firm have supplied in all, or have orders for, plant equivalent to 45,000 h.p., and amongst these orders is a large one for the Trafford Park Power Company. The firm has already granted sub-licenses to construct engines on the Schmidt system with reheating feeders to the following firms—*i.e.*: Messrs. Bow, McLachlan, and Co., Limited, Paisley, N.B.; Messrs. James Carmichael and Co., Limited, Dundee, N.B.; Messrs. Browett, Lindley, and Co., Limited, Patricroft, Manchester; Messrs. Fairbairn, Lawson, Combe, Barbour, Limited, Belfast, Ireland; and Messrs. J. and E. Hall, Limited, Dartford, Kent. Applications are also under consideration

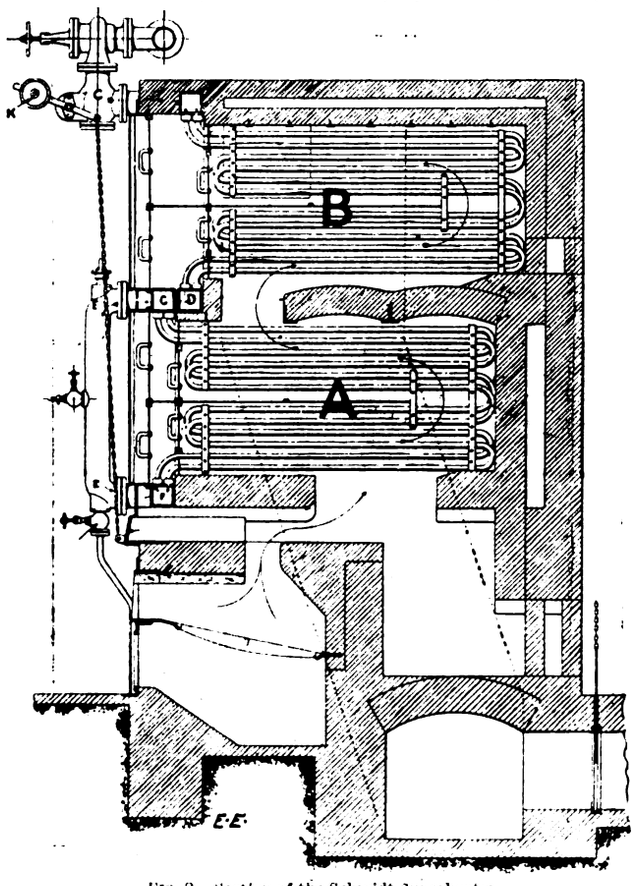

FIG. 2.—Section of the Schmidt Superheater.

from a number of first-class firms. The license of Messrs. Easton and Co. only extends to stationary engines, but on Tuesday last we were shown drawings of the application of the system to both marine and locomotive engines. The engine working at Erith was being lubricated by graphite forced in just beyond the stop valve. The supply was regulated by means of a piston working in a cylinder, which was capable of containing a fortnight's supply. The piston was slowly forced down by means of a ratchet and worm and wheel gear, worked by means of a belt from the shaft of the dynamo. The graphite was in the form of a paste, being mixed up with a mineral oil. We understand that for the horizontal types of engines the firm are using high-class mineral oils to lubricate the high-pressure cylinder.

The following is the full text of Prof. J. A. Ewing's report, which is dated March 14, 1902, and addressed to Messrs. Easton and Co.:

"On Feb. 28 I carried out a series of trials of the high-speed engine at your Erith works, to determine the steam consumption under various loads, when the engine is supplied with highly superheated steam. The engine works with triple expansion, and is of the vertical inverted double-action type, with enclosed crankshaft and forced lubrication. It runs at fully 400 revolutions per minute. It is coupled direct to a dynamo on the same bed-plate, which supplies continuous current at about 220 volts. There are three cranks set at 120deg. apart, with two cylinders in tandem over each crank. The steam expands first in one of the upper cylinders; then is divided between the two upper cylinders; and finally passes through an intermediate receiver to the three lower cylinders, which act jointly in the third stage of the expansion. In the

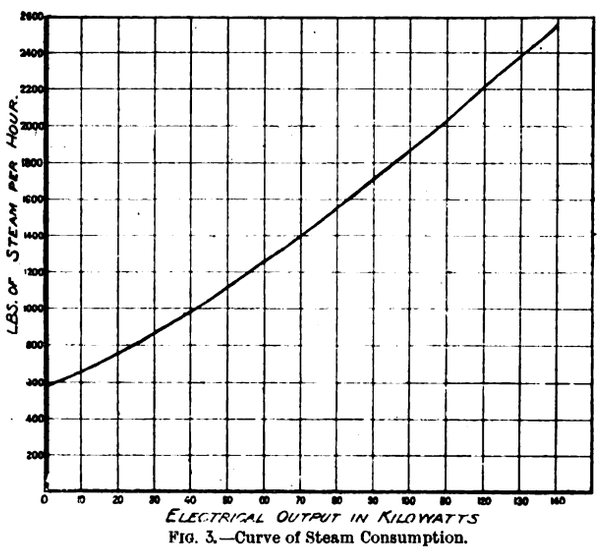

FIG. 3.—Curve of Steam Consumption.

high-pressure cylinder, and each of the two intermediate cylinders, the diameter is 12in.; in the three low-pressure cylinders it is 16in.; the stroke is 8in. The intermediate receiver is furnished with Schmidt's patent reheating arrangement, whereby a portion of the superheat is taken from the steam before it enters the engine, and is applied to dry or superheat the steam which comes from the intermediate cylinders. The distribution of steam is by piston valves in three lines, corresponding to the three lines of cylinders, with a supplementary expansion valve to control the cut off in the

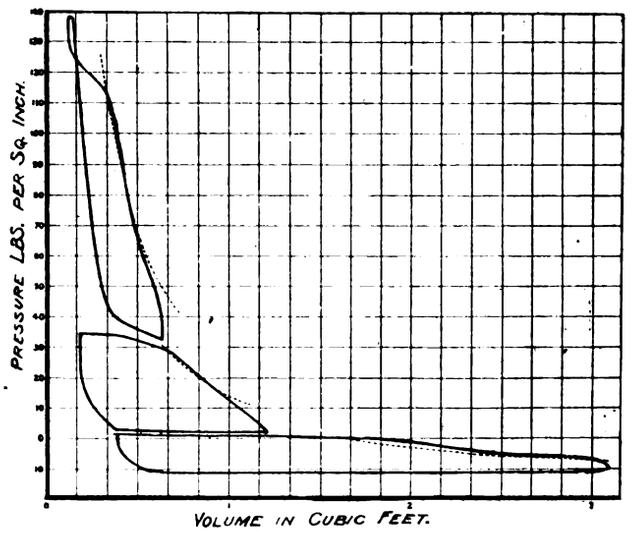

FIG. 4.—"Rankinised" Indicator Diagrams taken on the Erith Engine working with Superheated Steam.

high-pressure cylinder. This valve, which is of the piston type, is automatically regulated by a powerful shaft governor operating on its eccentric. The governor is prompt and effective in its action, and allows the load to be suddenly thrown off or on without more than a small temporary disturbance of the speed. The regularity with which the engine runs is all that can be desired. The governor is provided with a hand-wheel, which allows the speed to be adjusted at will. An oil-pump in the casing which encloses the crank draws oil from the bottom of the casing and delivers it, under a pressure of about 15lb. per square inch, through a system of

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Trial	A.	B.	C.	D.	E.
Electrical output, in kilowatts	140·2	104·0	67·3	41·2	10·0
Number of pounds of steam condensed per hour	2,570	1,940	1,367	1,004	663
Number of pounds of steam per kilowatt-hour	18·3	18·5	20·3	24·4	—
Pressure at stop valve, pounds per square inch	129	130	131	126	82
Temperature at stop valve, ° C.	376	371	368	352	295
Temperature at stop valve, ° F.	709	700	694	666	563
Temperature of high-pressure steam after receiver, ° C.	316	305	298	293	255
Temperature of high-pressure steam after receiver, ° F.	601	581	568	559	491
Temperature at intermediate cylinder exhaust, ° C	141	128	121	118	118
Temperature at intermediate cylinder exhaust, ° F.	286	263	250	245	245
Mean temperature at low-pressure cylinder inlets, ° C.	203	193	184	174	159
Mean temperature at low-pressure cylinder inlets, ° F.	397	380	363	345	318
Vacuum, inches	23·15	23·5	23·8	23·8	22·7
Barometer	29·6	29·6	29·6	29·6	29·6
Indicated horse-power	226	—	—	—	—
Electrical horse-power	188	—	—	—	—
Ratio of electrical to indicated horse-power	0·83	—	—	—	—
Pounds of steam per indicated horse-power hour	11·4	—	—	—	—

pipes to the cross-heads, and to the bearings of the connecting rods and crankshaft. Cylinder oil is delivered to the steam by a ratchet pump. I noted that the volume of oil so delivered during five hours of continuous running was barely 20 cubic inches. The engine works in ordinary use with a jet condenser, but to facilitate the measurement of steam consumption a surface condenser was temporarily used during these trials. The air-pump is independently driven by an electric motor, which absorbs about 4½ kw. The steam is superheated by a Schmidt superheater in the boiler flue. On the occasion of these trials the temperature close to the engine ranged from 350deg. C. to 380deg. C. (662deg. F. to 716deg. F.). The pressure, tested by a standard gauge at the same place, was 130lb. per square inch. The saturation temperature corresponding to this pressure is 356deg. F., hence the greatest superheat was 360deg. F. Of this superheat about 115deg. or 120deg. was given up to the low-pressure steam in the receiver, so that by the time the live steam reached the high-pressure cylinder its temperature was no more than 600deg. F. During the trials the engine ran continuously for about 14 hours, and measurements of the steam consumption were made at a series of five different loads, ranging from the full load of 140 kw. to 10 kw. The superheat was maintained nearly constant down to half load, but it fell off somewhat when the load was very much reduced, and in the trial at 10 kw. the temperature was only 295deg. C. (563deg. F.). The air-pump discharge was measured by delivery into a pair of 30-gallon measuring tanks. The electrical output was measured continuously by an integrating wattmeter, readings of which were taken at the instant when each tank became full. The readings of the wattmeter were checked throughout by keeping a systematic log of the volts and amperes on standard instruments which were calibrated in my laboratory here. The contents of the two measuring tanks were also determined by weighing in this laboratory, when the average weight of contents was found to be 298·6lb. Indicator diagrams were taken by 12 Crosby indicators. The indicated power has been determined for the full power trial, but all the trials give a direct comparison of the electrical output and the consumption of steam. To measure accurately the indicated power of a high speed engine is always a matter of some difficulty, and I attach much more importance to the measurements of electrical power. The results of the trials are given in the above table.

"The quantity of steam used per hour is shown graphically in Fig. 3 for the various trials in relation to the electrical output in kilowatts. It will be noticed that the observed quantities fall well on a smooth curve. From the curve the following table has been prepared to show the number of pounds of steam used per electrical unit generated at various grades of output:

Kilowatts	Pounds of steam used per electrical unit.
140	18·3
120	18·5
100	18·7
80	19·4
60	20·8
40	24·5
20	38·0

"The trials show that this engine, using highly superheated steam, maintains a very high standard of efficiency in regard to steam consumption throughout a large range of power from full power downwards. Good as these results are, they would doubtless have been better if the boiler had permitted the supply of steam of higher pressure. The boiler imposed a limit of 130lb., and the engine, with its triple-expansion action, would no doubt show to better advantage if the pressure were 40lb. or 50lb. higher.

"Fig. 4 shows a representative set of indicator diagrams taken during the full power trial, "Rankinised," or drawn to a uniform scale of pressure and volume. The dotted lines on this figure show the volume which would be occupied by the quantity of steam apparently present in the cylinder had this been saturated. The quantity in question is reckoned by taking in each cylinder the sum of the steam used per stroke, and the cushion steam or steam shut up in the clearance space. The "saturation" lines so drawn are nearly coincident throughout with the actual expansion curves, and show no considerable amount of superheating at any stage.

"Probably, however, they overstate the quantity of steam present (and, therefore, understate the amount of superheat), for some steam passes the valve without entering the cylinder, and this is borne out by the temperatures, which show more superheat at the intermediate pressure outlets than is apparent in the figures. What the superheat is at that stage in the expansion is rather to be judged from the following figures:

Pressure at exhaust from intermediate cylinder.	Corresponding temperature of saturation.	Actual temperature observed at intermediate cylinder outlets.
17½lb.	220deg. F.	286deg. F.

"By the action of the reheater, this steam is further superheated to 397deg. F. before admission to the low-pressure cylinder, and is thereby prevented from becoming wet at any stage in its expansion. A steam consumption of only 18·3lb. per electrical unit is a remarkably good result in view of the small size of the engine and of the fact that it was working with steam of a pressure too low to take full advantage of triple expansion, or to develop economically the engine's full power. The trials exhibit in a striking way the economy of high superheating.

"(Signed) "J. A. EWING."

SOME NOTES ON ELECTRIC HAULAGE FOR MINES.

Electricity as a motive power has now been applied to practically all industrial purposes, and owing chiefly to the great flexibility, safety, and economy of electrical apparatus, it has been found that it can replace with advantage almost every other known method of power distribution. Among the most successful applications of electrical power has been its application to surface and underground haulage in mines, both by means of locomotives and in conjunction with the rope systems.

Concentration of Plant.—Not the least of the factors which have contributed to the great success of electric haulage is the readiness with which electricity may be applied to all other mining operations requiring power, such as pumping, hoisting, lighting, coal cutting, boring,

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rock drilling, ore crushing, stamping, washing, and sifting, and, in fact, all other duties apart from haulage requiring mechanical power. But perhaps the most important point in favour of electric power for this work is that it admits of the concentration of the power plant necessary for the operation of the various machines (even when these are scattered over a large area) under one roof and under the control of one staff, and also that it permits of the use of engines of large power and high efficiency in conjunction with the electrical generating plant. Thus the energy required is obtained with a minimum loss in generation, and as electric motors are most efficient machines, even through a wide range of load, the transmission losses will also be a minimum if the cables are made large enough. The cables for transmitting the power to any part of the workings can be designed to work with a loss ranging from 2 per cent. upwards of the total power transmitted, the only limiting factor being the capital invested in the necessary copper. An economical value for this loss is about 10 per cent., lost in the cable when transmitting the maximum load; this, under average working conditions, will result in a loss throughout the period of working of between 5 and 7½ per cent. These are advantages which are not obtainable in any other system, and the increase in general efficiency obtained by such concentration of power will be readily appreciated by those who have had experience with the various small engines generally found scattered about large mines, the cost of maintenance and general inefficiency of these small engines being almost entirely neglected by reason of the fact that it is never considered necessary to make any tests on them, and they are deemed to be good enough so long as they will do the work required, irrespective of the cost in steam at which they do it. The economy in fuel and water thus obtained by electric transmission is a most important consideration in dry or barren districts, such as some of the Australian diggings, where these commodities are scarce and valuable.

System of Supply.—The selection of the site for the central power-house usually determines the system of electrical distribution to be employed. If the distance from the central station to the furthest point where considerable power is required does not exceed three miles, it would be difficult to improve on the 500-volt continuous-current system, except when the distance is quite short and the pressure drop unimportant, in which case a lower voltage, such as 220, may be used, as this pressure is admirable for the electric lighting, which is always required about the works, and the danger of shock to employés and the trouble and expense of maintaining the insulation is considerably reduced by its employment. When the distance exceeds three miles, however, a high-tension two or three phase current should generally be employed, which may be reduced to any convenient pressure by static transformers at the working. As three-phase motors are equal in every respect to two-phase, and as this system requires less copper in the line for equal power transmission than the latter (assuming the same potential difference between the lines), the three-phase system, with voltages varying from 2,000 to 20,000 (depending on the length of the line) is usually employed for this class of work.

Frequency.—A very important point in connection with the choice of an alternating-current power system is that the frequency should be low, say from 25 to 50 per second. As far as lighting is concerned, no advantage is gained by increasing the periodicity beyond this latter figure, and the reduced cost of transformers for higher frequencies is more than counterbalanced in *power* plants by increased trouble in connection with the rest of the apparatus. Where it is necessary to run the generators in parallel, and to operate synchronous motors or rotary converters, it is usually best to adopt about 25 as the frequency. Apart from the above consideration, it is easier to obtain satisfactory constants for induction motors at low frequencies than at high, and where a slow-speed motor is required, some difficulty may be experienced in winding its stator for a sufficient number of poles unless a low periodicity be adopted. Taking all considerations into account, probably a frequency of about 40 periods is the most satisfactory to adopt for general power and lighting work.

Systems of Haulage.—With regard to the system of electric haulage to be employed, there is clearly no single system which can be put forward as the best for all cases, and the local and working conditions alone can determine which system or systems should be used. Where the grades are excessive and the loads heavy, it is evident that locomotives should not be employed, and, on the other hand, endless rope haulage would be found awkward and most wasteful where the tracks are long and intricate.

Rope Haulage.—Of the two kinds of rope haulage—the endless and the intermittent or reversing—the former is the most inefficient, as with it the rope is continually running over a number of not very frictionless pulleys, whether a load is being hauled or not, thereby wasting a very large percentage of the power employed. When the system is used, however, and the power supply is by direct current, the best motor to use is a *shunt-wound* motor. This, if supplied with a constant voltage, will maintain the speed of the rope constant within 5 per cent. without any attention or regulation. On the other hand, for winding engines which hoist the load either vertically up a shaft or haul it up an incline, stopping when the load has got to the top, the *series-wound* motor is undoubtedly the best; but where the load is applied to the motor through a friction clutch, the motor being allowed to run when the load is thrown off, a shunt motor should be used, as the series motor would race excessively on light load. The latter arrangement has frequently been used in the past, and in some cases even the motor has been arranged to run continuously in one direction, the reversing being done by mechanical means, such as a friction reversing clutch or crossed belting; but these methods are now seldom employed, the modern practice for electrical winding engines being to use either one or two series motors geared direct to the winding drums and controlled in speed by resistances in the main circuit. The series motor, owing to its great starting powers and capacity for overloads, seems specially adapted for this class of work. For large engines, two motors are used so as to take advantage of the more efficient series-parallel system of control.

Brakes.—Rheostatic braking is frequently employed in connection with these winding engines, as also a mechanical brake electrically operated by means of current supplied by the motors when running as generators. But perhaps the most common type of brake used is the magneto-electric. This is simply a mechanical brake actuated by a spring or weight, but in which the brake shoes or strap are kept off the disc by an electromagnet in series with the main current, so that the brake acts when this main current is broken, and the shoes are lifted the instant the circuit is made.

Speed.—A common speed for electric hoisting from depths up to 500ft. may be taken as between 200ft. and 250ft. per minute, and the net load somewhere in the region of one ton, 20-h.p. to 25-h.p. motors being employed for this purpose.

Cost of Plant.—At the present time the price of electric winding gear may be taken to be about double that of equally powerful compressed-air engines, but owing to the poor efficiency of the latter, especially for engines so situated that the air cannot be reheated before use, and also owing to the greater ease with which the electric plant can be shifted and fixed at different points in the workings, electricity is fast superseding its older rival in this field.

Locomotive Haulage.—The advantages of the locomotive system of haulage over rope haulage, especially for surface work where the gradients are such as can be managed by locomotives, are the greater simplicity of working and improved efficiency, as well as the decrease of maintenance cost due to the elimination of the numerous sheave wheels, rollers, and other mechanisms peculiar to the rope system. As locomotives are made with a wheel base which will admit of operation on curves of radii as short as 15ft. they form a very flexible method of haulage, indeed, but so much depends on the grades and loads to be hauled that, as mentioned previously, this method cannot be recommended offhand without studying the local conditions. It need hardly be mentioned that the trolley system with bare overhead conductors and rail return is the only one to be employed for practical locomotive haulage, any attempt at

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surface-contact or conduit systems being out of the question. Where the continuous-current system is adopted the locomotive is equipped with a series-wound motor or motors, the regulating switchgear being of the ordinary tram controller type. If two motors are used, as becomes necessary when the power is considerable and the gauge narrow, it is advisable to adopt series-parallel control. The motors are always of the *enclosed type*, but as the load is of a very intermittent character, being on the average much less than the maximum, the heating difficulties usually encountered with enclosed motors are not serious in this case.

Rating and Efficiency.—A common system for rating these motors is based on a temperature rise of about 75deg. C. after one hour's run at the rated load. A motor rated in this way will run sufficiently cool on actual service. The efficiency of these motors with gearing at rated load may be taken as at least 77 per cent. for the smaller sizes and 80 to 82 per cent. for 30 b.h.p. motors.

Three-Phase Locomotive.—When the power supply is by three-phase currents, it is necessary to have two insulated conductors, which slightly complicates the case. The motors used are always of the induction type, and, in order to provide for speed regulation, the rotor winding at three points is brought to collector rings for the purpose of inserting an external resistance in the rotor circuit. By this means any required speed regulation may be obtained at about the same efficiency as with the continuous-current motor controlled by series resistances. The behaviour of these motors at starting and under overloads is not quite so admirable as that of the series direct-current motor, but, on the other hand, the absence of a commutator and the inability of the motor to run at a speed much above that of synchronism, are two decided advantages in favour of three-phase motors for locomotive work.

TABLE I.—Standard Mining Electric Locomotives: Draw-bar Pull in Pounds at Eight Miles per Hour.

Type.	Level.	1 % grade.	2 % grade.	3 % grade.	4 % grade.	5 % grade.	6 % grade.
A	500	460	420	380	340	300	260
B	1,000	920	840	760	680	600	520
C	1,000	920	840	760	680	600	520
D	1,500	1,380	1,260	1,140	1,020	900	780
E	2,000	1,860	1,720	1,580	1,440	1,300	1,160
F	2,500	2,340	2,180	2,020	1,860	1,700	1,540
G	3,000	2,820	2,640	2,460	2,280	2,100	1,920
H	3,500	3,300	3,100	2,900	2,700	2,500	2,300
I	4,500	4,260	4,020	3,780	3,540	3,300	3,060
J	5,500	5,200	4,900	4,600	4,300	4,000	3,700

TABLE II.—Standard Electric Locomotives.

Type	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.
Draw-bar pull in pounds—	500	1,000	1,000	1,500	2,000	2,500	3,000	3,500	4,500	5,500
Speed in miles per hour—	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10
Number of motors—	1	1	2	2	2	2	2	2	2	3
Horse-power of each motor—	10	20	10	20	25	30	35	40	50	35
Weight of locomotive in pounds—	4,000	8,000	8,000	12,000	14,000	16,000	18,000	20,000	24,000	30,000
Minimum gauge—	22in.	36in.	18in.	28½in.	28½in.	36in.	36in.	36in.	40in.	39in.
Minimum gauge with outside wheels—	34in.	48in.	30in.	45½in.	45½in.	53in.	53in.	53in.	57in.	53in.
Width over all with inside wheels minimum gauge—	40in.	56in.	37in.	48½in.	48½in.	56in.	56in.	56in.	60in.	59in.
Height over all, excluding trolley—	36in.	39in.	36in.	39in.	39in.	39in.	39in.	39in.	43½in.	46in.
Length over all, excluding bumpers—	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
	7 4	7 9	9 3	9 4	9 4	9 4	9 4	9 4	10 10	11 8
Wheel base—	30in.	35in.	36in.	40in.	40in.	40in.	40in.	40in.	40in.	62in.
Diameter of wheels—	24in.	28in.	24in.	28in.	28in.	28in.	28in.	28in.	28in.	28in.
Lightest steel rails to be used in pounds—	8	12	12	16	20	25	30	30	40	40

Tractive Effort.—Generally speaking, the draw-bar pull required per ton for mining work is about 35lb. on the level, but for surface haulage 25lb. per ton should be sufficient on a moderate track. In either case about 22lb. per ton should be added for each per cent. of grade. The draw-bar pull exerted by the best mining locomotives, weighing from two up to six tons, may be taken as about one-eighth of the weight of the locomotive. From seven to ten tons about one-sixth of the weight may be taken as draw-bar pull, this fraction, of course, increasing as the weight of the locomotive goes up.

Weights, etc., of Locomotives.—Tables I. and II. give particulars as to gauge, draw-bar pulls, weights, etc., of a standard line of mining locomotives, and from which it can be seen that a locomotive weighing 8,000lb. gives a draw-bar pull on the level at eight miles an hour of 1,000lb.—that is, one-eighth of the weight—whilst the same locomotive on a grade of 1 in 50 gives 840lb. pull only. Taking the above figures in conjunction with the data given in the tables, we find that this locomotive weighing 8,000lb. will draw a load of 50 tons, or 25 two-ton wagons at eight miles per hour on the level (surface haulage), whilst 11 such wagons will load it on a 1 per cent. grade; seven wagons on a 2 per cent. grade, and on a grade of 3 per cent., nine tons or, say, four wagons only can be attached at this speed. It is evident from these figures that, as mentioned above, when heavy grades have to be negotiated locomotives are not serviceable, and one or other of the rope systems of haulage should be used.

Gauge.—The minimum gauge for the above 3½-ton locomotive when fitted with one 20-h.p. motor is 36in., but this can be reduced to 18in. when two 10-h.p. motors are employed, and the lightest rail which should be used is about 12lb. per yard.

Comparative Cost.—With regard to the cost of haulage by electric locomotives compared with animal haulage, it is difficult to arrive at exact figures. Taking, however, the results of a few colliery haulage plants which have been published, we gather that on the average there is a saving in favour of locomotive haulage of quite 60 per cent. in the cost per ton, even when making an adequate allowance for interest on capital and depreciation of plant. These figures are for coal haulage, but there is no reason to doubt that equally good comparative results can be obtained by electricity at all other classes of mining work, including the recovery of gold. Too much stress cannot be laid on the importance of electric power in connection with Australian gold mining, as in addition to the economy in fuel and water already referred to, there is the great flexibility and ease with which electric power plant can be removed and re-erected when mines are found to be of poor value and have to be abandoned, as is frequently the case in that country.

TRAMWAY SIGNALS.

A new system of automatic signalling for tramways has been devised by Messrs. T. H. Jones and E. Rotter, of which the following preliminary details are all that can be given at present, owing to the patents not being yet completed

This system of signalling, as installed in the Portsmouth Corporation tramways, has now been at work some time, and the services of two signalmen at the portion of line shown in the photograph have been dispensed with, thereby making a considerable saving. It is now proposed to instal the system of signals at other points on the line where there are dangerous curves. On each end of a portion of line which is to be protected, or on which it is not possible or desirable for two cars to meet or pass each other, a signal is erected. This can be atttached to the tramway standard or other suitable support. It is provided with the usual semaphore arm and spectacles, the light for the latter being provided by incandescent lamps enclosed in the drum. On a car approaching the signal, and having stopped at a point determined (if a stop is necessary), the motorman, on putting on his controller to start the car (if the line is clear), the semaphore arm of the signal in front of him will lower, showing a green light at night; at the same time the signal at the far end is locked in a horizontal position, and red light at night indicating danger, or that the line is not clear. It may be mentioned that these arms are counterweighted to return to the danger position, as required by the Board of Trade.

Having lowered the arm (if the line is clear) the car passes on its way over the portion of track, at the end of which, having stopped (if a stop is necessary), the motor-

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man again puts on his controller to proceed on his way, which action unlocks the signal at this end. The system is also arranged to be worked as a "lock and block" system, that is, only allowing one car on the portion of line at the

Fig. 1 illustrates the car having lowered its signal passing on its way. Fig. 2 illustrates a car waiting, having been held at danger by the signal which has been locked by the car seen approaching around the corner. The system can

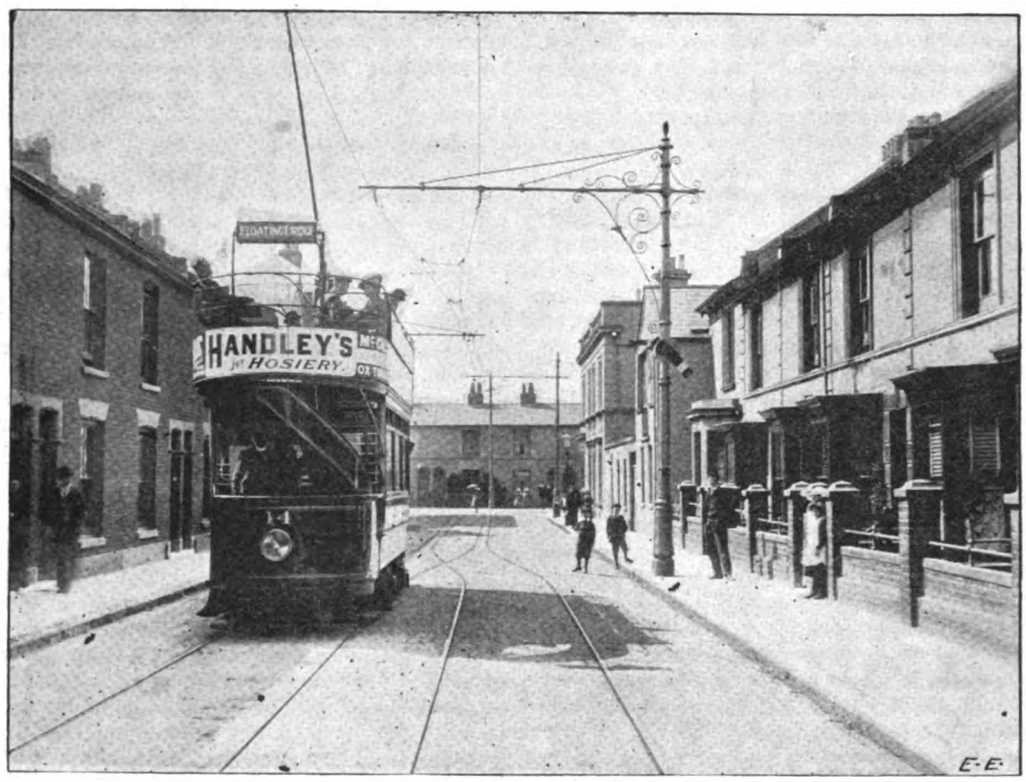

FIG. 1.—The Harison Automatic Signals used on Portsmouth Tramways.

time; whereas, on the ordinary "lock" system one car is allowed to follow another in the same direction. The possibility of two cars reaching opposite ends of the section of line to be protected at the same moment, and putting

be arranged to protect any length of line, either double or single, with double or single conductors, be they the overhead, double, or single trolleys, conduit, third-rail, or other systems. The installation is easily made—in fact, in

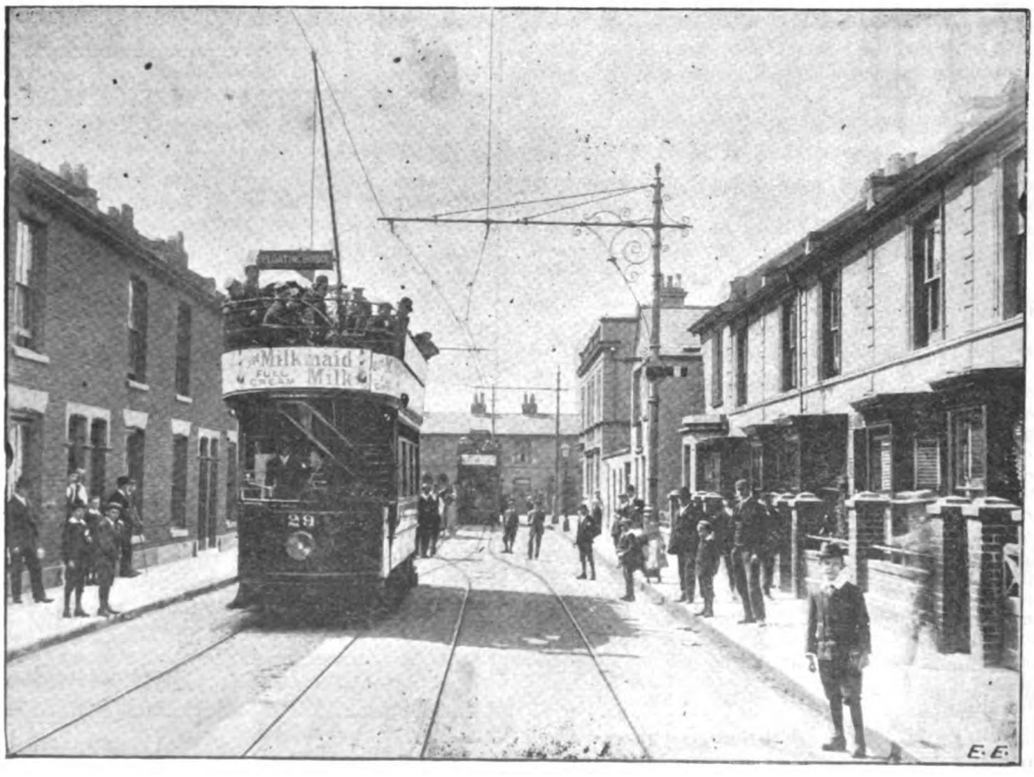

FIG. 2.—Another View of the same with Signal at Danger.

on the controllers at exactly the same instant, and locking the two signals in the danger position, has been provided against by arranging the mechanism of one signal so that the car at this end prevents the other from locking the signal.

Portsmouth was carried out without interruption to the service. Not only as a labour-saving device, but as regards reliability of working and saving of time, this should prove an excellent innovation, and for underground railways, where trains follow one another in quick succession, more

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particularly. There are no movable electrical connections to wear, spark, or get out of order. In conclusion, it may be stated that this is the invention of Mr. T. Harison Jones, late of Toronto, Canada, who has had a number of years' experience in electrical engineering in America and abroad

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

489. What is the best system of guarding against explosions in gaseous coal-mines where it is necessary to use electric signals in a main haulage road, which is also the return airway?—P.

490. I have seen on a high-tension alternating switchboard of the receiving end of a power transmission plant an instrument indicating the number of cycles. I should like to have the theory of this instrument?—E. E. C. P.

ANSWERS.

Question No. 483.—Six 400-kw. machines connected across the outers in a three-wire station are on load; five of them are excited from the station 'bus bars, the sixth being a self-exciting machine. The armature bands of this self-exciting machine give way, and, jamming between the pole-pieces, earth the armature and blow the fuses on the main switchboard without affecting the + or - volts in the slightest. On examining the recording voltmeter cards afterwards a very slight drop is noticed a while before the main fuses went; at the point where the fuses did blow a slight rise is noticed. How can this be satisfactorily explained?—R. M.

Answer to No. 483 (*awarded* 7*s.* 6*d.*).—Presumably the preliminary drop in voltage was only of very short duration. It would commence at the instant when the short-circuit to earth occurred, and would continue until the fuses blew, and would simply be due to the large current flowing from the 'bus bars through the faulty armature to earth, causing the volts on the generators to drop, accentuated possibly by a slight fall in speed. As soon as the fuses went this overload would cease, and the station volts would rise to their old value, or even slightly above it, due to the engine governors permitting a slight momentary rise in speed when the load was suddenly reduced. In most cases, however, unless the load on the faulty machine happened to be very small at the time, the final voltage of the 'bus bars after the blowing of the fuse would be lower than before, due to the load of the six machines being thrown on to five machines. In any case, however, a momentary rise in volts might occur due to the imperfect action of the governors.—Q.

Answer to No. 483 (*awarded* 7*s.* 6*d.*).—The phenomena described by "R. M." are only those which would be expected, and are easy of explanation. We know that with any shunt-wonnd self-excited dynamo there are two paths open for the flow of the current from the armature, the first through the shunt coils, and the second through the outer circuit proper. Now, theoretically the value of the current which flows through these circuits will be $C_s = \frac{E}{R_s}$ and $C_e = \frac{E}{R_e}$ respectively, where E = the effective volts, C_s = the shunt current in amperes, C_e = the current in amperes flowing through the external circuit, R_s = the resistance in ohms of the shunt coils, and R_e = the resistance in ohms of the external circuit. From these equations it would appear as though these two currents were entirely independent of each other, but in practice this is not the case, and if R_e is made very small and R_s large, the distribution of the flow will not be exactly as $\frac{E}{R_e}$ to $\frac{E}{R_s}$.

This can be rendered self-evident by taking an extreme case. Suppose $R_e = 0$ and R_s = infinity − 1, then all the current will flow through the external circuit and none through the shunt coils. A further proof, if one is necessary, lies in the fact that every dynamo designer knows that it is impossible to excite a shunt dynamo, not only if the machine is shorted on itself, but also if the external resistance is so low as to "drain" the shunt of its due proportion of current.

Admitting the truth of the above assertions, it is easy to anticipate what would occur in the case given. Shortly before the fuses blew the armature was earthed, and owing to the earth on the system an excessive current was generated. Now, it does not materially affect the result how this current was absorbed, whether through an outer circuit or through a short-circuited armature; in either case the same conditions obtain. There is a much easier path for the current than through the shunt, hence the current through this circuit is to a certain extent weakened, and the volts drop to that extent. Immediately afterwards the main fuses flow, and the effect is the same as putting a very high, or infinite, resistance in the easy path; the shunt then takes again its normal current and the volts rise.

The above is the simple electrical explanation, but this is further complicated by the action of the engine. The E.M.F. depends not only on the forward induction, but also on the speed. When the earth developed, a heavy load was suddenly thrown on the engine, and probably it appreciably slowed down. When the fuses blew, the load was as suddenly removed, and the engine speed would increase. These two causes would be ample to fully account for the phenomena recorded.—M.

Answer to No. 483 (*awarded* 5*s.*).—When the armature bands gave way and caused the armature winding to make contact with the pole-pieces, it is very likely that some of the armature turns would be short-circuited, and thus the E.M.F. generated by the machine would be lowered. Although the point is not noticed in the question, it is very probable that the speed would be somewhat reduced. This would cause a further drop in the voltage of the dynamo. Thus the fuses would be blown by a return current from the 'bus bars. Suppose the normal voltage at 'bus bars to be 225 and the main dynamo fuses arranged to blow at 2,500 amperes. We will take the armature resistance as ·005 of an ohm It will be noted that this resistance would be reduced if several turns of the winding were short-circuited. Then the difference required between the voltage of 'bus bars and that of the faulty dynamo to blow the fuses would be:

$$\begin{aligned} \text{volts} &= \text{amperes} \times \text{resistance} \\ &= 2{,}500 \times \cdot 005 \\ &= 12 \cdot 5. \end{aligned}$$

i.e., fuses would blow when the volts at dynamo terminals fell to

$$225 - 12 \cdot 5 = 212 \cdot 5.$$

That there would be scarcely any drop on either side is quite to be expected, for the voltage at 'bus bars would be the mean of the potential of the six dynamos. The volts at terminals of damaged machine would fall, more or less quickly, to, say, 212·5, which is the figure we have already taken that would cause fuses to blow. The voltage at 'bus bars would then be

$$\frac{(5 \times 225) + 212 \cdot 5}{6} = 222 \cdot 9.$$

The relief to the other dynamos when the fuses went would probably cause a slight rise in volts, but this should at once fall to the normal.—M. M.

Answer to No. 483 (*awarded* 5*s.*). — The following hypothesis may serve as a possible explanation of the accident detailed in the question. The machine which failed was connected, in common with five others of equal power, to the outers of a three-wire system. The frame being earthed, as seen from the question, it was thereby virtually connected to the middle wire. When the armature bands broke they connected some part or parts

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of the armature, in every probability positive or negative to earth, to the middle wire. Hence on the machine, there would be insufficient back E.M.F. between this artificial neutral point and, say, the positive terminal to balance the 'bus voltage, and a rush of current would set inwards to the generator. On the other pole the machine volts developed between the earthed point and the terminal would be, assuming that the armature bars were not short-circuited on themselves as well as being connected to earth), in excess of the voltage between the 'bus bars and earth, and a rush of current would flow outwards. Half a revolution later (in the case of a multipolar, half a magnetic cycle in the armature later) the excessive voltage would be directed to the positive side, and the current would reverse and flow out to the positive; similarly, the direction of flow would be reversed in the negative. We have then a heavy oscillating current developed, which would be sufficient to blow the fuse on each pole. It is apparent that, as the number of oscillations would probably be of the order of 25 per second, the recording voltmeters would not show the rapid variations of voltage consequent on the additions and abstractions of current, but would indicate the mean of these values of 'bus-bar voltage on the positive and negative side, and the volts would appear to be unaffected.

As regards the slight drop in voltage some time before the accident occurred, one is disposed to regard that as an independent circumstance, due possibly to some external load having come on. The same suggestion may be offered as regards the rise when the fuses blew. It is impossible that the withdrawal of part of the generating power should fail to produce a drop, unless the external load also went off, or the other generators had their fields strengthened at the same time. The only other suggestion is that the self-excited machine was motoring. This might also account for the drop noticed previously.—S. A. J.

Question No. 484.—In an Allis three-line engine of 4,000 h.p., driving a traction generator, the diameter of the shaft is increased in each successive line approaching the armature. Is this practice to be recommended as sound engineering? State reasons for or against.

Best Answer to No. 484 (*awarded* 10*s.*).—The statical stresses to which a shaft of the above type is subjected are (1) twisting moment, (2) bending moment, (3) shearing stress. The relation between the diameter of an engine shaft as above and the maximum twisting moment to which it will be subjected under working conditions is expressed by Rankine as follows:

$$d = \sqrt[3]{\frac{T}{f} \times 5{\cdot}1},$$

where d = diameter of shaft, T = maximum turning moment in inch-pounds, and f = 8,000 for wrought-iron solid shafts above 10in. in diameter. The bending moment exerted upon the shaft depends upon the distance from the main bearing at which the pressure upon the crank-pin is applied. This distance is usually measured from the edge of the main bearing cap. Rankine combines the twisting and bending moments in the following formula:

$$T_1 = M + \sqrt{T^2 + M^2},$$

where T_1 = what he terms the "equivalent twisting moment" and M = bending moment in inch-pounds.

$$\text{Hence} \qquad d = \sqrt[3]{\frac{M + \sqrt{T^2 + M^2} \times 5{\cdot}1}{8{,}000}}.$$

The factor 8,000 will be sufficient to cover any shearing stress which the shaft will be called upon to withstand. Let us now investigate separately the actual torsional stress transmitted through each journal of the shaft in question. The engine indicates 4,000 h.p.; assume that the stroke is 5ft., and that the engine runs at 90 revolutions per minute.

Then mean twisting moment =

$$\frac{40{,}000 \times 33{,}000}{5 \times 3{\cdot}1416 \times 90} \times 30 \text{ inch-pounds} = 2{,}800{,}000 \text{ inch-pounds.}$$

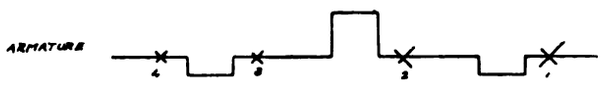
It may be also assumed that the mean turning moment on each crank

$$= \frac{2{,}800{,}000}{3} = 933{,}333.$$

The maximum twisting moment in a three-throw crankshaft, with the cranks at 120deg., is assumed to be (mean twisting moment × 1·05) by Rankine. It will be nearer the truth, however, if we assume maximum twisting moment of each crank

$$= 933{,}333 \times 1{\cdot}4 = 1{,}306{,}666 \text{ inch-pounds.}$$

Now, supposing that the engine has four main bearings arranged, as in sketch, and numbering them 1, 2, 3, 4,



beginning at the end farthest from the armature, the twisting moment at No. 1 journal is simply that necessary to revolve it in its bearing, and possibly to turn an eccentric. The twisting moment at No. 2 journal = that exerted through the high-pressure crank-pin by the steam on the high-pressure piston = 1,306,666 inch-pounds. ∴ diameter at this point of the shaft should theoretically be (neglecting bending moment)

$$\sqrt[3]{\frac{1{,}306{,}666 \times 5{\cdot}1}{8{,}000}} = \text{(say) } 9\text{in.}$$

Twisting moment transmitted by journal through No. 3 bearing is that due to the effort of both high and intermediate pistons and diameter

$$= \sqrt[3]{\frac{1{,}306{,}666 \times 2 \times 5{\cdot}1}{8{,}000}} = \text{(say) } 12\text{in.}$$

Twisting moment transmitted by journal through No. 4 bearing = full turning moment exerted by engine

$$1{,}306{,}666 \times 3 = 3{,}919{,}998.$$

∴ diameter of journal

$$= \sqrt[3]{\frac{1{,}306{,}666 \times 3 \times 5{\cdot}1}{8{,}000}} = \text{(say) } 13{\cdot}5\text{in.}$$

Thus it is evident that, so far as the torsional stresses in the shaft are concerned, the practice of increasing the diameter of a two or multiple throw crankshaft toward the end where the power is given off is supported by theory. The above figures do not, of course, take into consideration the bending moment due to pressure on crank-pin, and these bending moments can be worked out only when the positions of the main bearings are known.

The Board of Trade, Lloyds, and the British Corporation give formulæ fixing the smallest diameter of crankshaft which they will permit, so that the shaft is generally made of the same diameter throughout. For instance, Lloyds give a formula determining the diameter of the intermediate shaft, which, of course, transmits the full turning effort of the engine, and then stipulate that the diameter of the crankshaft shall be at least $\frac{21}{20}$th that of the intermediate shaft. In most marine three-line engines having crankshafts above 10in., the crankshaft is made in three sections, which are coupled together. When these are made interchangeable there is the advantage that if the low-pressure section shows a serious flaw in a foreign port it can be interchanged with the high-pressure section, where it will have less work to do, or a spare section may be carried by the ship. In the engine under notice the bending moment due to the weight of the armature will alone require the shaft to be made stiffer at that end of the engine.

There is also another consideration which will sometimes fix the lower limit of the diameter of the shaft. It is advisable in the interest of cool running not to let the pressure between the crankshaft journal and the bottom bearing exceed 400lb. per square inch, and where there is not room to obtain these results by lengthening the bearings, it is sometimes necessary to increase the diameter of the shaft for the same purpose The Americans generally fit extra heavy crankshafts to such engines as are designed for electric traction, being evidently under the impression that these shafts are more severely stressed than those of marine engines of similar power and speed, which is a matter of opinion.

It may be said, in conclusion, that the practice under discussion of varying the diameter of the crankshaft,

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though entailing complication and expense in the drawing office and works, and at the sacrifice of interchangeability (it being evident that more spare brasses, etc., must be stocked), has the advantage of giving a lighter shaft.—E. C.

Answer to No. 484 (*awarded* 7*s.* 6*d.*).—The practice of increasing the diameter of the crankshaft in each successive line approaching the generator is not in accordance with sound engine design. Although the section of shaft nearest the armature has to transmit the combined twisting moment of the three lines, and, therefore, theoretically should be of a greater diameter than the part of the shaft most remote from the armature, there are practical considerations that render the practice of increasing the diameter very undesirable. The shaft being of different diameters at each bearing puts all idea of interchange out of the question, which, although not a vital point, may be of the utmost importance in the event of a breakdown of one line and the necessity arising of working with two lines only, of course assuming that the ordinary practice of building large shafts in sections is adopted. Then, again, the bearings being of different diameters makes the wear down of the shaft very liable to vary considerably at each bearing owing to the greater wearing surface presented at the lines where diameter of shaft is greater. This unequal wear down would tend to throw the shaft out of line, thereby localising the bending moment and causing hot bearings at least, if not ultimate fracture, a very large proportion of broken crankshafts being due to this cause. Owing to the difference in diameter on each side of the cranks, the bending moment will be very unevenly distributed, and severe strains set up in the crank-pins. The manufacture of such an engine is rendered more costly, as a separate set of patterns would be required for each bearing, and the boring out and bedding in of the brasses and crankshaft becomes a more difficult matter, and more liable to error than in the ordinary engine. Finally, the fact that no English engineers adopt this practice, even where lightness is of the first importance, as in warships, speaks for itself. The only gain to be had by varying the diameter of the crankshaft, is a saving in the weight of the shaft, which is a very doubtful gain, indeed, when the terrific strains set up at times of short-circuit and water in the cylinders are considered.—T. R. O.

Answer to No. 484 (*awarded* 5*s.*).—From the point of view of good scientific design the practice is a good one. This is readily made obvious if the torsional stresses in the shaft are considered. Calling the "line" furthest from the armature No. 1, the next No. 2, and the third No. 3, we see that in No. 1 the shaft has only to transmit the power of line No. 1, while in No. 2 it transmits the combined powers of Nos. 1 and 2, and in No. 3 it transmits the power of the whole three. It is therefore clear that the shaft need not be as large in line No. 1 as in No. 2, and in No. 2 as in No. 3. Of course, the stresses set up in the shaft due to bending are to be considered. These will be about the same in each engine, however, and they therefore do not affect the previous result in any way, except to thicken up the shaft.

There are several advantages resulting from the above arrangement which are very pronounced in a *large* engine of the character mentioned in the question. Chief among these are economy of construction—as regards material—and less weight of the moving parts.

Against these may be advanced several disadvantages. In a case where the crankshaft is in three pieces, connected by couplings, and where spare parts have to be supplied in the case of breakdown, it undoubtedly reduces the number of spare parts by uniformity in the construction of the engine. For instance, if each part of the crankshaft was made the same, only one spare crank need be kept, whereas if the shaft in each successive line was reduced in diameter, a whole crankshaft would have to be kept. If the shaft is very different in size at successive bearings, it would necessitate the bearings being slightly different in construction. This would, under some circumstances, prove to be a decided disadvantage. In the case of an engine of 4,000 h.p. standardisation is not an element of great importance, and whereas in the case of a small engine a good deal would be sacrificed to gain an uniform size of parts, under the conditions stated the probability is that what would be aimed at would be "as low as initial cost as possible compatible with a good engine." The "low initial cost" in a large engine would be obtained more by economy of material than by standardisation.—T. T.

INTERNATIONAL TRAMWAYS AND LIGHT RAILWAYS CONGRESS.

Particulars are to hand of the arrangements for the holding of the twelfth International Tramways and Light Railways Congress at the Berner's Hall, Agricultural Hall, Islington, in the week opening Monday, the 30th inst. The Right Hon. G. Balfour, President of the Board of Trade, will open the congress at 12 noon. A large and influential reception committee is being formed, and invitations to the opening ceremony will be issued by them in the names of the Union Internationale Permanente de Tramways and of the Tramways and Light Railways Association. The headquarters of the committee will be at De Keyser's Royal Hotel, Thames-embankment. Immediately after the opening ceremony the official inauguration of the Tramways Exhibition in the Agricultural Hall will take place. On the evening of the opening day a *réunion* will be held at the Institution of Mechanical Engineers, the invitations to which will include a lady. The first meeting of the congress will be held at 9.30 a.m. on Tuesday, July 1, after which members will have the option of proceeding on one of the excursions arranged or of making an inspection of the Tramways Exhibition. In the evening the conversazione of the Institution of Electrical Engineers at the Natural History Museum will take place, to which members of the congress are cordially invited. On Wednesday and Thursday congress meetings will be held at the same hour, 9.30 a.m., and excursions made in the afternoon. The following are some of the excursions and visits which have been provisionally arranged: visit to the City and South London Electric Railway, and the power station; the Central London Railway, and the power station; the Waterloo and Baker-street Electric Railway, in course of construction; the London United Tramways, and power station; the London County Council tramways, in course of construction; the Islington municipal electric lighting station (the congressists will be received by the mayor and alderman, by whom they are invited to luncheon); Messrs. Crompton's electric works, Chelmsford, about 30 miles east of London. In addition to the above, arrangements are in progress for visits to the following and other places: the Bankside electric lighting station, in London; the Westminster electric station; the Westminster hydraulic power station; Messrs. Siemens's electric works at Erith; and Doulton's pottery works.

NEW COMPANIES REGISTERED.

C. E. and H. M. Peel, Limited.—Capital, £20,000. Objects: to acquire and carry on the business of C. E. and H. M. Peel, metal merchants, electrical, mechanical, and general engineers, etc.

Clubbe and Southey, Limited.—Capital, £2,000. Objects: to acquire the business of A. W. Southey, and turn to account certain patents; as mechanical, general, and electrical engineers, etc.

Foote and Milne, Limited.—Capital, £15,000. Objects: to carry on in all or any of their respective branches the businesses of electrical, mechanical, and general engineers and contractors, brass and other metal founders; to acquire the business carried on by H. Foote, L. Milne, and E. J. Owen at 66, Victoria-street, Westminster, etc.

Pekin and North China Electrical Corporation, Limited.—Capital, £100,000. Objects: To acquire the business heretofore carried on by the Siemens und Halske Actien-Gesellschaft, Messrs. Mandl and Co., and the Chinesische Electricitäts-Gesellschaft, M. B. H., and to carry on business as electrical engineers, and builders of electric plant, and contractors at Peking, in the empire of China, with all or any the assets and liabilities of the proprietors thereof; to adopt an agreement made between the Syndicat du Yunnan Tel of the one part and the Peking and North China Electrical Corporation, Limited, of the other part, and to carry on the business of generators, accumulators, and distributors of electrical energy for the purposes of light, heat, or power; as manufacturers of all plant and apparatus, cables, wires, lines, motors, generators, dynamos, accumulators, transformers, lamps, plant, and machinery, etc.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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"ACCOMPANIED BY COPIES OF THREE RECENT TESTIMONIALS."

The above is what generally constitutes the concluding sentence in almost every advertisement emanating from either a municipal, technical, or district council, when requiring the services of some person to fill some position which has become either vacant or created under the council. Whatever the correct interpretation of the above fashionable phrase may be, is perhaps known to some of the councils in question. Nevertheless, very many who are desirous of competing for the positions to which this term is attached do not know what is required; consequently they allow their conscientiousness, or probably pride, to prevent them going round begging for such testimonials, eventually sending applications which do not rigidly conform to the specified regulations. The result is the informal applications are often consigned to the waste-paper basket, and many a good man is compulsorily retired. With regard to the term itself, it surely cannot mean that the candidate desired should have been in three similar situations recently, for then the mere fact of possessing the regulation copies would be sufficient proof that the man was either a natural gad-about or an inefficient workman, who neither desires nor has opportunity of staying long in any situation. Probably, however, the meaning of the term is that testimonials from three separate individuals in the same establishment or locality is sufficient. If that is the case, it gives a great advantage to those candidates who have the mean audacity to ask everyone directly or remotely connected with the works in which they have been employed for a testimonial. Even if the above should be the correct meaning, one testimonial from some person in authority who is really acquainted with the abilities of the applicant would convey the same, if not a greater amount of truth than threefold testimony. Whatever is the proper interpretation, the practice certainly caters for those gentlemen who make it their business to collect testimonials from all sources, getting them typewritten, together with dozens of copies, in order to sort them out to suit particular situations for which they apply, in the hope that they may by chance be selected for a good position irrespective of their true abilities. Of course, whatever these abilities turn out to be, the council or firm in question are in a position to say the man had good testimonials. And in the case of a council, it would be too much an exhibition of weakness to dispense with the services of someone whose abilities were not found to tally with the testimonials shown. There are, however, two sides to the question The fault does not wholly rest with the recipients, for the persons who give testimonials always have the power, if not the discretion, to refuse. Unfortunately there is a good deal of "human nature in man," and when one of these testimonial hunters asks for a testimonial, the hearer either feels flattered to think that a word from him will go a long way—"which in this case is a fact"—or from the desire to improve the man's position he does not care to say no. Many electrical engineers keep a good supply of typed and copied testimonials because they are fully aware that little notice will be taken of their applications if not accompanied by these advertisements, being thereby forced to become testimonial hunters. A great mistake is in the flippant manner in which the term "electrical engineer" is used. For example, a person goes to either fit up or repair an electric bell, probably in the residence of a councillor. When finished he has the presumption to ask for a testimonial to assist him in obtaining some particular situation. On the face of it this

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seems a small request, and it is consequently complied with. He is thus recommended, by the aid of this testimonial, to some person or council who require the services of an electrical engineer, and this document, being signed by an alderman, will carry more weight when sent to a council than half a dozen coming from a private firm, however much the latter may be better acquainted with the meaning of the appellation "electrical engineer." More lasting satisfaction would be given to both parties, with a slightly increased initial trouble, if references only were required. Few employers at the present day object to men trying to improve their position. Thus by referring to a firm or council for whom the applicant has worked, a better knowledge of his capabilities will be obtained and a better choice made, for it is a by-word among "electrical engineers" that the actual ability of a man varies inversely with the number of testimonials he carries.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

AIR-PUMPS.

SIR,—I notice in the current issue of your paper a note pointing out some "glaringly misleading statements" in my reply to Question No. 478. If your correspondent, "E. Cosgrave," will refer to his standard book (Seaton's "Manual of Marine Engineering," which he recommends), he will find on p. 230 the words, "With a jet condenser a vacuum of 24in. is considered good, and 25in. as much as possible." This, of course, refers to the usual type of jet condenser, shown well in my outline sketch, which has so raised "E. Cosgrave's" ire. The air pump is *usually a horizontal double-acting one*, and may be worked either from the main engines or from an auxiliary one, as is done in the Worthington, Blake-Knowles, Klein, and Smith-Vaile jet condensers.

I am quite aware that with special constructions, such as the Klein barometric jet condenser, better results may be obtained, but I should say a vacuum of 27in. is an exceptional thing, even with them.

Secondly, I cannot imagine what is wrong with the term "leaks in." Surely all the air must have leaked in from somewhere, either with the condensing water or through leaky joints.

Thirdly, the diameter given for the air-pump barrel is alleged to be too small. This dimension is obtained directly from the efficiency of the pump, which I have taken as 50 per cent. Seaton, on p. 247, gives the efficiency as ·6 to ·4, so that my figure is just between the two. The valve area I did not give, as it depends on the type of valve used, but I did give the limiting velocity through the valves as 10ft. per second, which is good up-to-date practice. The velocity through the foot and head valves may, perhaps, be a little less than this, as the space is not so restricted as with the bucket valves.

Fourthly, it is certainly true that double-acting pumps have a lower efficiency than single-acting ones. This is due to the fact that the direction of motion of the water and air is constantly being reversed, whereas in a single-acting pump it is always in the same direction. The difference in efficiency, however, is not very great in well-designed pumps (Seaton gives the limiting values as ·6 and ·5 respectively), and the point was omitted in my reply.

I think, Sir, I have shown that the statements given in my reply were substantially correct, and, in conclusion, I think it would be better if in future "E. Cosgrave" would take the trouble to inform himself more carefully of the matter under discussion before launching out into print; he may then avoid showing his "charming ignorance" of the subject.—Yours, etc., T. SQUARE.

THE GENERAL ELECTRIC COMPANY.

SIR,—The General Electric Company (1900), Limited, wish to express their unqualified regret at the terrible results which attended the fire at their premises on Monday, the 9th inst., and to state that they are taking steps to give this sentiment practical shape. They would also like to take this opportunity to convey to their friends and customers their thanks for the many expressions of sympathy received in letters, telegrams, and personal enquiries, and to inform them that the part of their premises which was involved is small. Business will be carried on exactly as before, and it is hoped that if at first one or two delays may have occurred the firm will receive indulgence on this account.—Yours, etc.,

THE GENERAL ELECTRIC COMPANY (1900), LIMITED.
(M. Bing, Managing Director).

London, E.C., June 11, 1902.

[N.B.—We have decided to defer all detailed reference to the above lamentable fire till the facts are given at the inquest.—ED. *E. E.*]

INSTITUTION OF ELECTRICAL ENGINEERS.

The following is a copy of a letter, which is being circulated amongst the members of the Institution of Electrical Engineers, dealing with the important question of the subscriptions. It behoves all who belong to this Institution to look into the figures here given, so as to be able to express their opinion when the matter comes up for discussion. We have taken the trouble to average out the rates which are given in the addendum, and find that there are, roughly, 3,500 members of all classes whose average contribution to the Institution is £1. 15s. per member per annum. This is considerably below the average figure for new members, owing to the fact that there are a large number of old subscribers whose rates have not been increased of recent years. A perusal of the accounts of the Institution for the past years, however, will show that there has always been a very considerable surplus, which is now being added year by year to the building fund. This building fund is also being urged as a reason for increasing the subscriptions of all classes of membership. We think that it would be well to remember that the first object of the Institution is the good of its membership, and that this is not strongly connected with the housing of the parent institution in a building which would never be used by the majority of the members, and only by the London members in the winter months. In fact, the load factor of all such buildings is a very poor one, such as a borough electrical engineer would not make much capital expenditure to obtain. The letter reads as follows:

Dear Sir,—For a considerable time past it has been apparent to your Council that an increase in the amount of the subscriptions of all classes of members has, in view of the largely extended influence and work of the Institution, become imperative, and they are strongly of opinion that such increase should apply not merely to the subscriptions of future members, but also to the future subscriptions of existing members.

They have carefully considered the case of those members the amount of whose subscriptions remains the same as they were during the early life of the Institution, and they believe that the postponement until now of any increase therein will, in the interests of the Institution, be regarded by them as a sufficient consideration for their support in the days when the Institution was but a small society, and the expenses were consequently light.

In arriving at the above conclusion, your Council has been largely influenced by the pressing, and, indeed, unavoidable necessity, for the provision of suitable accommodation for the Institution by the rapid extension of the system of local sections at home and abroad, and the consequent enlargement of the *Journal*, by the issue of *Science Abstracts*, and by the steps that have to be taken to give effect to the general desire that the standards of qualification for the admission of all classes of members should be high.

To meet these needs it will be necessary that the following subscriptions, irrespective of the member's place of

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residence and of the date of his election, should be paid in future by all: (1) members, three and a-half guineas per annum; (2) associate members, two and a-half guineas; (3) foreign members, two guineas; (4) associates, two guineas.

In recommending the proposed increase the Council relies upon your approval, confident that every member of the Institution is prepared to support steps requisite to meet this increased expenditure.

Appended is a statement affording some data in relation to the present amounts of subscriptions, receipts, and expenditure per member, together with other information which it is thought will be of use in enabling members to realise the position

The Council will, in due course, submit to a special general meeting of members, as prescribed by Articles Nos. 54 and 56 of the articles of association, the scheme for giving effect to their proposals, and the alterations in the articles of association which will consequently be necessary.

I am directed to express a hope that the Council may receive from you, as soon as possible, any remarks you may wish to offer on the subject.

The fact that the building fund now amounts to over £10,000 prompts the Council to anticipate an early realisation of their wish to provide a permanent home for the Institution.—I am, dear Sir, yours truly,

WALTER G. MCMILLAN, Secretary.

Statement giving Information as to Existing Income and Expenditure.

At present there are on the lists, approximately:

Of *Members*—120 who pay only £1 per annum, 285 who pay two guineas, 180 who pay £3, 155 who pay three guineas.

Of *Associate Members*—110 who pay only one guinea per annum, 785 who pay two guineas.

Of *Foreign Members*—135 who pay only £1 per annum, 15 who pay only one guinea, one who pays two guineas.

Of *Associates*—185 who pay only £1 per annum, 375 who pay only one guinea, 445 who pay £1. 10s., 700 who pay one guinea and a half.

The lowest estimate of the cost of conducting the affairs of the Institution on the present scale and under the present limitations to its usefulness, shows an expenditure per member, including students (whose subscriptions it is not proposed to raise), of nearly 30s.

This expenditure provides no margin for the normal increase, which is unavoidably progressive, or for contribution to those demands which must at no distant date attend the provision of suitable Institution premises.

It should also be pointed out that between 1894 and 1901, while the average revenue per member including all classes has increased by 4s. per annum, the expenditure per member has increased by 8s.

It is further worthy of note that, while the expenditure per member of this Institution is at present approaching 30s., that of the Institution of Civil Engineers appears to be about 57s., and that of the Institution of Mechanical Engineers 54s., and the subscriptions to these institutions are largely in excess of the averages of those now in force in the corresponding classes of the Institution of Electrical Engineers.

FORTHCOMING EVENTS.

FRIDAY, JUNE 13.

Royal Institution.—At 9 p.m., Mr. G. Marconi on "The Progress of Electric Space Telegraphy."

Physical Society.—From 3.30 to 6 p.m., visit to the National Physical Laboratory, Bushy House, Teddington. Trains leave Waterloo (south station) at 2.36, 3.14, 4.15; and Waterloo (Windsor line station) at 2.40, 3.17, 3.40.

TUESDAY, JUNE 17.

Institution of Junior Engineers.—Visit to the Globe Rope Works, East Ferry-road, Millwall, E.

WEDNESDAY, JUNE 18.

Institution of Electrical Engineers.—At 12 noon, deputation to the President of the Board of Trade on subject of electrical enterprise.

Royal Meteorological Society.—At 4.30 p.m., ordinary meeting.

THE ELECTROLYSIS OF GAS-MAINS.*

BY JAMES SWINBURNE, M.I.C.E.

Argument: Tramways and telephones—Cross's Committee—Parliament considered forbidding earthed returns greater hardship to tramway industry than chance of electrolysis to pipe companies—Should tramways be liable for damages due to electrolysis?—Little definite information as to real damage by electrolysis available—Explanation of anode and cathode—Corrosion at anode only—Methods of minimising corrosion—Measures to be taken by pipe companies—American electrolysis—Natural earth currents.

About 10 years ago there was a good deal of friendly friction between the National Telephone Company and the electrical traction industry. Electrical traction was just beginning to develop in this country at that date; and electrical engineers were promoting Electric Tramway Bills in Parliament. The telephone people complained that the leakage, or stray currents, from the tramways disturbed their telephone systems; and they asked for protective clauses. In some cases such clauses were inserted, and in others the telephone people failed. In one case the committee, in their anxiety to be quite fair, ruled not only that the tramway must not disturb the telephones, but the telephones should not disturb the tramways. The whole question became very acute when the National Telephone Company sued Graff Baker and the Leeds Tramway Company for disturbing their circuits in Leeds. This action was heard by Mr. Justice Kekewich, who decided that the Telephone Company could get no damages because the tramway people worked under an Act of Parliament, and were not negligent, but were doing the best they could in reason.

A joint committee of both Houses of Parliament was soon appointed to go into the whole question. This committee discussed the telephone question very fully, and finally decided broadly that, as the telephone circuits could be easily protected by doubling, instead of using earth return, and that as they were adopting this metallic return anyhow, because it gives a better service, they should not have the protection they sought. The gas and water companies, however, also appeared in this enquiry; and this was practically the opening of a question which has awaited satisfactory settlement for the last decade. This committee—generally known for short as Lord Cross's Committee—decided that uninsulated returns are permissible, and that preventing their use would throttle the industry. But they also decided that the tramway people should take all reasonable precautions in building and working their undertaking, so as not injuriously to affect by fusion or electrolytic action any gas or water pipes.

Since this recommendation there has been little done by the gas and water companies until recently. Electrical tramways are now being put down on such a large scale that the owners of underground pipes are naturally beginning to regard the whole question as being very serious. When we consider the capital value of the buried pipes in this country alone, which must run into very many millions of money, it is clear that the question whether they will be eaten into holes and destroyed by tramways, without either means of prevention or redress, is of enormous importance.

The first question was whether tramways should be allowed to have leakage currents at all. Parliament practically decided that as it was a very great convenience to tramways to have what is called an earth return, and as the corresponding harm to other people was small, they should be allowed to have earth returns—that is to say, the gas, water, and telephone companies are not to have immunity. The Telephone Company is not on all-fours with gas and water companies, as the National Telephone Company was not incorporated by Act of Parliament.

During last session the controversy between the tramways and the gas and water companies was substantially that the tramway people said they caused no damage to the pipes, or none that would ever be perceptible; and Parliament had already decided that they should be allowed to use earth returns. The pipe owners said, "We do not want to stop your use of the earth return. You say it does us no harm. We do not know whether it does or not; but we fear it may. We therefore ask you to be liable for damages if you eat our pipes. If you do not eat them, such a protection, while satisfying our fears, does you no harm, and if you do destroy our property it is only fair that you should indemnify us." The tramways said: "We will not hurt your pipes, and it is unfair that if your pipes are naturally corroded, or are corroded by some other tramway people, we should have to pay, for however carefully we guard against leaks we may at any time be made liable by the mistake of an arbitrator for a fabulous sum without having done any harm to you at all." The tramway companies also argued that they worked under the Board of Trade regulations, and that the Board of Trade regulations were designed to prevent corrosion of pipes, and were amply strict enough for the purpose. The pipe owners urged that there was always electrolysis, and the Board of Trade merely reduced it as far as was consistent with the satisfactory working of the tramways, without by any means rendering the tramways innocuous. This we may discuss more fully later. Last session the gas and water companies on the whole failed to get even the smaller protection they asked for, and this session they have done but little towards getting the insertion of clauses in their favour. Such is very shortly the history of the question.

When I was asked to give a lecture on this subject I was very undecided as to what sort of paper I had better give. I might give an elementary treatise on electricity, with special reference to electrolysis, or I might give a lecture full of experiments. Or I might have drawn awe-inspiring pictures of the future of your distribution systems, when all the iron of your pipes had been eaten away and the gas merely ran along the tunnels left in the ground. Or I might

* Lecture delivered before the Incorporated Gas Institute.

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have urged the tramway point of view that the electrolysis is very minute, and what there is is rather good for the pipes, being a pleasant stimulant. An experimental lecture appeals to those present, and is, no doubt, more interesting in a way, but I felt that I had been honoured by being asked to deal with a subject which is of enormous importance to your industry, and therefore concerned many people who would be outside this lecture room.* I therefore concluded that you would probably prefer me to deal with the subject broadly, and try and give you as fair and full an idea as I can of the whole subject.

It is difficult, of course, to be impartial on such a matter; and you will no doubt regard me as being specially electrical. I am, however, also an old gas man, as I was for some time at the South Shields Gas Company's works, under Mr. Warner, whom you all know. In the various contentions I have appeared in the law courts, and in the committee rooms, sometimes on the electrical side and sometimes for the gas and water people. My views have thus been moderate, and I think fairly impartial; and I will do my best to be impartial in this paper.

But by far the greatest difficulty is to give any real information as to the true effect of the earth currents from tramways. The question from the technical or scientific side is very obscure. If pipes are being corroded—even if the corrosion goes on to a very serious extent—it may not show for a long time. In fact, corrosion would only show when considerable damage had been done, unless a pipe company happened to examine a pipe which was specially strongly affected. The only thing is for me to give as much information as I can.

Electrolysis, or electric separation, applies to electric separation of chemical compounds. The most familiar example is the electrolysis of water. If an electric current is caused in, say, acidulated water, the piece of metal which leads the electricity down is called the anode, or way down. The piece which leads the electricity up again is called the cathode, or way up. The two pieces of metal are called electrodes, or electric ways. The liquid is called the electrolyte, or thing that can be separated electrically. Water and solutions of salt are all electrolytes—that is to say, they are decomposed when there is an electric current, and a current cannot exist between metallic electrodes in an electrolyte without decomposition. The decomposition is strictly proportional to the current and the time. Thus when acidulated water is decomposed, the quantity of oxygen and hydrogen liberated depends on the current and the time it is on. The unit of current is an ampere, and an ampere decomposes 0·3357 grm. of water per hour, yielding 0·0374 grm. of hydrogen and 0·2983 grm. of oxygen. If, instead of water, other substances are decomposed, the amounts liberated are proportional to the combining weights. If the electrodes are platinum there is no corrosion, as the platinum does not easily form salts. Suppose, for instance, the solution, instead of being acidulated water, is water containing common salt and other salts, and suppose iron electrodes are used, then the anode will be converted into ferrous chloride. Hydrogen will come off at the cathode unless there is some metal that will deposit instead of it. Thus if we have copper electrodes in copper sulphate, copper will be eaten off the anode, forming copper sulphate, and copper will be deposited on the cathode, forming a fresh-coloured coating. This process is carried on on a huge scale in copper refining.

What we are concerned with is the corrosion of iron when used as an anode in the ground. In the ground in a town we may take it that the pipes are buried in earth or sand which is damp with salt and other compounds of sodium, potassium, and ammonium. Iron has a very curious property. It is not attacked when it is used as anode in an alkaline solution. In caustic soda, for instance, it is not touched. But this property is scarcely likely to help it in the ground, for even if the ground was slightly alkaline, an effect of the electrolysis is to render the region round the anode acid. The iron is thus attacked. If there is plenty of salt present, we get chloride of iron, but the chances are that the iron is converted into basic salts or oxides. It does not matter much to the pipe what it is converted into. No harm is done to the pipe where it forms a cathode, as the only thing that could happen would be that metal might be deposited. Iron could not be deposited under the circumstances, so that we need only consider the corrosion of the anode. As the combining weight of iron is 28, the consumption of iron per ampere is 0·00029035 grm. a second, or 20lb. a year.

It will be clear then, that a gas-gipe can only be corroded where it is acting as an anode—that is to say, where the electric current is leaving it to pass into damp ground. There is no corrosion where the electricity enters the pipe, because it is a cathode there, and there is no corrosion where the electricity leaves, unless it passes into an electrolyte such as damp earth. If the electricity is taken off by a metallic conductor, such as a wire, which is not an electrolyte, there is no corrosion.

(To be continued.)

* The lecture actually given was experimental and explanatory. As the same lecture does not both sound and read well, I practically prepared two.

THE SALFORD ENQUIRY.

Upon this enquiry being resumed, **Mr. C. R. Turner,** formerly electrical engineer of the Corporation, said he thought undue influence had been exercised in favour of the acceptance of certain tenders. In cross-examination, Mr. Turner admitted that while he thought that a report which was produced was intended by Mr. Clirehugh to help Galloways to obtain an order, he knew Mr. Clirehugh advised the committee to adopt engines of another type, and that, in fact, Galloways did not get the contract. He had been told by Mr. Clirehugh that Messrs. Galloway must have the job. He had ceased his opposition after having been told that "if he did not, it would be worse for him."

Mr. William Hunt, elective auditor for the borough, said that Messrs. Lacey and Clirehugh approved of Mr. Turner's plans and specifications at about £80,000. The present work would cost approximately £400,000, and the result was that there were 12 boilers and six engines lying idle, and likely to do so for some time to come. He suggested there were only two sets of people responsible—the consulting engineers and the Electric Light Committee. The Council could not be held absolutely free from blame, but the responsibility rested with the professional advisers of the Electric Light Committee. Mr. Hunt said he wished to protest against what had been done with respect to boilers, and also said that to place in the hands of Sir Richard Mottram the responsibility of conferring with the consulting engineers as to the type to be adopted was unjust to other firms afterwards invited to tender. Mr. Hunt proceeded to read from the minutes with a view of showing there had been delay in supplying what was required under the contracts, and that the material, such as that of motors, was not satisfactory. He did not suggest that the committee were endeavouring unduly to shield any contractors, but that they had not a due regard to the interests of the ratepayers. With regard to the works, he thought it would have been possible to avoid the closing of Walness-road, and to have supplied all the requirements, so far as electric traction was concerned, from the other stations.

Mr. S. V. Clirehugh spoke as to the employment of his firm as consulting engineers. In their first report they suggested that less money should be spent than was proposed in putting down the electrical plant. He denied that they were at any time prepared to carry out the scheme on Mr. Turner's specifications. There was no truth in the statement that he altered the report at Sir Richard Mottram's instigation. The latter had been opposed to the appointment of the witness. He had not stated that he had made the alteration at the request of Sir Richard Mottram. It was untrue that Sir Richard had influenced him in his recommendations. He denied that he had ever been approached directly or indirectly on behalf of Sir Richard Mottram with a view of improperly influencing him or of doing so on behalf of Mr. Haworth. He denied that he had made a statement to Mr. Wheatcroft as to Sir Richard Mottram. It was because of information which he had received that the witness had altered his report, and after a visit to Galloways. In a letter produced he had said he was prepared to make the works second to none in the country. This must no doubt have been to collaborate with Mr. Turner on his specifications. This scheme would have been second to none in cost as well.

The enquiry was adjourned.

On Saturday, when **Mr. Clirehugh** continued his evidence, he repudiated the suggestion that he had been influenced by Sir Richard Mottram in favour of Galloways, or that the latter firm had done anything out of the ordinary course of business.

Sir Richard Mottram explained that he took some interest in the matter of the undertaking owing to the letter from Mr. William Mather. As an engineer himself, however, he thought it was better for him not to interfere. He mentioned the matter to the Mayor and Mr. Alderman W. Robinson. At a meeting of the committee which he attended he did not go for the purpose of advocating Galloway's or any other firm's claims. He denied that he had advised in committee as to the acceptance of any tenders. He had spoken in favour of a particular type of engine. His presence on the occasion in question was due to special circumstances, and he did not attend at meetings afterwards when tenders were accepted.

Mr. A. Haworth, a former member of the Salford Council, said he was appointed chairman of the Electricity Committee of the Corporation when that committee was formed. He denied that he had told Mr. Turner there was a conspiracy to upset his specifications. He had given no information about Galloway's tenders, and he had no interest in regard to any; all that he wanted was to get the best for the Council. He no doubt did mention being "pestered" to Mr. Wheatcroft. He was pestered chiefly by men coming from the works and complaining.

Mr. W. E. Norbury, director of Messrs. Galloways, Limited, said it was part of his business to call on firms, and he had not done anything improperly to influence the orders of the Corporation. He had only seen Mr. Haworth on 'Change, and had tried to do business with him, but not in any underhand way.

Judge Parry said the charges against Messrs. Galloways had been withdrawn, and, as far as he could see, there was nothing whatever done by that firm that was wrong.

Mr. Wheatcroft said the cable contract of Messrs. Glover was not the lowest tender. He contended that the report made by the consulting engineers distinctly favoured Messrs. Glover as against the lowest tender, that of the British Insulated Wire Company. He did not blame Messrs. Glover, who were men of business. He added, in reply to Judge Parry, that the contract was obtained honestly. Mr. Wheatcroft further urged that the engineers had permitted Messrs. Glover to put down brick instead of stone troughs in the laying of the cables.

Mr. Turner contended that the report of the engineers was unequal and unfair to other tenderers besides Messrs. Glover. He went over the details mentioned in the report, and contended the contractors did not carry out the work according to specifications. He did not suggest fraud, but he said it was a loss to the Corporation.

Judge Parry intimated that he did not wish to hear anything which merely suggested error. No doubt mistakes had been made. If necessary, he would have an independent expert opinion to ascertain whether the contract had been carried out.

Mr. Cobbett having complained that the matter had been brought up after Mr. Clirehugh had left, the judge said he would ask Mr. Cobbett to send him a statement on this subject.

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Mr. A. E. Tanner, managing engineer for Messrs. Glover, who had the carrying-out of the contract, said he suggested the change as to the troughing to Mr. Clirehugh. He did not think stoneware was any better than brickware to go underground.

Mr. W. Hunt, elective auditor, then gave evidence in support of his complaint that Messrs. Galloway did not deliver boilers in the time specified. He contended that Messrs. Galloway had departed from specifications in regard to the mouthpieces and the fittings of the boilers. The latter had been condemned by the Steam Users' Association on account of the material in them.

Mr. Galloway admitted the ground of the complaint as to the mouthpieces. The boilers were all ready.

Judge Parry said there was no suggestion of bad faith or of injury to the ratepayers. Messrs. Galloway had given a guarantee to put anything right.

Councillor Jackson was also called, and stated that Galloway's tender was £320 more than another firm's tender. He had understood that they would not tender. Their tender, however, was accepted. He did not approve of the invitations to certain members of the Electric Light Committee to a luncheon at Messrs. Galloway's on the occasion of the visit of the Iron and Steel Institute. He received an invitation, but did not go.

Judge Parry, in closing the enquiry, said he was strongly impressed with the evident desire there had been on the part of Messrs. Wheatcroft and Hunt to serve the public. He left Mr. Turner out of his reference, because his portion of the case might not be finished, and he did not wish to criticise. Having said so much for their portion of the case, he had been considering whether, as his report would take some time, it was not due to the other parties to make a statement. On one matter he had made up his mind with regard to Messrs. Lacey, Clirehugh, and Sillar that, though he did not think direct charges of fraud were made against them, there were certainly suggestions of fraud and ill-doing made which, while hanging over them, must be damaging. He had yet to go into much detail, and might have to say whether or not they had been guilty of irregularities. He had, however, come to the absolute conclusion that nothing like fraud, ill-doing, or undue influence was made out against them. He was prepared to say the same with regard to Sir Richard Mottram. He might have to report that Sir Richard was indiscreet, but between doing ill and making a mistake or an error of judgment, there was an enormous difference. He was able to congratulate the Corporation and the public on this part of the finding With regard to ex-Councillor Haworth and others, he found no evidence on which they were rightly to be charged with fraud, or ill-doing, or wickedness, or cheating of any kind.

TUBE BILLS IN PARLIAMENT.

LORD WINDSOR'S COMMITTEE.

THURSDAY, JUNE 5.

After sittings extending over several weeks the Select Committee of the House of Lords presided over by Lord Windsor concluded their labours. The whole of the day's proceedings was occupied with the consideration of applications for special clauses against the promoters of the Brompton and Piccadilly-circus, the Hammersmith, Piccadilly, and City, and the North-East London Railways.

Mr. Coward, K.C., brought up a clause for the protection of the Shaftesbury memorial fountain in Piccadilly-circus, and the clause was amended and agreed to. Mr. Coward then raised the subject of workmen's fares, and asked for what was known as "the Central London clause" to be applied to the whole of the undertakings of the Brompton and Piccadilly-circus and Great Northern and Strand Railways.

Mr. Littler objected to the clause, and the committee declined to impose it upon the companies.

The committee assented to special clauses for the protection of the Hippodrome.

Mr. Pember, K.C., for the London County Council, asked the committee to pass a clause providing that in no circumstances should any interference be ordered by any arbitrator with the gradients or position of the main or branch sewers of London.

The clause was rejected.

Mr. Pember pointed out that in Railway Bills it was customary to insert a clause providing that any objects of geological and antiquarian interest discovered by the railway company in the course of carrying on their works should be subject to the disposal of the County Council. He noticed, however, in one of the Bills, that this power was given, not to the County Council, but to the Borough Council. It was better that these objects should be collected in one special museum than that they should be distributed among 28 councils scattered all over the Metropolis.

The committee directed the clause to be so amended.

A number of other clauses were submitted on behalf of the London County Council, but rejected by the committee, **Viscount Knutsford** remarking that their acceptance would practically constitute the County Council the authority to manage the whole of the affairs of the companys.

Mr. Pember, at the conclusion of the consideration of the clauses, congratulated the committee on having brought their long labours to a close.

The **Chairman** thanked Mr. Pember for his congratulations, and, on behalf of the committee, acknowledged the assistance they had received in the conduct of the proceedings from the learned counsel engaged on both sides.

The clauses were subsequently gone through, and the Bills ordered to be reported to **the House for third reading.**

CREWE ELECTRICITY ACCOUNTS.

The accounts of the Crewe electricity works for the year ended March 31, 1902, show a total expenditure on capital account of £39,420. Abstracts of the revenue account and balance-sheet, and statement of electricity generated, sold, etc., are given below:

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity	1,230	10	5
Distribution of electricity	80	4	4
Public lamps	146	15	8
Rates and taxes	91	13	4
Management expenses	364	3	7
Special charges	7	13	0
Total expenditure	1,921	0	4
Amount carried to net revenue account	2,769	14	10
	£4,690	15	2

Cr. Income.	£	s.	d.
Sale of current per meter, less discounts	2,167	3	4
Public lighting	2,428	9	5
Meter rentals	51	15	10
Sale and repair of lamps and other apparatus	43	6	7
	£4,690	15	2

GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
Loans received as per capital account	26,000	0	0
Less amount repaid	1,239	19	9
	24,760	9	3
Sundry creditors	434	19	9
Amount owing to treasurer on capital account	13,527	6	4
Less in hand on revenue account	472	1	11
	13,055	4	5
Net revenue account—balance at credit	948	16	4
	39,199	9	9
Balance—excess of assets over liabilities	1,239	10	9
	£40,439	0	6

Assets.	£	s.	d.
Amount expended for works as per capital account	39,420	11	5
Stores on hand	275	5	3
Sundry debtors for current and meter rentals	715	0	8
Other debtors	21	6	7
Cash in hand	6	16	7
	£40,439	0	6

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		347,758
Quantity sold: Public lamps	182,535	310,505
Quantity sold: Private consumers by meter	127,970	
Quantity used on works		19,090
Total quantity accounted for		329,595
Quantity not accounted for		18,163
Total maximum supply demanded (kilowatts)		245

Number of public lamps: three arcs, 675 posts incandescent.

SHEFFIELD ELECTRICITY WORKS.

The report and statement of accounts of the Sheffield Corporation electricity department for the year ended March 25 last have now been issued. The capital expenditure amounted to £433,015. 11s. 9½d., and the expenditure to £538,501 17s. 7d. The following is the revenue account: Total income received from all sources, £39,831. 0s. 6d. Cost of generation and distribution, rates, taxes, and management, £13,585. 14s. 10d., from which must be deducted interest on mortgages, stock, and bank charges, £14,858. 17s. 7d., and the third instalment set aside out of revenue for the extinction of loan indebtedness amounts to £5,782. 6s. 1d., leaving a surplus for the year, after covering all charges, of £5,604. 2s., to which must be added the surplus at March 25, 1901, £6,294. 6s. 5d., leaving a present available surplus of £11,898. 8s. 5d. The report of Mr. S. Edgar Fedden, general manager and engineer, states that great progress has been made in all departments, and a very large amount of extra work has had to be carried out on account of the change over from 100 to 200 volts pressure, and the change over from 100 to 50 periods per second of alternation of current. He thinks the staff generally are to be congratulated on the successful way in which they have carried out these most difficult operations. In the generating station new plant has been installed as follows: two 550-kw. Electric Construction Company's alternators, coupled to McLaren triple-expansion engines; one 300-kw. Parsons steam-turbine; two Brown's marine type boilers, with Ellis and Eaves's induced draught and Bennis stokers. Five Hotchkiss water-circulators have been fitted to the boilers. A large cooling tower has been erected, capable of dealing with 180,000 gallons of water per hour. The cooling fans and Gwynne pump for lifting the water to the top of the tower are driven by Westinghouse two-phase motors. Two 60in. ventilating fans have been erected in the station to clear the

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atmosphere and to reduce the temperature, which at times reaches 90deg. F. The litigation with the Brush Electrical Engineering Company with regard to the 600-kw. "Universal" set has been arranged, and terms for the reconstructiou of the plant agreed on. The Ferranti 1,100-kw. set is also being changed over from 100 period single-phase to 50 periods two-phase. There is a very marked improvement in the condition of the electricity mains, which has been brought about by a number of changes. In consequence of these alterations the local extinctions for the 12 months ending March 25, 1902, were only 31, as compared to 206 for the 12 months ending March 25, 1901, and this notwithstanding that many miles of additional mains have been laid and connected, thus greatly increasing the extent of the system. The manufacture of transformers by the Corporation's own factory has proved completely successful, and has been a great boon to the construction department. The supply of transformers in the past was always a source of anxiety. The construction department now finds itself for the first time fully supplied with thoroughly reliable transformers. The work carried out in the meter department has been satisfactory. The work in the factory has been in full swing all the year, and the output considerably increased in order to keep the requirements of other departments supplied. The wiring and fittings department has also made steady progress during the year. The orders of all kinds received during the year numbered 3,592, as against 2,700 during the corresponding period of last year, showing an increase of 892 orders. These orders represent an addition to the supply mains of an equivalent of over 22,000 8-c.p. lamps. During the year experiments have been made with a view to bringing down the initial installation cost to a lower figure, but so far no less expensive system of wiring has been found which justifies a change from that heretofore adopted. It is a pleasure to record that a number of consumers who have had work done by this department during the year have made complimentary communications to the way in which the officials and workmen have carried out their work. These have been passed on to those engaged in the department, who have been much gratified to find their efforts thus appreciated.

HEREFORD ELECTRICITY WORKS.

The report of the Electric Lighting Committee of Hereford for the year ended March 25, 1901, is as follows: Your committee regret that the results for the last financial year are not so satisfactory as during the preceding 12 months. The profits made in the year ending March 25, 1901, were not only sufficient to pay the interest on the capital, but to provide over £700 toward the repayment of capital, leaving only £85 to be borne by the rates. In the present year the surplus revenue, after providing for the interest on the debt, is only £407. 10s. 6d., leaving £392. 9s. 6d. to be provided out of the rates. Your committee told the Council 12 months ago that they could not anticipate to report as favourably in the immediate future as on that occasion, but they had hoped to have had to ask for a smaller sum than that mentioned above, but part of the amount is due to exceptional expenditure, part to the rebate made to customers under the resolution of the committee adopted by the Council reducing the period of maximum demand from two hours to one, and partly to the greater economy of some of the consumers. The quantity of current supplied up to the end of 1901 was in excess of that supplied in 1890 by nearly 30,000 units, but the consumption during the first quarter of this year shows a very slight increase over the consumption for the corresponding quarter of 1901. This is believed to have been caused principally by the remarkably fine bright weather in February. The financial results of the undertaking for the year ended March 25, 1902, are as follows: total units sold, 95,892, as compared with 86.098 units sold in 1900-1. Of these there were charged at 6d. per unit, 66,749 units; at 4d., 20,022; at 3d., 6,851; at 2d., 2,270—producing together, less rebates (£4. 3s. 1d.), £2,102. 16s. 6d. Meter rents amounted to £94. 6s. 5d., and sundry receipts and portion of premium of apprentice to £56. 1s—total, £2,253. 3s. 11d.; less discounts, being the reduction due to the alteration of the period of the maximum demands, £129. 9s. 4d.—total, £2,123. 14s. 7d. The working expenses for the year, including wages, salaries, oil, stores, coal, repairs, taxes, etc., were £1,123. 0s. 7d. and interest £593. 3s. 6d — total, £1,716. 4s. 1d.—leaving a profit towards the repayment of the capital of £407. 10s. 6d.

APPOINTMENTS VACANT.

Clerk of Works, Batley Corporation electricity station, 50s. per week, June 27. See advertisement.

Assistant Engineer, Guardians of St. Mary, Islington, £2 per week. See advertisement.

Shift Engineer, Blackpool Corporation electricity works, £125 per annum, June 23. See advertisement.

Station Superintendent, Blackburn Corporation electricity works, £175 per annum, June 19. See advertisement.

Draughtsmen (several). See advertisements.

Estimating Engineer, with wide experience in permanent-way and overhead equipment for light railways and electric trams. See advertisement.

Assistant Superintendents (5), Indian Telegraph Department, commencing salary 4,200 rupees, June 30. See advertisement.

Teacher of Electric Lighting and Power Transmission, Acton and Chiswick Polytechnic, Bedford Park, W., June 19. See advertisement.

LEGAL INTELLIGENCE.

CLAIM FOR PERSONAL INJURIES.

On the 6th inst. at the West Hartlepool County Court, before Judge O'Connor and a jury, Mary Milne, claimed £100 damages for personal injuries alleged to have been caused by one of the Hartlepools Electric Tramway Company's cars running off the rails at Cleveland-road, Hartlepool, on Feb. 19. The plaintiff alleged negligence on the part of the company or their servants, or, alternatively, the defective condition of the company's lines.

Mr. Shortt, for the plaintiff, stated that on Feb. 19, between 7.30 and 7.45, Mr. and Mrs. Milne and a friend were passengers on one of the company's cars from West Hartlepool to Hartlepool. In Cleveland-road the pavement had been excavated to the depth of about 1ft. on both sides of the line for the purpose of repairs. It was obvious to everyone, said Mr. Shortt, that at such a spot special care was required on the part of the driver; but the car in which plaintiff was travelling did not slacken speed when passing over this portion of the line. The result was that it left the rails, and Mrs. Milne was fiast thrown forward and then backward, striking the base of her spine against the corner of the seat. She was in bed for some six or eight weeks, and the doctor would tell the court that she was by no means recovered yet.

Evidence was given in support of counsel's statement.

Mr. Harrison, for the defence, said the company did not contest their responsibility, and the question for the jury was simply one of assessing reasonable damages.

The jury found for plaintiff for £70, and his Honour gave judgment for that amount with costs.

AN ORGAN MOTOR.

In the Westminster County Court on Friday the Lewisham Electric Installation Company sued the Rev. Tupper Cary to recover the balance of an account due for the supply of an electric motor. Defendant, who was connected with the Oxford (Christ Church) Mission, obtained an estimate from the plaintiffs for a ½-h.p. motor to blow the church organ. The motor was put in, but according to the defendant's evidence was by no means a success. Most wind came up when the organist wanted very little, and *vice versa*. Moreover, the motor made "a frightful noise," which drowned all the music, and it was stated the principal thing heard by the congregation was a series of alarming groans and creaks. But the worst complaint was that the dynamo fired during a service, and Mr. Cary described the effect as resembling a big catherine wheel, which flung sparks in all directions and frightened the organist almost out of his life. That happened last year, and they had been afraid to use it since. Plaintiffs sued for £30, balance of £60, and the defendant counterclaimed for the return of the £30 paid, and £10, the cost of removing the useless motor.

Judgment was eventually given for the defendant on the claim, and on the counterclaim for £35, with costs.

EFFECT OF TRAMWAY COMPETITION.

At the Leeds Bankruptcy Court last week the affairs of E. Spurden, an omnibus proprietor, of Leeds, were enquired into. It appeared that the debtor's failure was due to the advent of the electric tramcars into the city. He explained to the judge that people would not ride in his 'buses once the electric cars were introduced on Cardigan-road, though he had thought he should always be able to run omnibuses on certain routes. But now nobody wanted 'buses anywhere. Vehicles which had cost him £145 had sold for £4. 10s. and £7.

Mr. Waugh asked for the bankrupt's discharge, which the official receiver opposed.

His Honour remarked that the practice of municipal corporations entering into competition with individual traders, while it was perfectly justifiable, entailed a great deal of personal hardship. And while the trader who was brought to bankruptcy by reason of such competition had no legal claim for compensation, he thought in a case of that sort every consideration should be shown to the debtor. The debtor, however, had failed to keep books, and on that account he must, under the Act, suspend the discharge for two years.

CONSULTING ENGINEERS' FEES.

On Tuesday in the Ormskirk County Court, before Deputy-Judge Goldthorpe and a jury, Messrs. J. and J. S. Enright, consulting engineers, of London, sued the Ormskirk Urban District Council to recover 10 guineas for the preparation of a preliminary report on the electric lighting of the town. It appeared that on Oct. 22 last year the Council's surveyor wrote the plaintiffs to the effect that his Council were contemplating laying down an electrical plant to light some of the streets of the town, and stating that "the Electric Lighting Committee should esteem it a very great favour if they could see their way to supply him with as much information as they possibly could relative to the question of cost for the supply of the public and private lighting of the town by electricity." Upon this letter Mr. J. S. Enright prepared a preliminary report. Certain details were entered into as to the probable demand and income and expenditure, but the whole was summed up in fixing the probable cost of an installation at £7,000, while the income would probably leave a profit of £280, after allowing for interest on loan, sinking fund, etc. Afterwards the plaintiffs sent in an account for 10 guineas for the report, which was repudiated, hence the present action. The defence set up was that the District Council's surveyor was never authorised to ask

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for the report in question, without first counting the cost, and liability or the sum claimed was denied.

Eventually the jury returned a verdict for the defendants, and judgment was accordingly entered in their favour.

His Honour, however, directed that each party should pay their own costs.

COMPANIES' MEETINGS AND REPORTS.

ANGLO-PORTUGUESE TELEPHONE.

The ordinary meeting of this Company was held at the offices, New Union-street, Moorfields, London, Mr. H. Fielden Jackson presiding.

The **Chairman**, in moving the adoption of the report and accounts, said the past year had been one of continued prosperity. They had added 70 new subscribers, who now numbered 2,534. The revenue was £20,619, being an increase of £1,410 on that of the previous year, while their expenses had decreased by £280. The contract with the electric tramway company of Lisbon had been completed, and £6,000 compensation had been paid by that company. This amount it was proposed to carry to the reserve fund, bringing that fund up to £38,000.

The motion was adopted unanimously.

ELECTROLYTIC ALKALI.

An extraordinary general meeting of this Company was held on Saturday at Middlewich for the purpose of increasing the number of directors to nine. Mr. W. Thomson presided.

The meeting unanimously agreed to the increase, and Mr. Geo. Herbert Harrison and Major Wm. Lee Pilkington were chosen as the additional directors.

The **Chairman** observed that there was no other business before the meeting, but he thought it well to state that the applications for shares had been successful. About £120,000 was applied for, and they only needed £100,000. As a matter of fact they had allotted 50,000 preference and 48,852 ordinary shares, and that he thought might be regarded as a highly satisfactory result.

The meeting terminated with a vote of thanks to the chairman and his co-directors.

MEXICO ELECTRIC TRAMWAYS.

The ordinary general meeting of the shareholders in the above Company was held on Wednesday at Winchester House, Colonel Sir Charles Euan-Smith presiding.

The **Chairman**, in moving the adoption of the report, said the year under review had been one of somewhat abnormal depression, which, while directly affecting their sources of revenue, had also seriously increased the sum of their outgoings. It was, therefore, to the future that he would call their special attention, believing, as the directors did, that they had now passed through the more costly period of their existence as an enterprise, and that brighter times were in store for them. It could never have been anticipated that while the whole of this large system was in actual process of reconstruction their returns would have been of a very satisfactory character; but the disadvantages that they could foresee were immensely emphasised and increased by those that could not be foreseen; such, for instance, as the breaking-up of the city roads for the sewerage construction works, which materially interfered with the business. The outlook, however, was now of a most encouraging nature, and in proof of this he quoted the cable returns received two days ago from Mexico, which showed that the receipts for the last month were 10,000dol. better than those of the preceding month, and no less than 18,000dol. increase over the returns of the same month last year. The construction of the whole line was now nearing completion, and when once all the important lines were worked by electricity they might have good reason to anticipate that they should be on the high road to success.

Mr. Ludwig Breitmeyer seconded the motion, which was unanimously adopted.

The retiring directors, Mr. Ludwig Breitmeyer and Dr. Rutherford Harris, having been re-elected,

A vote of thanks to the chairman brought the proceedings to a close.

W. T. HENLEY'S TELEGRAPH WORKS.

Report of the directors, to be presented to the shareholders at the ordinary general meeting to be held at the Cannon-street Hotel on Friday, June 20, 1902, at 12 o'clock:

The negotiations for the amalgamation of the Company with Messrs. Callenders' Cable and Construction Company, Limited, are still proceeding, and the directors are therefore unable to submit the terms to the shareholders, as intimated in their circular of Feb. 21 last. The directors are of opinion, however, that the payment of the final dividend should not be longer deferred, they therefore now submit the annual report, and will communicate the terms of the amalgamation to the shareholders as soon as the negotiations are completed. The accounts show that during the past year a net profit has been made of £64,447. 19s. 9d. After payment of directors' and auditors' fees, debenture interest, and income tax, and making the usual allowance for depreciation of buildings, plant, machinery, etc., there remains £57,449. 13s. 3d., making, with £24,210. 16s. brought forward from last year, a total of £81,660. 9s. 3d. The directors have transferred £1,000 to the debenture redemption sinking fund and £11,000 to the reserve account, and they recommend the payment of a dividend on the ordinary shares at the rate of 20 per cent. per annum (less income tax), including the interim dividends of 5 per cent. paid on Sept. 1, 1901, and 10 per cent. paid on March 1 last. These payments will, together with the preference dividend for the year, amount to £54,875, leaving £26,785. 9s. 3d. to be carried forward. The dividend warrants will be posted on June 20, 1902. Mr. Sydney Gedge and Mr. Frederick Newton retire by rotation in accordance with the provisions of the articles of association, and, being eligible, offer themselves for re-election. The auditors, Messrs. Ball, Baker, Deed, Cornish, and Co., retire, and, being eligible, offer themselves for re-election.

CHADBURN'S (SHIP) TELEGRAPH.

The report of the directors for the year ended March 31 last states that the balance at the credit of the profit and loss account is £11,577. Less managing director's remuneration, directors' fees, and expenses, depreciation on properties and plant, however, £2,811, there is £8,765. From this amount £5,400 must be deducted, being dividends which have been paid at the rate of £6 per cent. per annum on the preference shares and an interim dividend at the rate of £6 per cent. per annum on the ordinary stock, leaving £3,365 to deal with. The directors propose to pay a dividend on the ordinary shares of £10 per cent. per annum for the half-year ended March, making with the interim dividend already paid a dividend of £8 per cent. per annum for the 12 months, carrying forward £365, which, together with last year's balance—namely, £3,929—makes a total carried forward of £4,294.

BRITISH ELECTRIC TRACTION.

Directors: Sir Charles Rivers Wilson, G.C.M.G., C.B. (chairman); Charles Sinclair Drummond; the Hon. Sir Charles William Fremantle, K.C.B.; Emile Garcke, M.I.E.E.; C. Shirreff B. Hilton; the Right Hon. Lord Rathmore; John Smith Raworth, M.I.C.E. Managing director: Emile Garcke, M.I.E.E. Technical director: John S. Raworth, M.I.C.E. Chief engineer: Stephen Sellon, A.M.I.C.E. Secretary: Charles H. Dade.

Report of the directors to be presented to the shareholders at the sixth ordinary general meeting of the Company, to be held at Hamilton House, Victoria-embankment, E.C., on 16th inst. at 12 noon:

The profits, including £21,457. 5s. 7d. brought forward from last year, amount to £224,727. 5s. 5d. This does not take into account the premiums, amounting to £121,184. 11s. 6d., received in respect of new share and debenture capital, and which have been carried direct to reserve. After deducting the proportion of general expenses chargeable to revenue, and also the expenses incurred in connection with schemes not proceeded with and written off, sundry reserves, contributions to superannuation fund, and interest on debenture stock, there remains a net profit of £158,307. 7s. 8d. which the directors propose should be applied as follows: reduction of goodwill account, £1,500; reduction of licenses and testing of new systems account, £2,500; reduction of furniture account, £510. 14s.; dividend at the rate of 6 per cent. per annum on the preference shares for the year ended March 31, 1902, including the dividend paid to Feb. 15, 1902, and proportion of dividend payable Aug. 15, 1902, accrued to date, £54,847. 4s. 9d.; dividend at the rate of 12 per cent. per annum on the ordinary shares for the half-year ended March 31, 1902, making with the interim dividend at the rate of 6 per cent. per annum, paid for the half-year ended Sept. 30, 1901, a total distribution of 9 per cent. for the year, £71,511. 1s. 11d.; carried forward to next account, £27,438. 7s. The directors further propose that each shareholder should receive out of the issue of 20,000 ordinary shares referred to below an allotment at par of one ordinary share in respect of every 10 shares, whether ordinary or preference, held on June 6, 1902. The option given to Messrs. J. S. Morgan and Co. and the Electric and General Investment Company, Limited, to call for allotment of the unissued balance of 37,926 ordinary shares and 10,000 preference shares was exercised on July 8, 1901, and the shares have been duly allotted and paid for in full. There has also been issued £210,906 5 per cent. perpetual debenture stock. The total premiums received in respect of these issues, after deducting the expenses, amount to £121,184. 11s. 6d., and the whole of this amount has been added to reserve, which now stands at £459,705. 4s. 10d. The subscribed share and debenture capital at March 31 was £1,000,000 in ordinary shares of £10 each, £1,000,000 in 6 per cent. cumulative preference shares of £10 each, £810,906 in 5 per cent. perpetual debenture stock — total, £2,810,906. The directors recommend that the nominal capital of the Company be increased by the creation of 100,000 ordinary shares of £10 each and 100,000 preference shares of £10 each. A part of this new capital is required to carry out the absorption of the Electrical Power Distribution Company by an exchange of shares referred to below. It is proposed to make an immediate issue of 20,000 ordinary shares by allotment to the shareholders, as stated above. The directors consider it undesirable to make any public issue of ordinary shares at the present time, as in their opinion the market price of the shares is below what they consider to be their value. The balance under the head of contracts and undertakings, after deducting the cost of undertakings transferred, and after writing off expenses incurred in respect of schemes not proceeded with, but including a proportion of general expenses, is £199,179. 2s. 5d., made up as follows: expenditure on works and undertakings for account of other companies, £26,725. 0s. 1d.; expenditure on works and undertakings owned or leased by the B.E.T. Company and for general stores, £99,988. 5s. 6d.; expenditure in connection with schemes in course of development, and on Acts of Parliament, provisional orders, light railway orders, and other rights and powers secured or in course of promotion, less reserved, £72,465. 16s. 10d. The total amount of investments, after deducting cost of securities sold, stands at £2,332,932. 17s. 9d., and is made up as follows: consols (cost), £161,757. 19s. 8d.; loans and advances to associated companies and

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others, and deposits, £144,875. 16s. 1d.; mortgages, debentures and debenture stock, and shares of associated and other companies, less reserved, £2,026,299. 2s. There are certain contingent liabilities in respect of some of these investments. A portion of the consols is deposited with the Paymaster-General in respect of Acts of Parliament, etc. The Company has a large holding in the Electrical Power Distribution Company, and the two companies have joint interests in several combined electric lighting, power, and traction undertakings. Your directors are of opinion that the efficiency of the combined organisations will be increased, and that economies can be effected, by the complete absorption by the Company of the Electrical Power Distribution Company. With this view the directors propose to offer to the other holders of shares in the E.P.D. Company one B.E.T. fully-paid ordinary share for each fully-paid ordinary share in the E.P.D. Company and one B.E.T. fully-paid preference share for each E.P.D. Company fully-paid preference share. There are also 200 deferred shares of £1 each in the Electrical Power Distribution Company, which were issued and paid for in cash at the time of the formation of the Company. They are held by Messrs. E. Garcke, J. S. Raworth, W. L. Magden, R. Percy Sellon, and G. Offor. In 1900 an agreement was made between the E.P.D. Company and the holders of these shares, by which the E.P.D. Company has the option exercisable at any time within 10 years from Jan. 1, 1900, to extinguish the special rights attaching to such shares on the basis of the payment of £10,000 in cash. An agreement has now been made between the B.E.T. Company and the holders of the deferred shares, giving the B.E.T. Company the option within 12 months from June 6, 1902, of purchasing the 200 deferred shares at the price of £10,000, payable in cash, or at the option of the B.E.T. Company in fully-paid ordinary shares of the B.E.T. Company at the market price of the day on which the option is exercised, and upon the condition that the B.E.T. Company shall exercise such option in the event of its acquiring a majority of the ordinary and preference shares of the P.E.D. Company within the period aforesaid. It is intended to offer Mr. Madgen, the managing director of the E.P.D. Company, a seat on the Board. The British electrical superannuation fund is now in full and satisfactory operation. At the end of 1901 the membership was 81, and that 29 associated companies and undertakings had signified their intention to contribute to the fund on behalf of their salaried staff. The sum of £452. 2s. 3d. has been contributed by the Company during the past year. Attention is called to the British Electrical Friendly Society, which was constituted in December last, since when 19 branches have been formed in various parts of the country and 1,255 men in the service of the British Electric Traction Associated Companies have joined the society. The directors who retire this year are Mr. C. Shirreff B. Hilton and the Hon. Sir Charles W. Fremantle, K.C.B., and both are eligible for re-election. Messrs. Fred W. Smith and Co. retire, and offer themselves for re-election.

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital authorised—100,000 6 per cent. cumulative preference shares of £10 each, and 100,000 ordinary shares of £10 each	2,000,000	0	0
Capital issued—100,000 6 per cent. cumulative preference shares of £10 each, fully paid	1,000,000	0	0
100,000 ordinary shares of £10 each, fully paid	1,000,000	0	0
	2,000,000	0	0
Debenture stock—£810,906 5 per cent. perpetual	810,906	0	0
Reserve—premiums on issues of shares and debenture stock as at March 31, £318,520. 13s. 4d.; ditto in respect of subsequent issues, less commissions, brokerage, and expenses, £121,184. 11s. 6d.; amount transferred from profit and loss account, £20,000	459,705	4	10
Sundry creditors	138,671	1	3
Profit and loss account—preference share dividend due Aug. 15 accrued to date, £7,232. 17s. 7d.; proposed dividend on ordinary shares of 12 per cent. per annum for the half-year ended March 31, 1902, £60,000; balance carried forward to next account, £27,438. 7s.	94,671	4	7
	£3,503,953	10	8

Cr. Assets.	£	s.	d.
Contracts and undertakings—land, buildings, permanent way, electrical equipments, rolling-stock, horses, general stores, parliamentary and other rights, surveys, etc.	199,179	2	5
Investments — Consols, mortgages, loans and advances to associated companies and others, debentures and shares in associated and other companies, parliamentary and other deposits	2,322,932	17	9
Sundry debtors (including £736,113. 3s. 2d. due from other companies in respect of sale of undertakings and on construction and other works)	906,088	8	0
Goodwill account as at March 31, 1901, £2,500; amount written off at March 31, 1902, £1,500	1,000	0	0
Cost of licenses, and of testing and developing new systems of traction as at March 31, 1901, £7,141. 9s. 3d.; expended since, £1,301. 18s. 6d.; amount written off, £2,500	5,943	7	9
Office furniture and fittings as at March 31, 1901, £3,300. 11s. 4d.; expended since, £1,806. 8s. 10d.; amount written off, £510. 14s.	4,596	6	2
Cash on deposit, on current account, and in hand	54,213	8	7
	£3,503,953	10	8

Dr. PROFIT AND LOSS ACCOUNT.		£	s.	d.
General expenses—proportion not chargeable to contracts and undertakings, including expenditure on undertakings not proceeded with, and written off		12,960	0	5
Undertakings in course of promotion—amount reserved		5,000	0	0
Stock		4,000	0	0
Investments		10,000	0	0
Superannuation fund—amount of contributions		452	2	3
Debenture stock interest—Paid to Oct. 1, 1901		13,735	2	1
Proportion of interest accrued to date		20,272	13	0
Balance carried down		158,307	7	8
		£224,727	5	5
Goodwill—amount written off		1,500	0	0
Cost of licenses and of testing and developing new systems of traction—amount written off		2,500	0	0
Furniture and fittings—amount written off		510	14	0
Preference share dividend—Dividend paid to Feb. 15, 1902		47,614	7	2
Proportion of dividend accrued to date	£7,232 17 7			
Ordinary share dividend paid to Sept. 30, 1901		11,511	1	11
Proposed dividend on ordinary shares at the rate of 12 per cent. per annum for the half-year ended March 31, 1902	60,000 0 0			
Balance carried forward to next account	27,438 7 0			
		94,671	4	7
		£158,307	7	8

Cr.	£	s.	d.
Balance brought forward from March 31, 1901	21,457	5	7
Profits on contracts and undertakings, commission, underwriting, sale of investments, management, transfer and other fees, interest, dividends, etc.	203,269	19	10
	£224,727	5	5
Balance brought down	£158,307	7	8
	£158,307	7	8

PERTH ELECTRIC TRAMWAYS.

The report of the directors for the 18 months ended Dec 31, 1901, states that during the period 7 miles have been in operation for 3 months, 10¼ miles for 3¾ months, and 13 miles for 11¼ months, being an average of about 11½ miles during the 18 months. The total gross revenue earned from this mileage during that period amounted to £60,268. During the 18 months £102,109 has been spent on the construction of further sections, extra motive power, and additional cars. Since the date of the accounts additional routes have been completed, making the total mileage now in operation 16¼ miles. The working of the tramways has proceeded without interruption, and the service instituted by the management in Perth has given every satisfaction to the public. The accounts show a net profit from working of £21,697, from which has to be deducted interest on debenture stock and loans, leaving a net balance of £7,354. From this it is proposed to pay interest on the cumulative preference shares to June 30 last, which will absorb £3,272 and leave a balance of £4,081. After allowing for the debit of £2,957 brought forward from last account, a credit balance of £1,124 remains and is carried forward. The traffic receipts since Dec. 31 have been most satisfactory, and whereas in the year 1901 the weekly takings only exceeded the sum of £1,000 in a few instances, the weekly traffics in 1902 have not in one single instance been less than £1,000.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Nuneaton.—The Urban District Council invite tenders for a water-tube boiler and pipework. Tenders by 18th inst.

Shanghai.—The last day for receiving tenders for the proposed municipal tramway and motor 'bus service is June 30.

Blackpool.—The Corporation invite tenders for the supply and delivery of carbons for year ending March 31, 1903. See advertisement.

Sunderland.—The Corporation invite tenders for the supply of permanent way, overhead equipment, and cables. Tenders by July 9. See advertisement.

West Ham.—The Council invite tenders for 50 double-deck electric tramcars, complete with electrical equipment. Tenders by July 8. See advertisement.

Manchester.—The Tramways Committee invite tenders for the supply of line materials, trolley wire, etc., for overhead equipment. Tenders by June 14. See advertisement.

Bristol.—The Electrical Committee invite tenders for feed and general service pumps, water-softener, and tank coke filters and pipework. Tenders by June 20. See advertisement.

Romford.—The Urban District Council invite tenders for the construction and maintenance of electricity supply works in the district. Tenders by June 30. See advertisement.

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Valparaiso.—The Municipality are inviting tenders for electric lighting and tramways. We understand that particulars may be obtained from the Chilian Consul. Tenders by Sept. 1.

Bury.—The Tramways Committee invite tenders for the supply and delivery of rails and fishplates, fishbolts and nuts, tiebars, points and crossings, and sole or anchor plates. Tenders by June 24.

Walsall.—The Corporation invite tenders for the supply and erection of a reversible booster and switches, to work in series with a battery on a tramway circuit. Tenders by June 27. See advertisement.

Birkdale (Lancs.).—The Urban District Council invite tenders for wiring of the town hall and fire station. Specification, etc., may be obtained on application to Mr. J. F. Keeley, accountant, Town Hall, Birkdale Tenders by 14th inst.

Bootle (Lancs.).—The School Board invite tenders for the installation of electric light in the Bedford-road School, Bootle. Specification, etc., may be obtained from Mr. F. K. Wilson, clerk, School Board Offices, Bootle. Tenders by June 20.

Lowestoft.—The Corporation invite tenders for the construction of tramways, rails, fishplates, and bolts, and permanent-way construction. Specification, etc., may be obtained from Mr. R. Beattie Nicholson, town clerk, Lowestoft. Tenders by July 12.

Warrington.—The Corporation invite tenders for the following: (Section 11) tramcars, with motors and electrical equipment complete. Specification, etc., may be obtained at the offices of Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, S.W. Tenders by June 18.

Launceston (Tasmania).—The Corporation invite tenders for polyphase generating, transmitting, and distributing plant and apparatus, transforming apparatus, reconstruction of existing plant, and enclosed arc lamps and accessories. Tenders by Sept. 15. See advertisement.

Salford.—The Tramways Committee invite tenders for the supply of about 2,000 tons of tramrails, together with fishplates, soleplates, and tiebars. Further particulars may be obtained on application to the General Manager, Tramways Department, Town Hall, Salford. Tenders by June 17.

Kirkcaldy.—The Corporation invite tenders for wiring the central station. Specification, etc., can be obtained from Mr. Wm. L. Macindoe, town clerk, or seen at (but not obtained from) the office of Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. Tenders by 21st inst.

Manchester.—The Tramways Committee invite tenders for: (a) chilled cast-iron car wheels and axles; (b) lamp glasses for cars. Specifications may be obtained from Mr. J. M. McElroy, general manager tramways department, 55, Piccadilly, Manchester. Tenders by 1 p.m. on 14th inst.

Stretford.—The District Council invite tenders for the following in connection with its scheme for supply of electrical energy: Steam-raising plant, comprising boilers, superheaters, economisers, etc; generators, comprising engines, dynamos, condensers, pumps, etc.; and mains. Tenders by June 18. See advertisement.

Astrachan.—Erection of electric generating station and installation of public and private lighting, commencing with 150 arc and 6,000 incandescent lamps. Manufacturers who will undertake to finish the work within two years can obtain particulars from the Municipality. Agents will not be able to tender. Tenders by June 7-20.

Ipswich.—The Corporation invite tenders for the supply, delivery, and erection at the generating station, Constantine-road, Ipswich, of engines and dynamos, storage battery, overhead hand travelling crane, feeders, mains, and road work, permanent-way construction of tramways, and arc lamps. Tenders by July 5. See advertisement.

Little Woolton.—The Urban District Council invite tenders for (1) supply, laying, and jointing of cables and the supply and fixing of junction boxes and lamp connections: and (2) supply of lamp fittings. Specification, etc., may be obtained from the surveyor, Mr. Richard Simmons, Grange-lane, Gateacre, near Liverpool. Tenders by 20th inst.

Stockton-on-Tees.—The Corporation invite tenders for the supply, delivery, and erection of one 300-kw. steam generator, two Lancashire type boilers, one switchboard panel and instruments, surface condenser and cooling plant, pipework and valves, extension feeders, and mechanical stokers, economiser, and feed pump. Tenders by June 17. See advertisement.

Rotherham.—The Corporation invite tenders as follows: (Specification No. 12) tramway and lighting feeders, mains, and other cables, with roadwork; (13) boilers—first extension, consisting of three Lancashire boilers, with mountings, erected complete; (14) additional steam dynamo, with normal output of 320 kw., erected complete. Tenders by June 17.

Bury.—The Tramways Committee invite tenders for the work required in the construction of the permanent way in several parts of the borough—viz.: Fairfield section, Bolton-road section, Heywood-street and Knowsley-street sections. Specifications, etc., can be obtained on application at the office of Mr. Arthur W. Bradley, borough engineer and surveyor. Tenders by June 24.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board invite tenders for the supply, delivery, erection, and construction of three 500-kw. steam-driven, direct-coupled three-phase alternators, etc.; three 50-kw. steam-driven, direct-coupled continuous-current exciters, etc.; and permanent way, including copper bonding and conduits for cables. Tenders by July 7. See advertisement.

Wigan.—Tenders are invited for the wiring and equipment for electrical lighting of new warehouse, bakery, and stables, etc., in Dorning-street, Wigan. Specifications, etc., to be obtained and plans inspected at the offices of Messrs. J. B. and W. Thornley, architects, College-chambers, Library-street, Wigan. Tenders by 12 noon on 16th inst., addressed Wigan and District Equitable Co-operative Society, Limited, Powell-street, Wigan.

Worthing.—The Corporation invite tenders for the erection of a circular brick chimney shaft for their electric generating station, High-street, Worthing, 140ft. high from the ground level and 7ft. 6in. inside diameter at the top (the Corporation will construct the foundations and other brickwork to the ground level). Full particulars can be obtained on application to the Borough Surveyor, Municipal Offices, Liverpool-road, Worthing. Tenders by June 16.

Rotherham.—The Corporation invite tenders for the following materials: 2 pairs of cable jacks; 1 hand cart; 1 watchman's box; 200 yards of fencing chain with spikes; 1 tar boiler; 1 portable Weston voltmeter, with case, ranging from 0 to 300 and 0 to 600 volts; set of 6 Crosby indicators complete, with accessories and case; set of stocks and dies; 300 yards of ·1 – ·05 – ·1 triple-concentric Callender's vulcanised-bitumen sheathed cable; 250 yards of ·035 concentric cable, as above; 500 yards of ·022 ditto; 500 yards of ·012 ditto; 50 service boxes; 50 fuse boxes; 10 tons of bitumen. Tenders by 14th inst.

Genoa.—The Board of Trade have received through the Foreign Office a dispatch from H.M. Consul-General at Genoa notifying that tenders will be received up to 11 a.m. on 20th inst. for the supply of electric lanterns and lamps for use on board Italian warships to the estimated total value of 39,823 lire (about £1,555), to be delivered at the Royal Arsenals of Spezia, Naples, Venice, and Taranto. Tenders will be opened simultaneously at the General Directorates of the Royal Arsenals above mentioned, a deposit of 3,980 lire (about £155) being required to qualify any tender. A copy of specification, together with a translation thereof, may be seen on application at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, S.W., any day between 10 a.m. and 5 p.m.

Shanghai.—Messrs. Preece and Cardew are authorised to receive tenders for the supply f.o.b. of the following plant: one 100-kw. high-speed engine and alternator and exciter, for the Shanghai Municipal Commissioners. The engine is to be of the enclosed double-acting type, steam pressure 130lb.; and the alternator of the stationary armature type, 2,100 volts, 100 periods. As the plant is urgently required, offers of suitable second-hand plant will be considered. Specification, with general conditions and form of tender, may be obtained from Messrs. Preece and Cardew, 8, Queen Anne's-gate, Westminster, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Shanghai Steam Alternator," must be delivered to Messrs. Preece and Cardew by noon on 17th inst.

RESULTS OF TENDERS.

Soulcoates.—The Guardians have accepted the tender of the Hart Accumulator Company to supply accumulators for the workhouse, at £581. 8s.

Burton.—The Town Council have accepted the tender of the British Thomson-Houston Company, of Rugby, for generators and switchboard for the tramway system, at £4,099.

Blackburn.—The tender of Dick, Kerr, and Co., Preston, for the supply of dynamos, with engines by Willan and Robinson, Rugby, at £18,127, has been accepted.

Cleckheaton.—The Urban District Council have accepted the tender of the Lancashire Dynamo and Motor Company, Cleckheaton, for the supply, delivery, and erection of continuous-current electric motors.

Carnforth.—The Hematite Iron Company have decided to instal one of Willans and Robinson's standard compound engines for direct coupling to a dynamo of Mather and Platt's make for supplying power to their works.

Mersey Railway.—The Forest City Electric Company, Manchester, have received the contract from the British Westinghouse Electric and Manufacturing Company for the copper bonds and hydraulic bonding tools for the Mersey Railway.

Broughty Ferry.—The Town Council have accepted the tenders of Callender's Cable and Construction Company for cables at £4,964, and for a middle-wire distributor at £566; also that of Thomson, Son, and Co., Limited, Dundee, for steam-pipes and auxiliary gear.

Liverpool.—The tender of Willans and Robinson, Rugby, has been accepted for three 1,500-h.p. engines for direct coupling to Siemens dynamos. They have also received an order for three 1,500-h.p. engines from the British Thomson-Houston Company for direct coupling to three-phase alternators.

Grimsby.—The Town Council have accepted the following tenders: Gilbert Arc Lamp Company, Specification No. 15, arc lamps, £141. 11s 6d.; Mackenzie Bros., No. 16, arc lamp posts, £176. 15s.; Doulton and Co., No. 17, stoneware pipes, £54. 19s.; Johnson and Phillips, No. 18, cables, £229. 4s. 4d.

South Wales.—The South Wales Electrical Power Distribution Company have accepted the tender of Willans and Robinson, Rugby, for three engines of 3,000 h.p. each, and for several of smaller size, for their Pontypridd station. These engines will be direct coupled to alternators for supplying current for general power distribution purposes.

London County Council.—The Council have received the following tenders for electric wiring and fittings for the fire station in Euston-road: D. Assersohn, £268. 10s. (accepted); Lawrence and Co., £323; Jackson Bros., £352. 3s. 6d.; W. Mossop and Co., £357; C. Cooper and Co., £375. 10s.; A. Goldsmith and Co., £400; Wakelin and Co., £597. Tenders for a water-bore for feeding the boilers of the electricity generating station to be erected at Greenwich have been received

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from four firms, and, assuming that the boring would be 300ft. deep, these prices, which would be less should suitable water be found at a higher level, work out as follows: Le Grand and Sutcliffe, £310 for 8½in. borehole (accepted); Merryweather and Sons, £395 for 9in. borehole; C. Isler and Co., £545 for 10in. borehole; Docwra and Co, £592 for 9in. borehole. This includes boring, erection and removal of the boring plant, and the use of trial pumps for the purpose of ascertaining the quantity of water available.

Fulham.—The Guardians have received the following tenders for the supply, delivery, and erection on their premises of pipework:

Aiton and Co.	£1,330	13	0
Babcock and Wilcox, Limited	1,413	3	0
Sir Hiram Maxim Electrical and Engineering Company, Limited	1,439	4	0
D. Stewart and Co., Limited	1,541	10	0
Sir Hiram Maxim Electrical and Engineering Company, Limited	1,589	4	0
Rosser and Russell, Limited	1,643	4	0

Hackney.—The Borough Council have received the following tenders:

Boilers.

Stirling Boiler Company	£6,653	0	0
Babcock and Wilcox (accepted)	6,910	5	0
Hughes and Stirling	6,954	0	0
W. R. Renshaw and Co.	6,995	0	0
J. Thompson	7,385	0	0
R. Hornsby and Sons	7,620	0	0
E. Danks and Co., Oldbury	9,594	0	0

Water-softening plant.

Babcock and Wilcox (accepted)	1,120	0	0
Baker's Patent Appliances Company	1,206	0	0
J. Barrett	1,070	0	0
Desrumaux's Automatic Water Softener and Purifier	1,489	10	0
Doulton and Co.	1,696	0	0
Glasgow Patents Company	1,043	0	0
Lesson and Hjort	1,300	0	0
Masson, Scott, and Co.	1,540	0	0
Mather and Platt	1,795	0	0
Porter-Clark Water Softening Company	2,201	0	0
Potter and Co.	1,725	0	0
Sir Hiram Maxim Electric and Engineering Company	2,140	0	0
Stanhope Water Engineering Company	1,626	0	0
J. Thompson	2,485	0	0
J. Wright and Co.	2,442	0	0

Wiring offices for electric lighting.

National Electric Wiring Company (accepted)	130	15	9
J. C. Christie	164	1	8
Foote and Milne	165	4	8
J. H. Golding	184	13	3
Tamplin and Makovski	219	12	6

BUSINESS NOTES.

NOTICE.—On Wednesday morning we received a label and piece of string addressed to us. The postmark on the same is Preston, and the date June 10. The label is marked "Found without contents" by the Post Office officials, and we shall be obliged if the sender will notify us as to the nature of the parcel posted.

TRACTION.

Dunston.—Lieut.-Colonel von Donop has made his official inspection of the tramway at this place.

Aspull.—Inspection of the Whelley tramway extension has been made by the Board of Trade officials.

Leeds.—It is expected that the Street-lane tramway route will be ready for opening between the 17th and 20th inst.

Macclesfield.—It is proposed to include Bollington, Langley, and other districts in the light railways scheme for the district.

Northfleet.—The District Council have sealed the deed regulating the laying of the electric tramway cables under the footpaths.

Torquay.—A deputation are to be sent to Wolverhampton to inspect the Loraine system of electric traction in operation there.

Doncaster.—The takings on the day of the opening of the new tramways amounted to £43. 19s. 5d., representing 10,553 persons.

Halifax.—The working of the Corporation tramways last year cost £55,094, which, it is reported, exceeded the receipts by the sum of £27.

Reddish.—Colonel von Donop, Board of Trade inspector, on Friday inspected the Reddish section of the Stockport electric tramways.

Warrington.—Messrs. Bennie and Thompson have been requested to proceed with the construction of the tramway to Manchester-road forthwith.

Southend.—The subject of the Corporation's proposed light railway from Southend to Shoeburyness has been referred to the Highways Committee.

Singapore.—We learn that the Straits Legislative Council have unanimously passed the Bill for the introduction of electric tramways in Singapore.

Hammersmith.—The Borough Council have now approved the proposals contained in the London United Tramway Company's Bill for extending their lines in the borough.

Clydebank.—It is anticipated that in consequence of the arrangement come to with Glasgow, noted last week, the electric cars will be running to Dalmuir in three months' time.

Brighton.—The engineer has been instructed to arrange for Mr. Spencer's appliance for preventing the run-back of cars on a gradient to be fixed to the cars at a total cost of £5. 15s. each car.

Torry.—The Tramways Committee at their last meeting had a discussion on the question of a tramway in Torry, and the committee agreed to consider as to the promotion of a Bill on the subject.

Paris.—An electric railway between Paris and Versailles was opened to the public on Saturday. It has been built by the Western of France Company. There will be 15 trains per day in each direction.

Ainsdale.—A deputation from the Parish Council will shortly wait upon the Tramways Committee of the Birkdale Urban District Council with regard to extending the tramway system, when completed, into Ainsdale.

Hampton.—The London United Tramways Company have accepted the Council's requirements as to the double line opposite Ivy House, Hampton Court, and the laying of the 18in. margins with granite setts.

Rochdale.—The date on which the Norden section of the new tramways will be opened to the public depends upon the Board of Trade inspection. Probably in less than a fortnight the cars will be running on this section.

Nottingham.—The tramway along Lenton-boulevard to the Canal-street junction is being proceeded with in earnest, and with some degree of certainty it may be anticipated that cars will be running on this route in three months.

Dewsbury.—Terms have been agreed upon between the Corporation and the British Electric Traction Company for the supply to the company by the Corporation of energy for the electric tramways which are now being constructed.

Blackburn.—During the week ending May 30 the passengers carried numbered 145,558, and the receipts amounted to £841. 5s. 1d., compared with 179,794 passengers and £846. 5s. 7d. receipts—a decrease of 34,236 passengers and £5. 0s. 6d. receipts.

Military Motors.—The Kaiser has consented to the introduction of the Thornycroft steam-wagon into the German army. The wagon will carry 3½ tons on an ordinary macadam road, and will haul a further 3½ tons at a speed of six miles per hour.

Bury.—The Board of Guardians have appointed a deputation to wait upon the Tramway Committee of the Bury Corporation, urging them to extend their tramway system in the Bury Old-road to the Bury boundary, or at least to the Bury Workhouse.

Swansea.—The Swansea tramway service has been augmented by the docks cars running all the way to the Slip. On each of the three sections using St. Helen's-road there will be additional cars, ensuring a car leaving the hospital for town every 2½ minutes.

Audley.—Another unsuccessful effort has been made to secure for the Audley district a much-needed tramway loop line, the Tramways Committee having decided that they cannot at present see their way to depart from their previous resolution not to proceed with the extension.

Light Railways.—The Board of Trade have confirmed orders authorising the construction of light railways in the borough of Swansea and in the rural district of Llangyfelach, in the county of Glamorgan, and amending the Grimsby and Saltfleetby Light Railway Order, 1898.

Batley.—The contractor for the permanent way of the new tramway has now commenced operations. With regard to the proposed agreement between the Corporation and the British Electric Traction Company, it is likely that by the next Council meeting the agreement will have been completed.

Newcastle.—Notice has been given that the *locus standi* of the Tyneside Tramways and Tramroads Company, who have petitioned against the Newcastle Corporation Tramways Bill, is objected to. It will now be left for the Court of Referees to decide between the petitioners and the promoters.

Christchurch (N.Z.).—The Christchurch boroughs interested in forming a tramway board have agreed on the main details of a Bill to constitute the Board. Each local body is to have the nomination of three members. The Board will have control of the expenditure of £250,000 under the proposed scheme.

Blackpool.—A proposal for 1d. stages on the tramcars on the promenade has been rejected by the Town Council. The work in connection with the new road tramway is now practically completed. Only the squaring up of the track remains to be done, and this work will be carried out by the permanent staff.

Merthyr.—In connection with the tramway scheme at this place the Merthyr District Traction Company have notified the Urban District Council that they cannot increase their offer of £400 towards the cost of making a new bridge over the River Taff at Cefn, and pointing out that even this offer cannot be kept open indefinitely.

Glasgow.—An extraordinary meeting of the shareholders of the Glasgow Tramway and Omnibus Company has confirmed resolutions relative to the voluntary winding-up of the company. The salaries of Mr. Wm. Clark, chief engineer of the tramways, and of Mr. M. B. Field, the electrical engineer, have been advanced to £600 and £500 respectively.

Cardiff.—Major Druitt, of the Board of Trade, has inspected the remaining portions of the Corporation electric tramways—viz., the Cathays section, the docks section, from the Hayes to the pierhead, and that part of the Canton section between the workhouse and St. Mary-street as far as Wood-street corner. Yesterday all the sections were formally opened.

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Northumberland.—We understand that in consequence of the opposition to the Tyneside Tramways and Tramroads Bill and the Northumberland Electric Tramways Bill having been withdrawn, these Bills have been removed from the group of opposed Bills in which they were placed. They have now been referred to the chairman of the Committee of Ways and Means.

Reigate.—The promoters of the electric railway which it is proposed to run from the City to Reigate and Redhill are taking steps to bring their scheme into definite shape. The London terminus would be at the Monument, and the route to be followed would be *via* Brixton, Streatham, Norbury, Croydon, Warlingham, and Caterham, with a branch from Warlingham to Westerham.

Plymouth.—The Tramway Committee are making arrangements for running the electric cars over the lines in Union-street as far as the boundary of the borough. The construction of the Beaumont-road section of the Corporation tramways has cost £11,303. This is £773 more than the sum sanctioned by the Board of Trade, and it is proposed to make application to borrow the extra £773.

Walsall.—The Tramway Committee report having authorised the town clerk to take such steps as may be necessary to defend an action brought by the South Staffordshire Tramway Company to recover rent in respect of the tramway undertaking within the borough. The action, it is explained, is against the lessee company, which at present works the tramways, but the Corporation have agreed to defend it.

Barrow.—The negotiations between Barrow Town Council, the Furness Railway Company, and British Electric Traction Company with respect to the latter company taking over the tramway system, and substituting electricity for steam, have now been concluded. The present condition of engines and cars has long been a matter of serious complaint, and two months ago the Council refused to license them any longer.

Birkenhead.—The new offices of the tramways manager and staff are to be erected at the Laird-street depôt. The attention of the Tramways Committee is to be called to the question of providing facilities for the travelling public in the earlier parts of Sunday, bearing in mind the fact that between nine and ten o'clock on Sunday mornings the Liverpool authorities offer almost as good facilities as on weekdays.

Parkstone.—The Board of Trade held an enquiry on Monday relative to the application of the Poole and District Electric Traction Company to extend their tramlines through Parkstone. The opposition of the railway company to the proposal was first heard, and ultimately the Board of Trade officials decided in favour of the tram company. The opposition of the frontagers along the proposed line of route remains to be dealt with.

Tramway Competition.—It is reported in the provincial Press that several leading railway companies owning large systems in the Midlands and North of England are seriously considering the advisability of lowering their passenger fares in all three classes, with a view to competing more successfully with the electrical tramways. The work of revising fares and making uniform arrangements will be immense, and some little time must elapse before it is completed.

Dundee.—The burgh engineer reporting with regard to the progress of work in connection with the laying of the new tramway in Constitution-road, states that the permanent way and the double rails have been completed between the main entrance to the infirmary and Drummond-street, and on the north line eastward from that point along Constitution-street to near Rosebank. The construction of the west line in Constitution-road has now been commenced.

Thornhill.—The General Purposes Committee have decided, in reply to an enquiry from the British Electric Traction Company, that no span wires be allowed in any of the roads along the route of the proposed light railways in the district, except where it is absolutely necessary in the cases of corners and bends in the roads. It is further resolved to request the company to lay the tramlines in Lees Hall-road and Brewery-lane not more than 4ft. from the kerb.

Hull.—At the last meeting of the Town Council, on the minutes of the Works Committee, containing a balance sheet of the cost of the electric tram system, a member criticised the management. He said that the income from the trams appeared to be practically stationary, whilst there was a large additional expenditure. It was officially explained that the increased expenditure on the tramway system arose mainly in the increased pay to the conductors and drivers and other employés of the undertaking.

South Lancashire.—The two lines of rail, upon which about 200 workmen have been engaged during the past few months from Hulton boundary through Atherton, and from Lowton boundary through Leigh, are now practically completed and joined up at Leigh and Atherton boundary. This is the first finished length of the South Lancashire Tramways Company's big scheme for uniting Manchester, Liverpool, St. Helens, Warrington, Leigh, Wigan, and Bolton, and on Coronation Day horse cars will be run.

Light Railways in Essex.—The Light Railway Commissioners have decided to sanction the scheme for a light railway from Southend to Colchester. They authorise the proposals for crossing the Rivers Crouch and Blackwater, but they provide that no existing public rights of ferry on the Crouch shall be displaced, and that no exclusive rights of ferry on the Blackwater shall be conferred on the light railway company (except between their own piers). They limit the capital to be authorised for the construction and equipment of the proposed line to £500,000.

Bradford.—A curious accident has occurred on the Thornton-road section of the electric tramways. A guard wire broke in Thornton-road, near Jesse-street, dropping across the trolley wire and thence on to the rails. Finally it came into contact with a horse and cart. According to report, the four shoes of the horse were ripped off its feet, but the animal itself was not hurt, and no other damage resulted. A service of electric cars has been commenced from Four Lane Ends to Allerton. The estimates for the proposed tramway extensions are £184,248 tramways, and £83,942 street improvements.

Birmingham.—The shareholders of the City of Birmingham Tramways Company, Limited, have received a circular from Mr. James Ross, of Montreal, chairman of the company, stating that he has agreed to sell his ordinary shares for 37s. 6d. each, net cum dividend, and arranged that a similar offer should be made to all other shareholders, the offer remaining open until 30th inst. Messrs. Ross Bros. hold together 32,727 shares, so that the price paid is £61,000. It is stated that important developments are intended by the London syndicate, who are said to be the B. E. T. Company

Private Bills.—In the House of Commons the following Bills have been read a third time: London County Council (Subways and Tramways) Bill; London County Council (Tramways and Improvements) Bill; London, Tilbury, and Southend Railway Bill; and the City and Brixton Abandonment Bill. In the House of Lords the Central London Railway (New Lines) Bill; the North Staffordshire Tramways Bill; and the Rossendale Valleys Tramways Bill have been read a third time and passed; and the Great Northern Railway Bill and the Garston and District Tramways and Electric Supply (Transfer) Bill a second time.

North Shields.—The electric tramway to Wallsend is now laid. It was originally arranged that the County Council and the tramways company should conjointly pay the cost of widening and strengthening the bridge across Willington Gut, so that double lines could be laid over it, but a difficulty has arisen regarding the purchase of the additional land required. In the meantime the company have asked the Wallsend Council to grant them permission to construct a single line until the necessary ground is secured in order that the service may be opened as early as possible. The Corporation are likely to grant the concession.

Newport (Mon.).—In the Corporation Bill which is now being enquired into by a committee of the House of Lords, powers are sought to improve the tramway system from the town to the docks. At present the tramlines are single, and stop at the limits of the old boundary of the borough. It is now proposed to double these tramways, and to extend them to the edge of the new boundary and to introduce electric traction. The only opposition to the scheme is that of the Great Western Railway Company, who object to the tramway being extended from the point in Commercial-road across the Pillgwenlly level crossing.

Sheffield.—The extension of the Hillsborough tramlines is to be carried out to join the Owlerton route from Holme-lane and Parkside-road, and the paving of the tracks will be with wood from Holme-lane to Dykes Hall-road, the remainder to be granite. The Tramways Committee have decided that a sum of £50 should be expended on the decoration of the cars on June 26 and 27, and that three prizes—viz., £2. 10s., £1. 10s., and £1—be given to the motormen and conductors of the cars which are most tastefully decorated. The Council have confirmed the policy of the Tramways Committee in favour of ceasing to run cars to Harcourt-road.

Failsworth.—At the last meeting of the District Council a letter was read from the town clerk of Manchester enclosing print of the awards of the arbitrator in connection with the purchase of the tramways. The amounts of the respective awards are £39,373 and £12,012. The value of the permanent way is the same in each award, the difference arising out of the contention between the parties as to how much of the respective depôts and of the horse cars and other plant are to be purchased and paid for by the respective purchasing authorities. The case, it was stated, is being set down for hearing at an early date, with the view of an authoritative decision being obtained.

Newton-in-Makerfield.—At the monthly meeting of the Urban District Council, a communication was read from the solicitors to the Council stating that the South Lancashire Tramways Company had subscribed an amount in excess of £733,000 under the contract of the tramways company, and the company had informed them that they proposed to proceed forthwith with the construction of the tramways in the Council's district as included in their first construction scheme. The tramways in the district will enable the section now nearly completed to Leigh and Bolton to be connected with that on the St. Helens route. That connecting the trunk line to Warrington is contained in the second scheme.

Hastings.—The Hastings Corporation by 12 votes to 14 have consented to the Front Line Electric Tramways Bill. An application in regard to the scheme was, however, made to the Earl of Morley, chairman of committees of the House of Lords, on Thursday last week. After a short argument, the Earl of Morley stated that he could not disturb the decision of the Standing Orders Committee as to the Front Line scheme, based on the original vote of the Town Council on March 7 refusing consent to the Bill. The matter thus stands in exactly the same position as it did prior to the special meeting of the Town Council—that is, the Front Line scheme cannot be proceeded with in the present session of Parliament.

Wolverhampton.—A long discussion took place at the last meeting of the Town Council with regard to the tramway deadlock, and the correspondence between the Corporation and the British Electric Traction Company on the matter was read. The subject eventually dropped, the Council deciding to deal with it in committee. On Tuesday a communication was received from the Traction Company to the effect that they were prepared to accept the proposal of the Corporation that the company should bring their system to the Wolverhampton boundary on the overhead system to meet that of the Corporation. The company are further prepared to enter into an agreement at once to carry out the work, on the Corporation undertaking to pay the cost.

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Nelson.—Tenders for the supply and laying of cables for the light railways to Colne and Barrowford have been referred to the chairman of the Tramways Committee and the electrical engineer, with power to accept a tender. The following resolution has been adopted by the Town Council: "That in pursuance of the enabling provisions of the Light Railways Act, 1896, the Light Railway Commissioners be requested to confer upon the Council of this borough by means of the Colne and Trawden Light Railways Amendment Order, 1902, authority to enter into an agreement with the promoters of the said order to work or to contract for the working of the light railways authorised by the Nelson Light Railways Order, 1901, and the Colne and Trawden Light Railways Order, 1901.

Scarborough.—The Earl of Morley, chairman of committees in the House of Lords, has had under consideration the Scarborough Tramways Bill, the object of which is to incorporate the Scarborough Tramways Company, and to empower them to construct and maintain tramways and to execute certain street works in the borough. The capital power sought is £96,000, with the usual borrowing powers of one-third. The Bill enables the Corporation to subscribe or lend an amount not exceeding £10,000 towards the undertaking, and entitles the mayor or other member of the Council to become an *ex-officio* director of the company in the event of the Council having an interest in shares of the company to the extent of £5,000. The preamble having been formally proved, the Bill was sent for third reading in the House of Lords.

Newcastle.—A further extension of the electric tramways has been brought into service—viz., the Clayton-street route. Every second car leaving the Osborne-road terminus will now run to Elswick-road *via* Northumberland-street, Blackett-street, Clayton-street, and Westgate, and *vice versa*. In connection with this change, the cars that up to Saturday were running between Elswick-road and Heaton-road *via* City-road are now running between Westgate-road and Union-road *via* City-road and Raby-street. A supplementary service is also working between Westgate-road terminus and St. Nicholas's-square and Elswick-road terminus and St. Nicholas's-square. These practically mean a continuous four minutes' service from the West-end termini to the station, with the advantage that there will not be so many stoppages opposite St. John's Church.

Wakefield.—It will be within the recollection of our readers that the application for powers to construct a tramway to Dewsbury in connection with the Wakefield scheme fell through, and since then nothing appears to have been done in Wakefield. Enquiries have been made by the West Riding County Council, the Wakefield Corporation, and the Tradesmen's Association as to when a start will be made by the promoters, but no definite answer has been given. The promoters are allowed three years in which to make a start (of which one year has elapsed), but the time may be extended if sufficient cause can be shown. It is reported that the local solicitor of the promoters of the light railways scheme is expecting instructions to make fresh application to Parliament for powers to construct the proposed line to Dewsbury, *via* Ossett, which has once been refused by the Light Railway Commissioners.

Tyneside.—The Court of Referees of the House of Commons has had under consideration an objection raised to the North-Eastern Railway Company being heard against the Tyneside Tramways and Tramroads Bill. Mr. Mooney, K.C., for the North-Eastern Railway Company, said there were two grounds on which he asked the court to give a *locus standi*. One was on the ground of competition, and that related not only to passenger traffic, but to goods and mineral traffic. The second ground on which he asked to be heard was that of interference with works. In some places the tramways would pass under the North-Eastern Company's bridges, and it was intended to alter the level of the road. The result might be, and it very likely would be, that the foundations of the bridges would be interfered with. He thought the promoters must concede his right to be heard for the protection of those bridges. The *locus standi* was disallowed.

Hampstead.—The General Purposes Committee report that they have instructed the town clerk to obtain from the London County Council fuller details of the proposed scheme for constructing a tramway from Edgware-road to Child's Hill, and also from the Middlesex County Council fuller details of the proposed scheme for constructing tramways in the county of Middlesex, as set out in the notice of proposed application to the Light Railway Commissioners. With regard to the Charing Cross, Euston, and Hampstead Railway Bill now before Parliament, the Borough Council have resolved that, having regard to the fact that the necessary provisions for the protection of the borough have been inserted in the Bill, and being of opinion that the construction of the proposed railway would supply a good public need, the Council trust that the borough member will not only see his way to refrain from any contemplated opposition to the Bill, but will give it his cordial support when it comes before the House of Commons.

Stoke-on-Trent.—At the last meeting of the Town Council, Mr. Stephen Sellon, chief engineer to the British Electric Traction Company, wrote regretting that the Council had decided that a double line on the proposed light railway from Stoke, through Hartshill, to Newcastle, was not advisable in certain portions of the route. He considered the double line so essential, that it would be necessary for him to make application to the Board of Trade to appoint an arbitrator to decide this matter if they could not come to any understanding. The town clerk was instructed to write to Mr. Sellon, pointing out that no double line was shown on the original plan deposited on the application for the order, and stating that the Light Railway Sub-committee, with the borough surveyor, had taken a great amount of trouble in further considering the matter, and could not see their way to recede from the position they had taken up, but were prepared to meet Mr. Sellon at the *locus* and give their best attention to any argument he might use in support of his contention.

Manchester.—It is decided to invite tenders for a new type of car to be used on the circular route of tramways which will link the suburbs of the city together. As there are several low railway arches on these routes, a single-deck car has been adopted. The new car differs from the old in that a portion of it will be open at the sides. It will be constructed to hold 18 passengers in the central portion and 10 at each end. The electric tramways worked by the Corporation earned £5,180 last week, and 1,112,000 passengers travelled on the cars. In the previous week £2,761 was received from 689,863 passengers. This large increase was due to the opening on June 1 of the routes to Stockport and Denton. There are 50 miles of single track now worked by the Corporation. When the proposed scheme is complete the system will embrace 150 miles of single track. The greater part of the 100 miles to come in is upon routes still worked by the horse cars of the Manchester Carriage and Tramways Company. Yesterday the company began the sale of a further batch of 720 horses not now required.

Blackpool and Garstang Light Railway Co.—This Company has been incorporated with a share capital of £180,000 in £10 shares, and power to borrow £60,000, for the purpose of constructing and working about 14 miles of railways from Blackpool to Garstang, connecting with the London and North-Western and the Lancashire and Yorkshire Railways. The railway will give access to about 40 square miles of the most fertile part of the Fylde district, and it is expected that an immense quantity of agricultural and market garden produce will be available for transport to Blackpool, as well as to the trunk lines of the North-Western and Lancashire and Yorkshire Railways. The directors also expect that the company will derive all the advantages of interchange of the passenger traffic from the Blackpool and Fleetwood tramroad and the railways already mentioned. Tenders amounting to £148,112 have been received for constructing the railway and buildings, and it is thought that a portion of the line will be open for public traffic in the summer of 1903. Eighteen thousand £10 shares are now offered for subscription. The subscription list closes to-day (Friday).

Aberdeen.—The financial year of the Corporation tramways closed on Saturday last. The total receipts for the 12 months amounting to about £37,000, which gives an increase of some £2,225 on the preceding year. The details as to the expenditure are not yet available, but it is believed that there will be a substantial balance on the right side. The number of passengers carried during the year was 9,089,215, while for the preceding 12 months the figures were 8,361,711, showing an increase of 727,504. The Tramways Committee have decided to recommend to next meeting of Council that a single tramway be laid from Union-street to Ferryhill Free Church, along Crown-street and Ferryhill-road. The committee have decided to appoint a delegate to join with other corporations, notably Glasgow, Manchester, and Dundee to make a representation to the Board of Trade in regard to the rules which are issued from time to time by the Board in reference to the overhead wires and other matters. The Board of Trade inspection of the Albyn-place and Bayview, Holburn-street, and King-street sections of the electric tramways took place one day this week, thus completing the inspection of the whole of the existing tramway system in Aberdeen.

Light Railways Report.—The report of the proceedings of the Board of Trade and of the Light Railways Commissioners up to Dec. 31 last, under the Light Railways Act, 1896, is published as a parliamentary white paper. Since the date of the last report the Treasury have conditionally agreed to make the following advances in respect of light railways authorised by orders confirmed by the Board of Trade: South Norfolk—£24,350 as a free grant; Leek, Caldon Low, and Hartington (Waterhouses to Hulme End section)—£2,500 as a free grant and £7,500 as a loan with interest at 3 per cent. per annum, in addition to £15,000 previously promised; Tanat Valley—instead of the free grant of £28,000 previously promised, a free grant of £22,000 and a loan of £6,000, without interest, have been agreed upon, in view of altered circumstances. Lauder: £11,000 as a loan under Section 4 of the Act, with interest at 3¼ per cent. per annum. The Treasury have also conditionally agreed to advance a further sum of £7,000 as a free grant and £3,500 as a loan, without interest, in addition to £37,500 previously promised, in respect of the Cromarty and Dingwall light railway, the order to authorise which has recently been submitted to the Board of Trade, but has not yet been confirmed.

New Issue.—The Havana Electric Railway Company are inviting subscriptions for an issue of 7,500,000dol. 5 per cent. consolidated mortgage 50-year gold bonds, part of a total authorised issue of 10,000,000dol., at the price of 98 per cent., or 980dol. per 1,000dol. bond. The prospectus states that the company has been incorporated under the laws of the State of New Jersey, to acquire the concessions and property of the Ferro Carril Urbano y Omnibus de Habana (Havana City Railway and Omnibus Company), a local concern organised in 1876, for the construction and working of tramways in the city of Havana. The company is now, in its first year of operating, earning a gross revenue of from 1,100,000dol. to 1,200,000dol silver currency. The cost of the franchises, the old system, the construction of the new system, together with the electrical equipment, electric cars, car stations, and power station of sufficient size for extended future requirements has been about 7,000,000dol., and the proceeds of the present issue, less the amount required to redeem the outstanding bonds of the company, will be used for further extensions of the system, additional rolling-stock, etc. The bonds will be repayable by the operation of a sinking fund, or redeemable at the option of the company on six months' notice at 105 per cent.

London County Council Subways Bill.—In the House of Commons last week there was a long discussion on the consideration of the London County Council (Subways and Tramways) Bill as amended. The main object of the Bill is to authorise a subway for trams from north to south in London, the subway terminating near

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the north end of Waterloo Bridge, from which point the tramway would be continued to Westminster Bridge on the open thoroughfare of the Embankment. Mr. Whitmore moved a new clause as follows: "Notwithstanding anything in this Act contained to the contrary, it shall not be lawful for the Council to construct any tramway southward of the southern boundary of the premises No. 6 in the precinct of the Savoy upon the deposited plans." He strongly condemned the Bill as it stood as a measure which would result in disfigurement to the Embankment and in obstruction to traffic on that thoroughfare. Mr. H. Hobhouse, who was chairman of the committee on the Bill, asked the House to dismiss from their minds the fear that the system involved disfigurement of the Embankment, or the ultimate construction of a line over Westminster Bridge. There were other ways of crossing the Thames than that, and when a specific proposal for extending the line was made the House could deal with it on its merits. Finally, the new clause was rejected on a division, and the Bill was ordered for third reading.

London United Tramways.—Mr. Compton Rickett's Committee of the House of Commons, who are enquiring into the proposals of the above Bill, this week heard evidence in support of those portions of the scheme which affect the Wimbledon district. Mr. W. S. Bond, chairman of the Parliamentary Committee of the Wimbledon Urban District Council, who conducted the negotiations with the promoters, claimed that the agreement arrived at was eminently satisfactory for the ratepayers. The widenings and improvements would distinctly be advantageous to Wimbledon. These conditions the British Electric Traction Company would not accept, and communication with that company on the subject was discontinued last year. The general feeling among the inhabitants of Wimbledon was in favour of the tramway proposals, and this was shown by the unopposed return of five candidates in favour of the Bill in local elections last April. Even without the expenditure of £165,000 now proposed by the promoters on Wimbledon improvements, the tramway service would be of great advantage to the town, and especially for the working classes, for whom the railway facilities were inadequate, and as a convenient means of intercommunication with Malden, Kingston, and Hampton Court. He did not think that the construction of the tramway along Worple-road would lower the ratable value of property on the route. The tramway to the common was an important part of the scheme, and from the first had been included in the negotiations between the Council and the company. Mr. Balfour Browne, K.C., in reply to the chairman, said the promoters would be quite prepared to lay down a length of about 300 yards to connect their proposed No. 13 line with the London County Council tramway to Tooting, and Mr. Talbot undertook to communicate with the County Council, this short spur coming within the area of their administration. The committee adjourned.

Southport.—The report of Mr. T. G. Kendrew, the Corporation tramways manager, for the year ending March 31 last, states that there are at present 26 electric cars and two horse cars available for service. With the exception of one single-decked car, all the equipments are Preston make and interchangeable. Three of the new cars are fitted with the Tidswell patent lifeguard at each end, and the other is fitted with the Newton patent lifeguard. To facilitate the working of the heavy traffic along Scarisbrick New-road it was decided on the expiration of the Birkdale and Southport Company's lease to replace a short single line opposite to Seaton-street by double track, and this has proved of great service. No accidents have occurred through the falling of wires. There has been no breaking of any copper wires; this is due to the periodical examination of the overhead equipment, and doing small repairs when necessary. Efficient guard wires are fixed where telephone wires cross the track. These have been found very effective whenever a telephone wire has fallen, either keeping it off the trolley wire or fusing it when making contact with same. In no instance have the cars been stopped on account of falling telephone wires, as was the case on Friday, March 29, 1901, and only very rarely have the cars been delayed through accidents of any kind. The reconstruction of the lines leased to the Southport Tramways Company, Limited, was commenced on March 11, 1901. The first electric car was run from Manchester-road, *via* Cambridge-road, to the Botanic Gardens on June 5, 1901. The line from Duke-street to Botanic Gardens, *via* Cambridge-road, was inspected and passed by the Board of Trade on Sept. 9, the whole of the overhead equipment and track being completed within six months. A full set of tools is supplied to each car, in which rubber gloves and pliers are included, also a key of the section boxes, so that the fuse can be replaced as soon as possible after the broken wires have been cut clear. A lathe, drill, and other tools are on order, and will be working shortly at the depôt, so that our repairs may be carried out without delay. The whole of the lines, cars, electrical equipments, and equipments have been kept in first-class condition.

London County Council.—At the meeting of the London County Council on Tuesday the Parliamentary Committee reported the fact that the Select Committee of the House of Commons presided over by Mr. H. Hobhouse have passed the Tramways and Improvements Bill, authorising the following: the construction of tramway lines from Hammersmith-broadway *via* Putney Bridge to Lower Richmond-road; along the Victoria-embankment from near the western end of Westminster Bridge to join the Council's proposed shallow underground tramway to Theobald's-road at a point near Waterloo Bridge; from Eltham *via* Wellhall-lane and Woolwich-road to Beresford-square, Woolwich; from Camberwell-green *via* Grove-vale, Dog Kennel-hill, and Lordship-lane to the junction of the last-mentioned thoroughfare with Crystal Palace-road; widenings of Hampstead-road; Denmark-hill, Champion-park, Grove-lane, Dog Kennel-hill, Grove-vale, and Lordship-lane; Fulham Palace-road and High-street, Fulham; and Queen's-road, Peckham; the utilisation of the Council's Greenwich tramway depôt and land adjoining to be acquired for the purpose of an electricity generating station; the acquisition of land at New Cross-gate and Clapham for the purposes of a tramway depôt and the enlargement of an existing depôt respectively. The Parliamentary Committee also presented a report on the various "Tube" Bills which have been dealt with by the Lords' committees presided over by Lord Windsor and Lord Ribblesdale respectively. The Highways Committee recommended the Council to pass the statutory resolutions authorising them to require the Woolwich and South-East London Tramways Company, the South London Tramways Company, and the London, Deptford, and Greenwich Tramways Company to sell their undertakings to the Council. The tramways in question are mainly those from Vauxhall Bridge to Westminster Bridge, from Albert-embankment to Vauxhall Bridge, along a part of Southwark-street to Borough High-street and from St. George's-road to the Elephant and Castle. Reporting on the financial aspect of these purchases, the Finance Committee state that they had thought there was a reasonable prospect that the lines would prove remunerative, but the South London Company has lately suffered from the rise in working expenses which has been experienced by all such undertakings, and the latest available figures show a considerable falling off in the net earnings. On the basis of the present cost of horse traction, and the Council's standard of wages and labour, and apart from the connections which can be made with the Council's lines, it appears to them very doubtful whether the undertaking could be worked by the Council at a profit. Dealing with the undertaking of the London, Deptford, and Greenwich Company, the Finance Committee express the view that this can only be worked at a loss unless it can be acquired on very favourable terms. Besides, full advantage cannot, they say, be obtained until electric traction has been adopted over the whole of the lines, and this may involve considerable street widenings, as to the cost of which no estimates have as yet been prepared. On the question of the proposed electricity generating station at Greenwich, the Highways Committee presented the following report: "We have had under consideration the question of the manner in which water required for feeding the boilers of the electricity generating station to be erected at Greenwich may best be obtained. The cost of obtaining the water from the available public supply when the station is finally completed would be between £5,500 and £6,000 a year, and it has been suggested to us that, in order to avoid the necessity for this large expenditure, surface condensers shall be used at the station, and water obtained by means of a well to be sunk on the site. Should this course be adopted, it is anticipated that the annual cost of providing water for the feeding of the boilers will not exceed £300, but it will be also necessary to provide, at a cost estimated at about £300 per annum, a large amount of water for the general purposes of the station, so that the total annual cost for water will be about £600. Well borings have been made near the river at Greenwich with a view to ascertaining the suitability of the water obtained from the chalk or below it for boiler-feeding purposes; but the results have been somewhat conflicting, and it appears to us, therefore, to be advisable that a trial boring hole should be sunk at the site to a sufficient depth to tap the best water bearing strata. We have obtained prices from four firms experienced in such work, and, assuming that the boring would be 300ft. deep, these prices, which will be less should suitable water be found at a higher level, work out as follows: Messrs. Le Grand and Sutcliffe, £310 for 8¼in. borehole; Messrs. Merryweather and Sons. £395 for 9in. borehole; Messrs. C. Isler and Co., £545 for 10in. borehole; Messrs. Dowcra and Co., £592 for 9in. borehole. The prices above quoted are in respect of the boring, the erection and removal of the boring, plant, and the use of trial pumps for the purpose of ascertaining the quantity of water available. We are of opinion that it is advisable that the offer of Messrs. Le Grand and Sutcliffe should be accepted, and we recommend that the estimate of £350, submitted by the Finance Committee, be approved; and that the expenditure be authorised of a sum not exceeding that amount in connection with the boring of a trial wellhole at the site of the proposed electricity generating station at Greenwich; that the offer of Messrs. Le Grand and Sutcliffe to carry out the work at the prices specified in their letter, dated April 22, 1902, to the tramways manager be accepted; that it be referred to the clerk of the Council and the solicitor to take the necessary measures to give effect to the arrangement; and that the seal of the Council be affixed to any necessary document in connection therewith." The applications of the Middlesex County Council and of the Crystal Palace Light Railway Syndicate to the Light Railway Comsioners for orders will be opposed by the London County Council.

LIGHTING AND GENERAL.

Broughty Ferry.—Sanction has been obtained to the borrowing of £15,000 for electricity purposes.

Morecambe.—The charge for current through the prepayment meters is to be at the rate of 6d. per unit.

Shoreditch.—The Corporation's electric light and power station at Haggerston will be opened on the 16th inst.

Bournemouth Telephones.—A special committee has been appointed to consider the question of telephones.

The North Metropolitan Electric Power Supply Bill.—This Bill has been read a second time in the House of Lords.

Finchley.—An enquiry has been held into the application of the District Council to borrow £35,000 for electric lighting purposes.

Paddock Wood.—The National Telephone Company have opened their telephone exchange. There are already some 30 subscribers.

Rotherham.—The Town Council have granted a number of increases of salary to the staff of the electric light and tramway department.

Gloucestershire Electric Power Bill.—This Bill has passed through its committee stage in the House of Lords without opposition.

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Bristol.—It is proposed that 365 arc lamps be erected in main roads running out from the old city boundary to the new, and in the city.

Hull.—Lord Hawkesbury's Select Committee on Tuesday refused to allow the National Telephone Company (Kingston-upon-Hull) Bill to proceed.

Elland.—The District Council have decided to apply to the Public Works Loan Commissioners for a loan of £16,000 for dust destructor and electricity works.

Camborne.—The order granted by the Board of Trade to the electric light company is being considered by the Lighting and Town Improvement Committee.

Admiralty Appointments.—The Admiralty have authorised the entry of 125 electricians in the navy during this year, bringing the strength of this branch to 200.

Battersea.—The Council are obtaining a loan of £6,000 for providing and laying mains and services in connection with the electric lighting of the borough.

Edison Accumulator.—It is stated that the new Edison storage battery is now on the market. The plant for its manufacture at Silver Lake, New Jersey, United States, is completed.

Saltburn.—The District Council are discussing the question of lighting the town with electricity, and have made application to a company for the terms upon which a current can be supplied.

Torquay.—A minimum charge of 10s. per year is to be made in future to every consumer connected with the Corporation's electric lighting system who is not regularly using the light or current.

Durham.—The extension of the electric light from Rock House, New Brancepeth, to Allen Waters, in place of the existing oil lamps is proposed. The surveyor is preparing an estimate of the cost.

German Atlantic Telegraph Co.—The German Atlantic Telegraph Company propose to raise £1,000,000 by the issue of 4 per cent. bonds in order to provide the means for the construction of a second cable.

Transvaal and Orange River Colonies.—The civil administration will take over the telegraphs and telephones in the Orange River and Transvaal Colonies from July 1, subject to Lord Kitchener's final approval.

Eastbourne.—The last report of the borough accountant (Mr. John Allcock) on the accounts of the electric lighting undertaking, showing a profit of upwards of £3,000 in 12 months, is exceedingly gratifying.

Kingston (Surrey).—The Town Council have requested the Lighting Committee to obtain expert advice on the electric lighting works, and empowered them to spend a sum of money not exceeding £100 on the matter.

Failsworth.—A sub-committee is to wait upon the Electricity Committee of the Manchester Corporation and enquire on what terms they would be prepared to undertake such supply now that their electricity scheme was more matured.

Hackney.—The Borough Council have decided to invite tenders for an electric motor, estimated to cost £100, as the most suitable and economical means of driving the laundry machinery at the new disinfecting station at Millfields.

Dewsbury.—Sanction has been given to arrangements made by the Electricity Committee with the new tramways company for the laying of additional lighting mains in the cable trench of the company along Bradford-road to the Market-place.

Dutch-German Cable.—The Second Chamber of the States General at the Hague have adopted a convention between Holland and Germany regarding the cable service to the Dutch Indies to be worked by a Duch-German company.

Ayr.—The last report of the electric engineer shows that the number of new consumers connected during May has been 15, bringing the total up to 552, the number of lamps added during the same period being 301, bringing the total up to 23,116.

St. Marylebone.—The Guardians have referred the proposed electric lighting of the infirmary to the Infirmary Visiting Committee, who are to report upon the expenses connected with taking the current from an outside source, and for wiring the building.

Wireless Telegraphy.—Six firms have responded to the invitation of the United States Signal Office to instal wireless telegraphs in Alaska. Among them are the Marconi Company, of London, the Slaby-Arco, of Germany, and three American companies.

King's Lynn.—At the last meeting of the Board of Guardians it was reported that the Corporation's charge (cost price) for putting in an electric light installation at the workhouse was £145. 10s. The cost had been put down before as "not exceeding £148."

Warrington.—Electric light is to be supplied to places of public worship at a uniform charge of 3½d. per Board of Trade unit, and the price of current for Coronation illuminations will be reduced to 3d. per Board of Trade unit during the evenings of 26th, 27th, and 28th inst.

Harrogate.—The engineer's salary has been increased by £100 per annum. Several other increases have been granted. The charge for street-lighting will be reduced from 2½d. to 2d. per unit, but no alteration is to be made in the charge for domestic supply of electric light.

Durham.—The Durham County Electric Supply Company are making good progress with their lighting intallation at Jarrow. The mains are in, the power station in Beech-street is approaching completion, and it is expected that the current will be turned on within a month.

Obituary.—The death is announced of Sir Daniel Cooper, chairman of the Electric Construction Company, Bushbury, in his eighty-first year. He was previously associated for many years with New South Wales, where he was the first Speaker of the Legislative Assembly at Sydney.

Provisional Orders.—The Electric Lighting Provisional Orders Bills, Nos. 4 and 7, which recently passed the second reading stage in the House of Lords, include orders to Amble, Leadgate, Stanley, Morpeth, Ashington, Newbiggin-by-the-Sea, Morpeth (rural), and Chepstow.

South Wales Electrical Power Bill.—The Committee of Selection in the House of Lords have nominated the following peers to consider the above, among other private Bills: Lord Brougham and Vaux (chairman), the Earl of Romney, Lord North, Lord Colchester, and Lord Muncaster.

Sleaford.—The Electric Lighting Committee in their last report state that if the demand for the light continues a further engine and dynamo will be necessary. It is proposed to lay a new cable to the motor at the sewage pumping station. The electrical engineer estimates the cost at 7½d. per yard.

Huddersfield.—The negotiations for the establishment of electrical engineering works at Huddersfield are being continued, but no substantial development has so far resulted. It transpires that no inspection has yet been made of the Prague works by an electrical expert on behalf of the proposed company.

Sevenoaks.—At the last meeting of the Urban District Council attention was called to the fact that nothing appeared to have been done by the Kent Electrical Power Distribution Company under their provisional order. It was decided to ask the company for a definite statement as to what they proposed to do in the matter.

East Barnet Valley.—We understand that at the next meeting of the Urban District Council a resolution will be proposed with a view of rescinding a prior resolution, in order to enable the Council to reopen negotiations with the North Metropolitan Electrical Power Distribution Company on the subject of electric lighting.

Bexhill.—The report on the second year's working of the electric light in the town up to March 31 last shows a total revenue of £4,814. 6s. 10d., and a total expenditure of £2,736. 14s. 7½d., leaving a gross profit of £2,077. 12s. 2½d. Interest and sinking fund amounted to £1,654. 19s. 10d., leaving a net profit of £422. 12s. 4½d.

London County Council.—On Tuesday the Council agreed to lend the Stoke Newington Borough Council £3,000 for electric light installation, street-lighting, and meters. Sanction was also given to a loan of £26,100 to the Hampstead Borough Council for electric lighting and meters, and to the Stepney Borough Council £95,642 for the same purpose.

Desk Fans.—Johnson and Phillips are introducing electric desk fans, for which they claim efficiency, durability, and artistic appearance. The current taken to drive a 12in. is only about the same as for an ordinary incandescent lamp. They are made entirely at the company's works at Charlton in two sizes—*i.e.*, from 100-125 volts and 200-250 volts.

Stockton.—The Electric Light Committee have decided upon the following revised scale of charges for electricity: under 250 hours of maximum demand per quarter, 2½d. per unit; under 500 hours of maximum, 2d. per unit; and special terms by arrangement for larger consumers. The charges for places of worship is to be reduced to a flat rate of 4d. per unit.

Newcastle.—The Gas and Electricity Committee have considered a communication from Messrs. Rowcliffe and Co., solicitors, Manchester, notifying their intention to apply on behalf of a syndicate for parliamentary powers to erect generating stations and lay mains for the supply of electricity throughout North Staffordshire. It is proposed to oppose the application.

Ryton.—The surveyor (Mr. J. P. Dalton) has prepared a report upon the lighting of Greenside by electricity in the event of the offer of the Stella Coal Company, Limited. Twenty-two lamps will be supplied with current for £2. 10s. each per 50-c.p. lamps for the lighting season. Twenty-two lamps were estimated to cost £66. The question has been adjourned for two months.

Hornsey.—A number of tradesmen and residents in Turnpike and Vernon-road, Hornsey, have written to the District Council stating that they contemplated using the electric light either for private or business purposes, and pressing the Council to erect large arc lamps along the whole length of Turnpike-lane, but the Council replied that that cannot be done beyond Alexandra-road at present.

Coronation Carrillon.—A peal of 18 electric bells has been erected in Salisbury for the purpose of playing the National Anthem, etc. Mr. E. R. Dale, A.I.E.E., The Ford, Fisherton, Salisbury, who is responsible for the installation, informs us that his system can be applied to the heaviest of church bells, and that by its means tunes can be played on them by electricity as easily as on a piano or organ.

Wave-Motor.—It is reported that a wave-motor, or motor worked by the waves of the sea, has been installed at Avalon, California, by Mr. H. Banning, of the Wilmington Transportation Company, to work a fog-bell and pump salt water into a reservoir for watering the streets of the town. It can also be used for pumping out ships, and it is thought it could be utilised in generating electricity either directly or by filling a dam.

Chesterfield.—The minutes of the Electrical Energy Committee showed a gross profit of £867. 17s. 7d. for five months' working. The British Westinghouse Electric and Manufacturing Company, Limited, have received an order from the Bolsover Colliery Company, Limited, for a complete polyphase electric power installation. The power will be used principally for hauling and pumping purposes in the colliery workings.

Berwick.—At the last meeting of the Town Council the clerk read a letter from the solicitors to Messrs. Edmundsons, Limited, who

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obtained a provisional order to introduce electric light into Berwick, stating that they expected to make a commencement very shortly. It was thought the reply was very indefinite, and as the time for the provisional order was stated to have expired, the clerk was instructed to write again, and ask that a time might be specified for the beginning of the work.

Wakefield.—The electrical engineer in his last report states that, in order to cope with the load during the winters of 1902-3-4, extensions will have to be carried out at the works, including the erection of an additional 800-kw. plant and the provision of additional transformers, boiler, and mains. A recommendation that application be made for sanction to borrow a sum of £15,000—the estimated cost of such extensions—has been referred to the sub-committee of the Electric Lighting Committee.

Coventry.—Major Norton has held an enquiry into an application of the City Council to borrow a further sum of £20,480 for the electric light undertaking, and £2,000 for the purchase of electric motors to be hired out to manufacturers. The town clerk (Mr. L. Beard) in his evidence alluded to the increasing demand for electric motor power, the readjustment of rebates, a slight reduction in price, and the improvement of £800 on last year's working profit of the undertaking, and an improvement of £450 in the net profit.

Bury St. Edmunds.—At Tuesday's meeting of the Council the electrical engineer reported to the Electric Lighting Committee that during May applications for 71 8-c.p. lamps had been received, and cables for arc lamps in Abbeygate-street and Angel-hill had been laid. The premises of seven new customers in Churchgate-street had been connected with the new cable in that street. The Council agreed that the actual cost of the current consumed—1d. per equivalent 8-c.p. lamp—be the charge for illuminations for the Coronation festivities for each night from 8.30 p.m. to midnight.

Lowestoft.—There are now connected to the mains 251 consumers, representing a total of 11,785 8-c.p. lamps. Applications for 1,352 8-c.p. lamps to be connected are in hand. During the last month nine extra consumers, representing 290 8-c.p. lamps, have been connected. Local authorities within a radius of six miles from the borough boundary are to be notified that the Council intends to apply for a provisional order for the supply of electricity outside the borough to the parishes coming within that radius. The salary of the resident engineer is to be increased to £250 a year, to date from March 25 last.

Pocklington.—A month ago the Urban Council passed a resolution to the effect that they thought it desirable that a Post Office telephone exchange should be established in the town, but at the last Council meeting a letter was read from the Postmaster-General pointing out that the expense of establishing the necessary trunk communication between York and Pocklington would be "very considerable," and that, providing a sufficient number of subscribers were not forthcoming, a guarantee would be asked for. The councillors thought the prices would be prohibitive, and the matter, therefore, will be allowed to rest in abeyance.

Stock Exchange.—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the official list: British Westinghouse Electric and Manufacturing Company's further issue of 50,000 6 per cent. preference shares of £5 each, fully paid, Nos. 150,001 to 200,000; Eastern Telegraph Company's further issue of £102,377 4 per cent. mortgage debenture stock. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to Charing Cross and Strand Electricity Supply Corporation's 40,000 "City Undertaking" 4½ per cent. cumulative preference shares of £5 each, fully paid.

Aston.—Mr. E. A. Sandford Fawcett has held an enquiry into the Council's application for sanction to borrow £52,436 for electric lighting. The foundations of the generating station have been partly got out, the Council being under obligation to build the station for tramways, which are to be electrically equipped. Mr. T. Ansell, the town clerk, said the Council had had numerous applications from manufacturers asking when they would be able to be supplied with electrical energy, and all pressing on the Council the necessity for making such a provision. Mr. Wilson, the consulting electrical engineer, explained the technical details.

New Issue.—Willans and Robinson, Limited, are issuing at par £250,000 4 per cent. first mortgage debenture stock, of which £105,000 is to be utilised to retire the existing 4½ per cent. debentures, £10,000 is to be held in reserve, and £135,000 is now offered to the public for subscription. The new capital is required for completing the works at Queen's Ferry and Rugby, for providing additional plant and machinery, and for other purposes. It is stated that since the removal of the headquarters of the company to Warwickshire in 1897, the net trading profits, including that year, have averaged over £51,000 per annum, and in 1901 showed an increase of £1,300 over the previous period.

Blackpool.—The electric lighting revenue account for the year amounted to £27,911. 17s. 7d., made up as follows: private lighting, £15,748; tramway current, £6,123; public lighting, £5,916; sundries, £94. The expenditure totalled £17,720, leaving a gross profit of £9,192. The units generated in the year to March last are 22,262,516, against 1,760,469 last year, being an increase of over 23 per cent. At March 31, 1902, there were 930 consumers and about 90 miles of electric lighting mains. There are 260 public arc lamps and 290 incandescent lamps. The capital outlay for the year was £25,939. The total electric lighting capital stands at £167,493, and the accumulated sinking funds at £14,925.

Mexborough.—An arrangement has been arrived at whereby the Highways Committee will pay to the Electric Lighting Committee for street-lighting £3 per annum per pillar, and £15 per annum for arcs, including incandescent lamps, such cost to include all repairs, maintenance, cleansing, etc. The electrical engineer (Mr. Waring) has presented a statement of the estimated and actual expenditure, and the committee are congratulating the Council and the town on the fact that the entire lighting, together with some extras that were not foreseen and provided for, had been done for some £300 within the original estimate of £12,000. The services of Mr. Waring, the engineer, have been retained for a further period of three months.

Glasgow.—It is estimated that the Corporation's electricity department will show a revenue of £104,000 for 1901-2 as against £79,449 for the previous year. The total number of units sold will probably be found to reach 9,200,000 as compared with 6,813,000 last year. This increased output has been produced at a cost for fuel of £13,550, while the previous year's production cost £19,667 under this head. This reduction is partly brought about by the reduced average price of fuel, which has been 8s. 1d. per ton as compared with 11s. 9d., and partly by the increased economy of working in the new generating stations at Port-Dundas and St. Andrew's Cross. The actual quantity of fuel consumed has been 33,216 tons, as compared with 33,468 tons during the previous year. Therefore, the output has increased by about 34 per cent., while the fuel consumed shows an actual reduction of 252 tons.

Grantham.—With regard to the order of the Urban Electric Supply Company as the undertakers for the supply of energy under the Grantham Electric Lighting Order, 1900, the Town Council have decided not to offer objection to the proposed continuous-current direct-supply low-pressure service, with a three-wire system with the intermediate conductor being "earthed" at the generating station, on the condition that a copy of the proposed continuous record of the current from the intermediate conductor to earth at the generating station shall be forwarded monthly to the Council, and on the further condition that the undertakers before they commence work for the establishment of the three-wire system having a pressure between the outers of 550 volts shall, in accordance with the terms of their Act, "declare the constant pressure of pressures" at the consumers' terminals which they will adopt.

Personal.—We are informed that Mr. Arnold G. Hansard, A.M.I.E.E., after many years of service with the Brush Electrical Engineering Company, during which time he held various responsible posts, including at one time the direction of all the company's electrical designing in succession to Mr. W. M. Mordey, has now started as consulting engineer at 92, Victoria-street, Westminster.—The chairman and members of the Lighting Committee of the Shrewsbury Corporation presented a marble clock with inscription and a pair of bronzes, and the staff at the electricity works presented an aneroid barometer with inscription, to Mr. C. M. Johnston, the borough electrical engineer, on the occasion of his marriage, June 5, at St. Thomas's, Lancaster.—Mr. E. Dewar, assistant engineer at the High Wycombe electric light works, has been presented by the staff and employés with a gold chain on his departure from the town.

Colchester.—Colonel Smith has held an enquiry into the application of the Corporation for leave to borrow £8,500 for further electric light extensions. The Town Clerk stated that the current was first supplied in December, 1898, the capital expenditure being £14,900. From the outset the undertaking had been a great financial success, and in 1900 a further loan of £6,500 was necessary. The demand for current increased so greatly that by September, 1901, another loan of £15,825 was sanctioned for additional land, buildings, and plant, but last winter the demand was so great that the boiler power had to be continuously used, it being impossible to stop for cleaning or repairs. The loan now asked for was to enable the Council to provide still more boiler power and buildings. The actual amount required would be £8,172. The estimate for building was £2,870, and the accepted tender was £2,242, which reduced the total from £8,500 to £7,872. Adding £300 for a balancer not included in the original estimate, the amount asked for was thus £8,172.

Bury.—At the last meeting of the Town Council Councillor Duxbury, chairman of the Electricity Committee, said the gross profit had for the last year amounted to £2,356. 15s. 6d., as against £1,274. 12s. 6d. last year. The working expenses had been very considerably reduced in the manufacture of electricity during the year, but the interest account had risen something like £430, and the sinking fund had risen also. Compared, the interest and sinking fund was £2,515. 17s. 9d., against £1,932. 5s. 3d. The net loss this year was £158, as against £657 last year. That was very considerably reduced, and he thought that next year they would be able to make a profit instead of a loss. They had had an increase of 51 consumers this year, with 6,109 8-c.p. lamps. The number of consumers on the books was 305, with 24,668 8-c.p. lamps. The output had increased this year 62,090 units, equal to 23 per cent. For motors and hiring purposes there had been 59,773 units sold, as compared with 24,471 last year, an increase of 144 per cent. Councillor Spencer, in seconding the motion, said he thought they were making substantial progress, and that before very long they would be on the right side. One factor they were looking forward to to assist them was motors. What they wanted was a use of electricity during the daytime. Their expenses were just the same whether their place was worked or not; therefore, whatever they could get in the daytime was an advantage to them. Motors would be let on hire on the same lines as gas stoves. They had had 19 motors, equal to 89 h.p., added to their stock during the year and let out on hire. That was a substantial gain. The total number of motors in use now was 48, and the total horse-power was 187. The minutes were adopted.

Brighton.—Mr. H. Percy Boulnois has held an enquiry into the application of the Town Council for sanction to borrow the sum of £1,791 for purposes of their refuse destructor and the sum of £5,500 for purposes of supplying electrical energy. The deputy town clerk (Mr. Talbot), the borough engineer and surveyor (Mr. Francis J. C. May, M.I.C.E.), the electrical engineer (Mr. Christie), and the borough accountant (Mr. H. M. Stevens) gave evidence. Mr. Talbot stated

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that under the existing conditions the plant which had been provided for the supply of electricity to the town was considerably overloaded, and that in order to produce the amount of current required it was necessary at times to run the spare set. In order to increase the capacity of the plant it was proposed to instal a 325-kw. storage battery, and the effect of this would be to double the power of the existing installation. The development was necessitated so that extra working power might be provided for the trams. Mr. Christie gave the particulars of the estimated cost, and said it was proposed to utilise a house in Bread-street, belonging to the Corporation, so that no fresh building would be required.

South Wales.—Although in the North of England electricity has been extensively used in collieries and engineering works for a number of years, South Wales has until quite recently been without any large undertakings of this class. Several large installations are, however, now being carried out by Messrs. Ernest Scott and Mountain, of Newcastle-on-Tyne, amongst which that of the Tredegar Iron and Coal Company's installation is one of the largest, and consists of five sets of engines and multiphase generators, each of 400 b.h.p., which will be used for supplying electricity to 13 sets of haulage gear and 14 sets of pumps placed underground at Pochin, Bedwellty, and Ty Trist pits in the Sirhowy Valley. The current will be taken by overhead lines from one pit to the other at a pressure of 2,000 volts. Another interesting installation is the pumping plant for the Ocean Coal Company at their Treharris Deep Navigation Pit, Treharris. This plant consists of a 350-b.h.p. engine and generator. The current will be taken down the shaft through heavily armoured cables to the pump, which is placed at the 450-yard level. Besides the above, the same firm have in hand pumping plant for Messrs. North's Navigation Company, Messrs. the Glyn Coal Company, and what is believed to be the first electrical coal-cutting plant in South Wales for the Deiwen Merthyr Colliery, Limited, Quaker's Yard.

Cardiff.—Mr. Arthur Ellis last week reported that for the year just ended the revenue of the electricity department had gone up from £11,153 to £15,515. In addition to the cost of working (£8,255) the committee have paid off £5,692 interest and principal on the loan and still had a surplus of £1,106. If the committee had been a private company, free from the necessity of paying off capital, there would have been £6,798 to divide. The maximum load at the station has advanced from 729 kw. to 951 kw.; the load factor has gone up from 10·78 to 12·31; the number of lamps connected from 37,500 to 51,800; and the number of units sold from 688,000 to over a million. The electric station now ranks as one of the big stations of the country. The total revenue works out at 3·85d. for private supply, which is remarkably low. The Cardiff station is now fifth on the list in the country for the percentage of units sold to those generated. The demand is still vigorous, and it will be necessary to extend the high and low pressure mains in Cathedral-road for 2,505 yards at a cost of £529. There are already 611 applications on that route to help to defray the cost. An extension will also be required in the docks district from James-street to the sailors' hospital. For the month of May the works cost amounted to 1·28d. per unit, or including repayment of capital and interest, to 3¼d. per unit, which is a very fair average. The suggested extension has been approved by committee.

Kensington.—The Council have agreed to notices and plans relative to proposed extensions of their mains in the borough from the Kensington and Knightsbridge Electric Lighting Company (Pelham-street), and from the Brompton and Kensington Electricity Supply Company (Cromwell-crescent and Westgate-terrace); also an application from the National Telephone Company for permission to lay a branch main in Thurloe-square from Pelham-street to the south side of the square. The lighting engineer has been in communication with the city engineer of Westminster as to the lighting of the north side of Brompton-road, east of Montpelier-street, with electric arc lamps, and has ascertained that an order has been given by the Westminster City Council to Crompton and Co. to erect four lamps of the same pattern as those erected by this Council on the south side of the road. The Westminster city authorities have since written pointing out that under the electric lighting contract in their city the trimming and general maintenance is included, stating that they are unable to make arrangements for the necessary attendance to four isolated lamps, and asking this Council to undertake the maintenance of the lamps in question, the charge for current being paid direct by the Westminster city authorities to the Kensington and Knightsbridge Electric Lighting Company. The Council have offered to undertake the lighting, extinguishing, cleaning, and trimming of the lamps in question for the sum of £5 per lamp per annum, it being understood that the price will not include repairs.

Rochdale.—In the six months from October, 1900, to March, 1901, there were 63 applications for current and 57 consumers connected. In the year 1901-2 the numbers were: applications 91, connections 91. The last report contains the following items: "In the past year, though under normal conditions it has been possible to continue the supply from the accumulators during the morning in fair weather, the increase of load has made it essential for the plant to be ready for running at any moment should it become at all dull. This, together with the necessity for supplying motive power on some nights, has made stand-by charges heavy, and required certain increases of staff, which would need only small addition to enable the plant to run continuously throughout the 24 hours. It is, however, satisfactory to note that the Sunday consumption shows an improvement, and it is to be hoped that places of worship may take a supply for both lighting and motor purposes. Owing to the demand during the summer of 1901 being almost wholly for lighting purposes, the output was very small when compared with that of the winter—as to both quantity and maximum. This was naturally a very considerable item to be counter-balanced by the winter output, and makes it unfair to compare the two periods in separate years. It is to be hoped that the small demand for power may prove of assistance during the coming summer, and that the tramway supply will help the undertaking. With the commencement of this financial year the prices were reduced for lighting to 6d. and 2d. on the maximum demand system, or a uniform rate of 4½d., and for power to 2d., varying with the quantity consumed to 1½d. Naturally these charges have had a considerable effect upon the income, but it is practically certain that had these reductions not been made few, if any, consumers would have been connected, and it is very possible that some of those already connected would have discontinued the use of electricity. The applications for power may also be considered the result of the adoption of a more suitable charge."

Stafford.—With regard to the transplantation of Messrs. Siemens's works from Woolwich to Stafford, and to the enormous difference which the consequent addition of some 10,000 inhabitants is expected to make to the old borough, the *Midland Express* says it must not be supposed, however, that these well-known Government contractors are the pioneers of the engineering industry in Stafford. It is only necessary to mention here three eminent firms which for a number of years have carried on this trade with ever-increasing success, and upon which is dependent about one-tenth of the population. Messrs. W. G. Bagnall and Co., Limited, are world-famed engine builders and light railway constructors, important contracts having been carried out by them in all parts of the globe. Messrs. W. H. Dorman and Co., Limited, whose extensive works are in the north end, find occupation for some 200 workmen, and are always busy. Messrs. W. O. Hooper and Co., Limited, are old and well-known electrical engineers. They are at present engaged with large contracts for Sheffield manufacturers, and are in a very flourishing state. Nevertheless, the advent of Messrs. Siemens marks a new era in the commercial history of the town, and if, as some think, the shoe trade should soon prove to be in a moribund condition, engineering will be quite ready to take its place and constitute itself the staple trade of the district. There is no reason why some time in the not far distant future Stafford should not become a seat of industry as important in its way as the two great manufacturing districts of the North and South. It is conveniently situated on the main line of a great railway system, provides a terminus for branch lines of two others, and is also within easy reach of the North Staffordshire and Cannock Chase coalfields. Moreover, labour and land alike are comparatively cheap. Messrs. Siemens may not be the only firm to realise and take advantage of these facilities, and meanwhile Stafford will do well to prepare herself for future contingencies, so that when she is tried she may not be found wanting. A few good builders, with plenty of enterprise and plenty of capital, are badly needed. Now is an excellent time for them to come forward.

Poole.—We understand that a committee of the Town Council are considering the following proposal by the Bournemouth and Poole Electricity Supply Company with regard to electric lighting of streets from the quay, along High-street, Parkstone-road, to Bourne Valley North-road, part of St. Peter's-road, and View-road, Parkstone. The method of lighting proposed is partly by arc lamps of 2,000 nominal candle-power erected in special standards, and partly by incandescent lamps installed in the existing gas lanterns. The charge for current supplied to be for each arc lamp, inclusive of attendance, cleaning, renewal of carbons, lighted from dusk to midnight, £15. 5s. per annum. The charge suggested for current supplied to each incandescent lamp of 25 c.p., installed in the existing gas lanterns, inclusive of attendance, cleaning, and renewal of lamps, lighted from dusk to midnight is £2. 7s. 6d. per annum; or if lighted throughout the night the sum of £3. 12s. per annum. For 32-c.p. lamps the charge would be the sum of £2. 16s. 6d. per annum until midnight, of £4. 7s. 6d. per annum for all-night lighting. The Corporation would have to undertake the provision of the lamp-posts, lamps, and lanterns, etc., the estimated cost of which would be £25 per lamp. The Corporation would also have to pay for the conversion of the existing gas lanterns at an estimated cost of £1. 10s. each. In addition, there would be the cost of switchgear and connections to the main at an estimated cost of £2. 18s. each. The company propose to carry out the above at cost price, charging the Corporation a moiety of that total over a period of three years, under the terms of a purchase-hire system, or the cost might be paid outright if preferred. If the Council preferred to pay for current by meter, the charge proposed is 2½d. per unit net, the Council paying cost of installation and conversion. If after 12 months the contract be renewed for three years, the company would bear one-half the cost of switchgear and connecting the lamps to the main—viz., £1. 9s. per lamp—and if renewed for five years the whole of the cost or £2. 18s. per lamp. The above estimate makes no provision for moonlight nights, when all the lights would not be required, and for which allowance could be made.

Tunbridge Wells.—The Town Council have decided to apply for an additional £10,000 loan, owing to the rapid strides the electrical undertaking is making. During the debate it was stated that the committee were amply providing for the upkeep out of revenue in addition to their reserve fund on the capital account. The plant was now in better order than it was the first year. The best argument the speaker could use was that he could get a customer for the undertaking for £100,000, which had cost £60,000. The telephone undertaking also was worth more than it cost. On Friday the members of the Electric Lighting Committee paid an official visit to the generating station to inspect the extension works which the contractor had just completed. The chairman of the committee (Mr. Elvy Robb) and the engineer (Mr. Horace Boot) received the visitors. In six years these works have trebled in capacity, and, large as they are now, it is estimated that at the present rate of progress the limits of the present extension will be reached in three years, and a further enlargement will then be necessary. The works are already larger than those of Hastings, Eastbourne, Dover, or, it is said, of any neighbouring town except Brighton. There are now at the works six engines aggregating

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a total horse-power of nearly 3,000, together with five water-tube type and two Lancashire boilers. The station now has its own siding, so that the coal is only handled once from the pit's mouth. In the present building space is provided for two additional 18-h.p. boilers. The new cooling tower is of large proportions, and is capable of dealing with some 90,000 gallons of water per hour. The condensing plant is also particularly interesting. About 64 miles of distributing cable are now in use. The prevention of smoke nuisance is costing the undertaking £1,000 annually of its possible profits, so that this is a severe loss to the ratepayers. As the accounts published in another column show, the number of units generated during the past year shows a further substantial increase—viz., 800,160 as against 702,574 the preceding year. The number of lamps has gone up from 35,260 to 43,370, an increase of upwards of 8,000 lamps. The income of the undertaking is now no less than £11,200 per annum, or an increase of nearly £2,000 on the past year. The gross profit has also increased by £1,600. This profit has been obtained by selling electric energy at an average price of slightly over 4½d. per unit for private lighting and the low price of 1½d. per unit for public lighting. The net profit carried forward this year brings the surplus to £1,985, besides which £7,000 has been paid off the capital, and votes to the extent of 3d. in the £ made in relief of the general district rate.

South Africa.—We are indebted to the *British and South African Export Gazette* for the following items: The plans and specifications, upon which tenders for lighting Ladysmith with electricity can be called are in course of draughting, and electrical contractors are consequently in presence of an opportunity for securing the undertaking. A site for the generating station near the railway station coal-yard has been chosen. It is expected that the installation should be turned out of hand complete within 10 months. The watering of the locomotives in the dry season on the Natal Government railway system has hitherto been a serious problem. In the course of the past year, however, a new departure has been made in the cases of five stations on the main line, and the innovation will probably receive wider application. Instead of transporting the water in pipes along the line from distant sources of supply, electric pumping installations have been set up and water drawn directly from neighbouring rivers or dams. At Hill Crest, for instance, the water is drawn from the Umhlatuzi River, whereas formerly it had to be run from Pinetown Bridge, or even from Durban, 11 and 28 miles distant respectively. At Inchanga the pumping plant is combined with the electric lighting plant in one house and the water drawn from a dam. A new cement tank to hold 100,000 gallons, a part of the scheme, is now in course of erection on a neighbouring hill. At Cato Ridge the water is pumped from a drainage collecting dam and transported three miles in pipes to the railway. At Thornville Junction the water is drawn from the neighbouring Umlaas River, instead of, as formerly, run from Maritzburg, 11 miles distant. The Umsindusi River has also been drawn upon, at considerable cost, to supply the Maritzburg station, three miles distant, owing to the inability of the Corporation of the latter city to furnish the necessary supplies. Whether by way of advice or stimulation, the Assistant Secretary of the Transvaal Administration recently submitted a number of points for the consideration of the Town Council. The first invited the consideration and recommendation of the Council on and anent the charges levied for Government, municipal, or private lighting, furnished by concession or contract; the second requested the Council's opinion on the advisability or otherwise of granting to the Council legal authority to acquire, construct, and work a central power station with the necessary connections for the supply of electricity for lighting purposes; the third asked the Council's views on the advisability or otherwise of utilising such central power station for the supply of electricity for other municipal purposes, such as tramways, etc.; and the last tended to elicit the suggestions of the Council on the means by which it would meet the charges incurred by the several schemes. The Council have considered these matters in committee, and resolved to bring them before a subsequent meeting, but their final decision has not yet been announced. The scheme submitted by Mr. P. Herd, Durban, for lighting Newcastle (Natal) with electricity has been accepted by the Town Council. The concession is for 10 years fixed, after which date the Council is to have the right to continue the agreement, or acquire the outside installation at a fair valuation, the generating station and equipment being handed over to the Municipality free of charge. The projected service will be of a capacity of 1,600 16-c.p. incandescent lamps, and the concession includes the right to supply power. The current will be supplied to the consumers by meter.

PROVISIONAL PATENTS, 1902.

MAY 29.

12218. Improvements in or relating to electric ignition mechanism for internal-combustion motors. John James Henry Sturmey, 18, Hertford-street, Coventry. (Charles Edgar Duryea, United States.)

12231. Improvements in brushes for dynamos and motors. John Aspden and George Aspden, Penny Bank-chambers, Halifax.

12237. Circuit breaker with spark destroyer through an air current forcing its way into a vacuum. Richard Theodor Quaas, Willoughby, Westby-road, Boscombe.

12241. Improvements in or relating to electric arc lamps. Hugo Bremer, Westinghouse-building, Norfolk-street, Strand, London.

12262. Improvements in or relating to permanent ways of electric and other railways. Harry Pace, 21, Constantine-road, Hampstead, London.

12284. Improvements in light accumulators for continuous and alternating currents. August Engelsmann, 111, Hatton-garden, London. (Complete specification.)

12290. Improvements in pressure-regulating apparatus for electric mains. Charles Turnbull, jun., 70, Chancery-lane, London.

12291. Improvements relating to electric switches. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

12292. Improvements in electrical cut-outs or fuses. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

12293. Improvements relating to electric fuse boxes. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

12294. Improvements in dynamo-electric machinery. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

12301. Improvements relating to electric motor road vehicles. Adolph Pollak, 45, Southampton-buildings, Chancery-lane, London.

12309. An improved electric heating device. Frederic de Mare, 1, Queen Victoria-street, London.

12316. Improvements relating to electric railways and tramways. Jasper Wetter, 37, Essex-street, Strand, London. (A. Sengel, Germany.)

MAY 31.

12329. Improvements in instruments for measuring electric currents and minute mechanical strains or movements. Louis Rottenburg and Paterson, Cooper, and Co., Limited, 62, St. Vincent-street, Glasgow.

12330. Electric motor-starting switch. Louis Rottenburg and Paterson, Cooper, and Co., Limited, 62, St. Vincent-street, Glasgow.

12340. Electrical water-gauge indicator for steam-boilers or water-tanks. George Hunter Robinson, 31, Spring-road, Portswood, Southampton.

12343. Improvements in electric signals. Alfred Charles Brown, 7, Queen's-square, Finsbury-avenue, London.

12351. Improvements in or connected with apparatus for telegraphing or signalling through space. Anthony Bernard Tubini, 173, Fleet-street, London.

12386. Improvements in electric generators and motors. John Cook Stewart, 62, Vincent-street, Glasgow.

12390. The zinc-dust secondary cell. David Leonard Chapman, 10, Parsonage-road, Withington, Manchester.

12415. Improvements in regulators for alternating electric current circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.)

12416. Improvements in tubulating machines for incandescent electric lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William R. Burrows, United States.)

12438. Improvements in induction coils. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske A.-G., Germany.) (Complete specification.)

12439. Improvements in or relating to electric safety devices for railways and the like. Carl Peter Johansen, 111, Hatton-garden, London.

12449. Improvements in means for registering, or metering, electrical energy, to be charged for under varying conditions of supply. Leonard James Aron, 47, Lincoln's-inn-fields, London.

12463. Improvements relating to electrical measuring instruments. Edward Weston and Adelbert Oswald Benecke, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12469. Improvements relating to electrical indicating and recording instruments. Edward Weston and Adelbert Oswald Benecke, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12474. Improvements in wireless telegraphic systems. Harry Shoemaker, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12476. Improvements relating to electric recording apparatus chiefly designed for use in connection with electric measuring instruments. Edward Weston and Adelbert Oswald Benecke, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12481. Improvements in electricity maximum demand indicators. Guy Carey Fricker and George Hinde Nisbett, 46, Lincoln's-inn-fields, London.

JUNE 2.

12483. Means for operating electrically the signals on electric railways and tramways. Joseph Patrick Tierney and John Malone, 44, Booterstown-avenue, co. Dublin.

12494. An improved safety guard for electric tramcars and the like, or similarly propelled vehicles. Robinson Scalin Burn, 6, Finkle-street, Stockton-on-Tees.

12517. Improvements in multiplex telegraphy. George Lewis Hogan, 27, Chancery-lane, London.

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12536. Improvements in connection with electric tramcars. Joseph Black and Thomas Hogg, 23, Coleman-street, London. (Complete specification.)

12547. Improvements in making electrolytic baths. Fritz von Liebermann, 321, High Holborn, London. (Complete specification.)

12554. Improved means and apparatus for telephonic communication. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

12556. Improvements in thermo-electric batteries. Heinrich Kiefer, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

12570. Improvements in and relating to telephonic instruments. Isidore Bernard Birnbaum, 322, High Holborn, London. (Complete specification.)

12573. Improvements in electrolytic circuit breakers. Friedrich Dessauer, 6, Lord-street, Liverpool.

12578. Improvements in current-reversing mechanism for oscillating electricity meters. Philip Middleton Justice, 55, Chancery-lane, London. (Theiler and Co., Switzerland, and Paul Eibig, Germany.) (Complete specification.)

12581. Improvements in electric traction apparatus. Alfred Zehden, 46, Lincoln's-inn-fields, London. (Complete specification.)

12582. An improved system of electric lighting. William Lloyd Wise, 46, Lincoln's-inn-fields London. (The Moore Electrical Company, United States.) (Complete specification.)

JUNE 3.

12604. Automatic telegraphic field transmitter. Percy L. Robertson, 18, St. Swithin's-lane, London.

12607. Improvements in or relating to electric tramcars and the like. William George Inglefield and Herbert Gilbert Hackett, 55, Market-street, Manchester.

12624. Improvements in dynamo-electric machines and motors. Wilfred Robert Vernet Marshall, 121, West George-street, Glasgow.

12671. Improvements relating to telephone systems. Charles Goodwin Burke, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12684. Improvements in preventing leakage of current to studs in surface-contact systems of electric traction. William Griffiths and Benjamin Harry Bedell, 4, South-street, Finsbury, London.

12688. Improvements in or relating to polyphase-current transformers. William Phillips Thompson, 322, High Holborn, London. (Berliner Maschinenbau-Actien-Gesellschaft vormals L. Schwartzkopff, Germany.) (Complete specification.)

12689. Improvements in and relating to combinations of electric switches and wall-plugs. Albert Vandam, 322, High Holborn, London.

12691. An improved process for the electrolytic decomposition of alkaline chlorides and apparatus therefor. Hermann Cuénod and Charles Fournier, 6, Lord-street, Liverpool.

12694. Improvements in or relating to coils for dynamo-electric machines. Ludwig Lohner and Ferdinand Porsche, 111, Hatton-garden, London.

12697. Improvements in perforators for use in connection with automatic telegraph transmitters. Alexander Muirhead, 323, High Holborn, London.

12700. Improvements relating to the manufacture of active material for the plates of electric accumulators. Sigmund Adolf Rosenthal, 27, Chancery-lane, London.

12702. Improvements in the electrical production of iron alloys with the simultaneous production of alkaline oxides and alkaline earths. Gustave Gin, 1, Queen Victoria-street, London.

12706. Improvements in wireless telegraph systems. Cornelius D. Ehret, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JUNE 4.

12733. Electric door contact. Frank Edward Linnett, 137, Kettering-road, Northampton.

12737. Improvements in or relating to blowing-off machines for electric lamp bulbs. Alfred Swan, 50, Wellington-street, Leeds. (Complete specification.)

12738. Improvements in or relating to means or apparatus for effecting an all glass seal between the stem which carries the filament of an incandescent electric lamp and the enclosing bulb. Alfred Swan, 50, Wellington-street, Leeds. (Complete specification.)

12739. Improvements in or relating to bases for incandescent electric lamps, and in means or apparatus for manufacturing the same. Alfred Swan, 50, Wellington-street, Leeds. (Complete specification.)

12749. An improvement in electrical communications for railways and other purposes. Charles Mark Antonio Culverhouse and Frederick Victor Culverhouse, 634, Barking-road, Plaistow, Essex. (Complete specification.)

12752. Improvements in testing the insulation of electric cables. Ernest Alexander Claremont and Charles James Beaver, 4, Bloomsbury-square, London.

12755. Method for reducing or entirely suppressing synchronising currents of single or multiphase alternators working in parallel. Emil Kolben, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12764. Improvements relating to brush-holders for dynamo-electric machines and similar apparatus. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

12765. Improvements in and relating to the distribution of electricity. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

12766. Improvements relating to apparatus for cleaning electric lamp filaments. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

12767. Improvements relating to the control of electric motors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

12780. Improvements relating to telephone installations. Paul Hardegen, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

1782. Improvements in apparatus for rope haulage for lifts, mines, and the like. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

12783. An improvement in electromagnetic detents. Siemens Bros. and Co., Limited, and Alexander Siemens, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

12793. Improvements in the electrolytic refining of copper. The Metals Corporation, Limited, and Sherard Cowper-Coles, 70, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published June 28.

1901.

11315. Regulators for electric motors. Mackay and Sclater.

11545. Safety devices for automatically disconnecting the current supply to trolley wires used for electric traction. Heyes and Heyes.

12469. Current transformer for telephones. Berthelon.

13239. Alternating-current motors. Wüst-Kunz.

14825. Electrometallurgical treatment of zinc ores and especially blend. Tossizza.

15691. Electric railways on a road contact system. Betts. (Betts.)

17711. Transmission of telegraphic and telephonic signals. Maiche. (Date applied for under International Convention, Feb. 19, 1901.)

19811. Apparatus for testing the insulating of electric cables and the like. Claremont.

24816. Electric railways. Kintner. (Date applied for under International Convention, May 6, 1901.)

25270. Electrically-operated valves and gas-lighters. Baader and Rau.

25710. Electric ignition devices applicable to motor bicycles and to motors generally. Bailly.

26754. Apparatus for use in charging storage batteries. Stover and Suren.

1902.

382. Galvanic cells. Friese.

2816. Electric battery. Allison. (Banks.)

3024. Electric traction by the surface-contact system. Cruvellier.

3533. Winding and circuit-closing devices for electrically-wound clocks. Crook.

5104. Arc lamps and electrodes therefor. Soc. G. et P. de Mestral. (Date applied for under International Convention, Sept. 4, 1901.)

7062. Overhead trolleys for electric vehicles. Häller and Noiset.

8486. Means for operating the carriages, and controlling mechanism of same, of electric telegraphic and similar printing machines. Justice. (Rowland Telegraphic Company.)

8643. Means for damping the oscillations of shafts carrying the hands or pointers of electrical measuring instruments or the like. Nalder and Nalder Bros. and Thompson, Limited.

8809. Electric circuit controllers. Ghegan and Griswold.

9380. Fuse head for electric blasting. Render.

9720. Automatic electric fire-alarms. Offenbroich and Mafell.

9789. Electric railway systems, and more particularly to crossings and switches for the same. Keeler.

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TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	May 31	754	717	+ 36	36,875	34,648
Birmingham Tramways	June 7	5,287	4,624	+ 663	108,499	98,924
Blackburn Corporation	,, 6	1,029	674	+ 355	15,674	13,577
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 7	476	878	- 402	7,374	7,871
Bolton Corporation	,, 8	1,623	1,702	- 79	32,687	32,094
Bradford Corporation	,, 1	2,937	1,431	+ 1,506	51,258	18,638
Bristol Tramways Company	,, 6	4,678	4,406	+ 272	—	—
Carlisle Tramways Company	—	—	—	—	—	—
Central London Railway	,, 7	7,336	6,064	+ 1,272	154,819	142,535
City and South London Railway	,, 8	3,074	1,329	+ 1,145	68,496	45,363
Cork E. T. and L. Company	,, 6	555	544	+ 11	9,612	9,345
Darwen Corporation	—	—	—	—	—	—
Darwen-Hoddlesden	—	—	—	—	—	—
Dover Corporation	May 31	247	289	- 42	4,166	3,950
Dublin & Lucan Electric Railway	June 8	119	114	+ 5	2,209	2,143
Dublin U. T., electric cars	,, 6	3,639	3,819	—	—	—
Dublin S. District, Electric	,, 6	814	927	—	—	—
Dundee Tramways Company	May 14	647	678	- 31	—	—
Glasgow Corporation	June 7	12,182	11,598	—	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 7	1,765	1,657	+ 108	16,713	16,555
Liverpool Corporation	May 31	9,706	10,159	- 453	199,042	184,124
Liverpool Overhead Railway	June 8	1,506	1,657	- 145	32,874	36,106
Newcastle-on-Tyne Corporation	,, 7	2,665	—	—	—	—
Portsmouth Corporation	May 17	1,296	542	+ 754	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	June 8	4,237	—	—	—	—
Southampton Corporation	—	—	—	—	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £539 decrease.
Barcelona Ensanche y Gracia, £120 decrease. Barcelona £99 increase.
Brisbane, £431 increase (month of May, £10,832; decrease, £573).
Buenos Ayres and Belgrano Electric (month of May, receipts £12,454; increase £322), £218 decrease.
Calcutta, £246 increase.
Cape Town (month of May), receipts, £16,330; expenditure, £7,205.
Isle of Thanet Electric, £43 decrease
Mexico Electric (month of May), receipts, £20,380; expenditure, £11,400.
Perth Electric, £168 increase.
Port Elizabeth (month of May), receipts, £3,796; expenditure, £1,872.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	¼-⅛
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	⅛-¼
—— Ordinary, 1-125,000	1 ..	⅛-⅜
British Insulated Wire, Ord., 1-70,000	5 ..	7½-8½
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	5½-6
—— 5 per cent. Mortgage Debentures	100 ..	101-104
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5⅞-6
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2 ..	1¾-2¼
—— 4½ per cent. 1st Debenture Stock	100 ..	101-104
—— 4½ per cent. 2nd Debenture Stock	100 ..	95-100
Callender's Cable, Debentures	100 ..	111-115
—— Ordinary	5 ..	17-18
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	3-3½
—— 5 per cent. Debentures	100 ..	103-108 p.c
Edison and Swan United, Ordinary	3 ..	⅛-⅜
—— 5 per cent. Debentures	5 ..	2-3
—— 4 per cent. Deb. Stock, Red.	100 ..	75-80
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-1¾
—— 7 per cent. Cumulative Pref.	2 ..	2½-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	99-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	10-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	98-101
W. T. Henley's Telegraph Works, Ordinary	5 ..	16½-17½
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	99-102
Parker, Thos., Limited, Ordinary	10 ..	15¼-16½
Telegraph Construction and Maintenance	12 ..	34-37
—— 5 per cent. Bonds	100 ..	103-106
Telegraph Manufacturing, Ordinary	5 ..	9¼-10½
—— 5 per cent. Cum. Pref.	5 ..	5¼-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	8¼-9½
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107
Electric Railways.—		
Central London, Ordinary	100 ..	104-107
—— 4 per cent. Pref.	100 ..	103-106
—— ,, ,, deferred	100 ..	100-103
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	116-119
City and South London, Consolidated Ordinary	100 ..	71-74
—— 4 per cent. Debenture Stock	100 ..	115-118
—— 5 per cent. Pref. Stock '91	100 ..	128-133
—— ,, ,, ,, '96	100 ..	125-129
—— ,, ,, ,, '01	100 ..	121-125
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7¼-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	93-96

Name.	Amount paid.	Last price
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	¼-⅛
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	100-104
Bournemouth and Poole, Ordinary	10 ..	11-12
—— 4½ per cent. Cum. Pref.	10 ..	9½-10½
—— Debenture Stock, Red.	100 ..	103-106
Brompton and Kensington, Ordinary	5 ..	8¾-9½
—— 7 per cent. Preference	5 ..	8¾-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	8¼-9½
—— Nos. 20,001-30,000	5 ..	8¼-9½
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½
—— ,, ,, ,, £10 Ord.	6 ..	10½
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	105-107
Charing Cross and Strand	5 ..	9-10
—— Nos. 50,001-70,000	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5⅜
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5-5¼
—— 4½ per cent. Debentures	100 ..	110-113
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	11¼-12¼
—— 5 per cent. Debenture Stock	100 ..	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	103-106
County of London and Brush Provincial, Ordinary	10 ..	7¼-8¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	108-111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6¼-6⅜
—— 6 per cent. Cum. Pref.	5 ..	5⅜-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	108-111
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-4⅜
—— 5 per cent. Debenture Stock, Red.	100 ..	101-104
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5⅜-6¼
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10-11
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9½-10½
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4-4½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	95-100
Metropolitan, Ordinary	10 ..	16½-17½
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9½
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	14-15
Oriental, 1879	1 ..	1⅛-1⅜
—— £5 Shares	5 ..	7-7½
—— £4½ Shares, New	4½ ..	6-6½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1⅜-2⅛
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	3-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 ..	8¼-9½
—— 3½ per cent. Deb.	100 ..	98-101
Westminster, Ordinary	5 ..	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	2½ ..	3½-4
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4-4⅛
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	127-132
Blackpool and Fleetwood Tramroad	10 ..	13¼-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	3¼-4
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¼-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	104-107
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	7-7½
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9½-10⅛
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	102-104 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13¼-14½
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12¼-13
—— 5 per cent. Perpetual Debenture Stock	100 ..	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅜-1⅝
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4¾-5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	104-107
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2⅜-2⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	5-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11¼-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	96-99
Imperial Tramways, Ordinary	all ..	22-22¼
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	4¼-5
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref. \ Within 1-82,500	10 ..	10⅜-11¼
—— ,, ,, ,, ,, /	5 ..	5¼-6
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	106-108
—— ,, ,, Prov. Crts.	50 ..	55-57
New General Traction, Ordinary	5 ..	2-3
—— 6 per cent. Cum. Pref.	10 ..	3-4
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10⅜-10⅝
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	100-103
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	9¼-10½
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	107-110
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	12s. ..	¾
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	60 p.c. ..	60 p.c.
Telephones.—		
National Telephone, Preferred	100 ..	95-99
—— Preferred, 590,001-790,000	3½ ..	3½-3⅝
—— Deferred Stock	100 ..	53-57
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5-5¼
—— 3½ per cent. Deb. Stock, Red.	100 ..	94-97
—— 4 per cent. Deb. Stock, Red.	100 ..	103-107
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

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NOTES.

Institution of Electrical Engineers.—According to arrangement, the annual conversazione of the Institution will be held on Tuesday evening next at the Natural History Museum, Cromwell-road, S.W. An exceptionally large gathering is expected in view of the general invitation issued to members of the Tramways and Light Railways Congress, in London at the time, to attend the function.

Power Transmission in Canada.—We understand that the Shawinigan Power Company will shortly construct a 50,000-volt transmission line to Montreal, Canada, a distance of 90 miles from the generating station. The plans involve the transmission of 20,000 h.p. to that city, beginning with 4,000 h.p., to which additions will subsequently be made in 4,000-h.p. units. The cables for the line will be of aluminium, manufactured from the ore at Shawinigan Falls.

Glasgow Local Section.—At the annual general meeting of the above section of the Institution of Electrical Engineers, the suggestion was made that as the members would not be seeing each other very often in the course of the summer, it would be a good thing if one or two visits could be made to places of interest in the neighbourhood of Glasgow, such as the new electricity works of the Corporation at Port Dundas and Pinkston. It is probable that arrangements will be made in accordance with this proposal.

Telegraphs in Argentina.—The British Consul in the Argentine Republic, in the course of a report to the Home Department, mentions that there are 24,480 miles of telegraph line in the republic, of which 11,400 miles are owned by the Argentine Government. The gross revenue from the Government telegraphs in 1899-1—last year of which record has been published — was about £100,000. The telegraph system in Argentina is yet far from complete, but it is being steadily extended to reach the outlying portions of the republic.

Wireless Telegraphy on the Congo.—Some little time ago we mentioned in these columns that it was intended to establish a system of wireless telegraphy on the River Congo, in South Africa, as a result of experiments carried out in this country at Withernsea. We learn that fairly good progress has been made with the installation, but that the work has been greatly delayed by the loss of the vessel which was taking out some of the apparatus to South Africa. While awaiting the arrival of more material, however, the mast at Banana has been fixed, and it is hoped to have the service in operation very soon.

Ganz Motors in America. — We understand that an important combination has just been effected between Messrs. Ganz and Co. and what is called the Whitney-Elkins-Ryan-Dolan syndicate for the manufacture of the Ganz motors in the States. The syndicate mentioned recently purchased the Stanley Electric Manufacturing Company's plant near Pittsfield, Mass., and the intention now is to equip the works with plant suitable for turning out Ganz motors on a large scale. It is expected that when the extensions of the Stanley plant have been completed, the company will control one of the largest electrical manufacturing concerns in America.

Apparatus for Heating by Electricity.—Mr. A. Guntz has recently described a method of fitting up apparatus for heating tubes, crucibles, etc., by means of electricity, the heat being obtained, as in other cases, by passing a current through a thin platinum wire. The improvement, however, is introduced of employing a mixture of magnesia and alumina for embedding the platinum wire in the place of asbestos or fusible enamel, which possess the drawback that they alter the platinum wire when the temperature is raised to 1,200deg. or 1,300deg Particulars are given as to the management of such a heating arrangement and of the current which may be used with it, and the author states that he finds this apparatus more economical than gas.

Patent Law in Spain.—We understand that a new Act for the protection of industrial property, including patents and trade marks, in Spain has recently been passed, and came into operation on the 7th inst. Under the new law, so far as relates to patents, very important alterations have been made. The working conditions of patents have been very greatly modified, and a period for compulsory working has been extended to three years. In addition, the time for payment of taxes has been extended under a fine, while at the same time it is provided that inventors paying up their taxes in advance obtain discount on the same ranging from 5 to 20 per cent. It is also provided that applicants who have made prior applications in other foreign countries for patents must make application in Spain within 12 months, failing which any patent granted will be limited to five years.

Electric Furnaces.—In electric furnaces, the bar which supports the pendant electrode serves also to transmit the current. For furnaces of moderate size this is simple and convenient, but for the heavy currents of the present-day installations it is at least open to question whether two functions are properly discharged by a single element. The size of the support is governed by its strength, that of the lead by its conductivity, and both support and lead are limited in size by their capacity for conveying heat from the furnace. A system of connections noted by Mr. C. P. Townsend in the *Electrical World* for June 7 employs a conductor and a separate supporting yoke, each of the minimum size to permit a proper performance of its functions, and each provided with a circulating system for water. Other features of the furnace are a vertical discharge slit between water-cooled walls and a water-cooled fore-hearth—both adaptations from ordinary metallurgical practice.

Chicago Motorcar Regulations.—It is instructive to compare the stringent precautions the municipal authorities of Chicago are taking to protect their city from the motorcar invasion with those that obtain in this country. We doubt, however, very much whether it will be found possible to enforce the same. In effect it is proclaimed that no electric, steam, or other mechanically-propelled vehicle, while standing in any park or on any boulevard, street, or drive, shall have any of the machinery or generating plant in operation. Further, no person shall cause or permit any such vehicle to emit smoke, vapour, or offensive odours while in any park or on any of the boulevards, and no bell or gong is to be rung or other mechanical alarm given by any occupant of an automobile. A regulation limiting the speed of motorcars to eight miles an hour is also made. Under these conditions it is obvious that it is far easier, if at all, to keep within the law with an electric vehicle than with an automobile driven by steam or petrol.

The Paris Underground Electric.—The managers of the Paris metropolitan electric railways have found out that there is a limit above which it is impossible to compress even the most patient of railway passengers. Whether this is above or below the 16-to-one-compartment standard of our Underground, we cannot say from actual experience, but the fact exists that on the Paris line train after train arrives at the stations without being able to

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take up any of the passengers waiting. At the beginning of operations the trains consisted of four carriages, with accommodation for 50 passengers each. Latterly, during the busy hours of the day, trains composed of seven carriages, capable of holding 50-55 passengers each, have been run. Last week the police issued a temporary license allowing, as an experiment, the use of longer trains. The trains will be composed of eight carriages, the first and last of which will be fitted with two 140-h.p. motors, the whole of which will be under control of the driver at the head of the train

Wireless Telegraphy.—Mr. Marconi's new wireless telegraph station at Tablehead, Cape Breton, has, according to a Halifax message, now been completed, and the apparatus installed for the proposed Transatlantic service. The feature of the installation is the signal towers, which are 215ft. high. It had been arranged, if possible, to send a message from the new American station to the King on the occasion of his Majesty's Coronation, but it is feared that time is too short to permit of this arrangement being carried out. An interesting sidelight on wireless telegraphy is the unfinished chess match which took place in mid-ocean between passengers on the "Campania" and the "Philadelphia." The two vessels were separated at the time by a distance of about 70 miles, and the different moves of the rival players were indicated by means of Mr. Marconi's system The game was suspended for dinner. Then the "Lucania" interrupted the matter for a business talk with the "Campania," and the ships were unable later to get into communication again.

Separation of Metals. — Dr. N. S. Keith has described before the American Electro-chemical Society a striking method for the treatment of metallic solutions with insoluble anodes. In work of this character the concentration of the cations constantly decreases, and in order to secure a uniform regular deposit the current density must be correspondingly reduced. This is usually accomplished by controlling the current through the vat, a very uneconomical expedient. Dr. Keith's solution consists in circulating the electrolyte through a number of vats in series, the electrodes therein being connected in multiple and the number of plates increasing in successive numbers of the series. As the same current passes through each vat, it is obvious that the electrolyte is subjected to a current of diminishing density, and that if the strength of the incoming electrolyte be maintained constant, and the numbers of electrodes in successive vats properly proportioned, a regular deposit may be obtained throughout the series, and the full capacity of the generator used.

Mr. Edison's Storage Battery.—Several of the American technical journals received by the last mail publish particulars of the recent tests of Mr. Edison's latest form of storage battery, of which glowing accounts have been sent over here by the enterprising correspondents of the daily Press. The particulars referred to, however, are given in our contemporaries on the authority of Mr. Edison himself, and may, therefore, be assumed to be authentic. The first test, we gather, was made on a runabout machine carrying two passengers, and equipped with 21 cells, the complete equipment of batteries, including the electrolyte, weighing 332lb. The route selected was over the ordinary roads about New York, and in all 75 hills were ascended, varying from 2 to 12 per cent. grades. On the outward journey the automobile travelled 62 miles, and when it was brought back 83 per cent. of the original speed could still be had from the batteries. On another occasion over a fairly level road the car was run to a standstill. It travelled 85 miles, and stopped when the battery showed only 6·3 volts. The initial pressure from the 21 cells was 29 volts. Mr. Edison is now reported to have completed a 5,000-mile endurance test, and intends shortly to put his new battery on the market commercially. As far as distance travelled on one charge, the above figures do not come up to records for ordinary accumulators.

The Velocity of Light.—This important subject was recently dealt with by Mr. Michelson in a paper before the American Physical Society, an abstract of which is given in the current number of the society's *Bulletin*. The author shows that by purely optical methods the observed velocity of light and the observed sidereal aberration constant give a solar parallax of 8,808 seconds, with a probable error of less than one-thousandth. The optical method of measuring the sun's distance he regards as inherently more trustworthy and far less expensive than the astronomical methods. The highest development of the optical method calls then for as accurate a knowledge of the velocity of light as can be experimentally observed, and in this direction one has the aid of three converging sets of experimental methods—namely, those of electromagnetic measurements of the light-speed ration (r), those of invisible Hertzian waves, and those of visible light waves. Quoting from the report of the 1900 International Physical Congress as giving 300,010 km. per second for the best result with r, and 299,130 km. per second for Hertzian-wave measurements, he inclines to 299,890 km. $\pm$ 60 km. for the best result with optical measurements. Finally, a new method of optical measurement is outlined, using a revolving mirror making 250 turns per second. It is hoped that with this method the speed of light may be measured to within 5 km. per second or less.

A New Atlantic Cable.—We understand that an agreement has been arrived at between the German Post Office and the German Atlantic Telegraph Company for the construction of a second cable from Borkum to the Azores and New York. Experience has shown that a safe and uninterrupted service between Germany and America cannot permanently be maintained with one cable, and the Imperial postal authorities therefore urged the necessity of a second cable being laid between the two countries. The new line is to be set in operation by Jan. 1, 1905. The convention between the parties extends the period of the company's concession to Dec. 31, 1944, and carries with it a Government subsidy of £85,500 per annum for the use of the two cables. The company on their part undertake to pay the Government 1·92d. per word in the case of each message paid for at the ordinary rate of 1s. per word, and after deducting this charge the remainder of the receipts up to as many as 3,750,000 words goes to the company, who have to meet the other taxes and expenditure out of the amount. When the number of words in the paid messages exceeds 3,750,000, the Government will receive in addition to the tax of 1·92d. a further tax of 6d. per word up to 7,170,000 words, but the 6d. tax will not apply in case of any further increase in the number of words beyond that total. The contract for the supply and laying of the new cable, which is estimated to cost £1,050,000, has been placed with the North Sea Cable Works Company, of Nordenham.

Conductivity of Solutions of Mixed Electrolytes. Mr. Hans Wolf, in a paper published in Germany and abstracted in the Chemical Society's *Journal*, states that the conductivity of a mixture of two electrolytes differs from the sum of the conductivities of the electrolytes singly on account of (1) the change of viscosity of the solution; (2) decreased dissociation, due to replacement of water by the other electrolyte; (3) chemical reaction

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between the electrolytes. For solutions containing a small quantity of potassium chloride or sodium bromide and variable quantities of acetic acid or alcohol, the first action is alone of importance; with stronger solutions (0·5 normal), the second comes into play. When chloro-acetic acid is used in place of acetic acid, the matter is further complicated by the occurrence of the chemical reaction to an appreciable extent. The conductivity of zinc sulphate is diminished to a greater extent by acetic acid or alcohol than is that of potassium chloride. Tartaric acid has an effect similar to that of acetic acid, except in the case of zinc sulphate, the conductivity of which is but little affected. This is doubtless due to the formation of hydrogen ions in place of zinc ions, which increase the conductivity almost as much as it is diminished by the increased viscosity. Mixtures of the salts of fatty acids with fatty acids were also examined; in these cases, the chemical change can be calculated and allowed for; the remaining change of conductivity is found to be very similar to that observed in the case of sodium bromide and acetic acid.

Fulham Wiring Rules.—The Metropolitan Borough Council of Fulham have now drawn up a set of regulations for the supply of electrical energy and the wiring of buildings in their district. The Council not undertaking the wiring of houses, the first important provision is to the effect that all work inside houses is to be carried out in accordance with the rules issued by the insurance company with whom the premises are insured. This is an excellent clause, and one which will commend itself to consumers from the point of view that it tends to greatly simplify their responsibility in wiring their own premises. The regulations go on to give a number of useful points, amongst which we notice that no joints are to be made in wires to be buried in casing in walls. Another general provision is that no circuit shall require a current of more than five amperes. With regard to the refusal of the Borough Council to supply to any installation, it is laid down that the Council shall be entitled to exercise this right if when testing with a pressure of 200 volts the insulation resistance of the entire installation shall prove to be less than the total number of ohms which shall be indicated by the number resulting from the division of 20,000,000 by the figure expressing the maximum current in amperes which has been named by the consumer in his application for a supply of electricity. The clauses as to supply for motors are to the effect that when a supply is required for this purpose notice in writing must be given to the engineer, who shall approve in writing of the apparatus and arrangement before it is installed. Motors up to 3 h.p. may be single-phase, but over that horse-power two-phase motors will be required. Starting resistances must be so arranged that the variation between each stop does not exceed three amperes. The other clauses of the regulations are practically in the ordinary form, and do not call for special mention.

The Bow v. the Wheel Trolley.—Discussing European practice in electric traction in the current number of the *Street Railway Journal*, Mr. H. Vellgath says the most notable departure in European practice from American standards is in the use of the bow instead of the trolley wheel. During the last few years the former has grown steadily in favour, although it is not as generally used as the wheel. It is claimed on behalf of the bow trolley that it eliminates all danger of loss of contact, and that there is no necessity for reversing the bow when the direction of the car is changed. Greater contact surface is afforded and much easier spans in curves are secured, which, while improving the appearance of the overhead construction, greatly decrease the cost of maintenance. In order to allow the bow to turn over automatically when the car changes its direction, the distance between the rail and the trolley line ought to be as constant as possible. European engineers who favour this form of construction contend that there is no difficulty in doing this, and even many users of the trolley wheel favour the bow for higher speeds and heavier traffic where heavy currents are used. The writer states that many changes and improvements have been made in the bow in recent years, and in its present form it is favourably considered by the engineers of many systems who, however, adopted the trolley wheel when the bow was not in so efficient a state as it is at the present time. Further discussing European practice, the writer notes that the slotted conduit with complete metallic circuit has been found satisfactory, but it is only used in large cities where the traffic is very dense, where the difference in cost between it and a modern first-class trolley construction is very slight, and where the undertaking may be expected to pay good interest. On the Continent it has only been installed where the trolley has been forbidden. Thus, the system is extensively used in Berlin, Brussels, Paris, and Budapest, and on a smaller scale in a few other cities.

Developments in Electro-Chemistry.—Mr. C. P. Townsend, in the *Electrical World*, describes a distinctly novel electrical method developed by Mr. P. Bary, of Paris, for the distillation of various metals. The invention obtains its novelty from the fact that it depends for the volatilisation of the molten metal upon the spark, or, perhaps, more accurately, the arc which is formed when a stream of molten metal carrying a current is momentarily interrupted. Under the sudden increase of resistance metal is vaporised, and if the operation is carried out in a closed vessel, and in a current of inert or oxidising gas, the products are readily collected. In every form of apparatus described molten lead or tin flows in a thin stream from an upper to a lower vessel, and conducts the current between them. This falling stream is momentarily interrupted, either by a mechanically-operated valve controlling the outflow by a rotating skeleton wheel whose spokes break the column, or by the current itself. Full utilisation of the current requires a more rapid interruption than can be effected by mechanical devices, and Mr. Bary gives as his preferred form the following construction: The molten metal flows from the upper chamber to the hearth through a series of nozzles, perforated and extending over the surface of the pool. Each stream impinges upon a metallic contact in the circuit, and the volatilised products, together with the excess of liquid metal, pass through a tube, the former to the collecting chambers and the latter to what is known as the "trap" beneath the tube. A current of inert or oxidising gas flows through a pipe and then through the lower chamber. This chamber is fitted with a refractory bed and with resistances, the function of the latter being to keep the metal in both chambers in molten condition. The necessary interruption of the flowing stream in this construction depends upon the experimental fact that a film of metal traversed by a current of sufficient density is contracted and broken, to be at once restored, the interruptions occurring at the rate of several hundreds per second.

A 50,000-Volt Transmission Plant.—The distinction of being the first to place in actual commercial service a large plant employing 50,000 volts transmission belongs to the Missouri River Power Company. Mr. W. G. McConnon contributes an admirably illustrated article to the *Electrical World* of the 7th inst., in which he describes at length the principal features of the interesting installa-

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tion. At the mouth of Black Rock Canyon a dam has been thrown across the River Missouri about 480ft. in length, and designed to give a 30ft. head of water. The canyon by which the water comes to the power house is from 400ft. to 700ft. wide and less than half a mile long. It is interesting to note that in winter, although the lake above freezes over, the water in the canyon does not freeze over, and the flow to the power house is as free from ice in winter as in summer. The power plant consists of 10 750-kw. direct-connected generators, with four exciters, of which two are 90-kw. machines direct-connected to separate wheels, one a 225-kw. machine with a separate wheel, and one a 115-kw. motor-driven generator. Each waterwheel has its own governor. The feature of the installation, however, is the high voltage employed on the lines to Butte. This is 50,000ft. The distance by pole line from Canyon Ferry to the Butte sub-station, where step-down transformers are employed to reduce the voltage to 2,200 volts, is 65 miles. The line starts out at an altitude of about 4,000 volts above sea-level, and gradually rises until it reaches an altitude of 7,300ft., a few miles east of Butte. The line itself consists of two ranges of poles about 50ft. apart. The cables are arranged in an equilateral triangle, with a spacing of 78in. between centres. Each line consists of three seven-strand copper cables, each cable having a cross-section of slightly over 106,000 circular mils. These cables are transposed five times between Canyon Ferry and Butte. The average distance apart of the poles is 110ft. A view and cross-section of the insulator used on the line, with the glass sleeve fitting over the pin below the insulator, is shown in one of the illustrations, and the writer explains that it has been found, after exhaustive tests, that a thoroughly dry oak pin of the length used in this installation, boiled in paraffin, will hold up alone under 50,000 volts. Hence the object of the glass sleeve below the insulator is to keep as great a length as possible of the pin dry under all conditions of weather. Practically the whole of the electrical apparatus in this plant was furnished by the Westinghouse Company, of Pittsburg.

Three-Phase v. Two-Phase for City Distribution. With this title Mr. B. A. Behrend read an important paper before the recent convention of the American National Electric Light Association at Cincinnati, in which he ultimately decides in favour of the three-phase system as having certain slight advantages over the two-phase system for distribution in cities. At first there were a great many advocates of the two-phase current on account of greater simplicity, but looking to-day over the installations of alternating-current systems for city distribution, it is found that the three-phase distribution has been preferred in the majority of plants. The system which will be most favourable for distribution of light and power is that in which the potential on one phase is as little as possible affected by a change on load on another phase This may be considered the criterion by which to form an opinion of the superiority of one system over another. Theoretical considerations, as well as experience, have established the fact that a two-phase machine, so far as independence of phase is concerned, is not superior to a three-phase machine if the load on the latter is properly arranged. The output of a two-phase generator is equal to the output of a three-phase generator. In other words, any two-phase generator may be wound as a three-phase generator without changing the rating, and *vice versâ*. The regulation of both two-phase and three-phase machines being equally good, according to the statements above made, it would seem that the three-phase system was preferable to the two-phase on account of requiring only three wires instead of four, leaving out of consideration the two-phase three-wire system. There is, however, a very interesting fact which should be observed—namely, a three-phase generator on which the load is connected between the outside wires is greatly inferior to a two-phase so far as regulation is concerned. Only, if the neutral connection of the three-phase generator is made use of, and if the load is put on between the neutral and the outside wires, the regulation in the three-phase machine is, in all respects, equal to that of the two-phase machine. But it must be observed that the three-phase machine requires, under these conditions, four wires, as in the case of the two-phase machine. Summing up the *pros* and *cons*, Mr. Behrend considers that there is comparatively little choice between the two-phase and the three-phase systems, but there are certain slight advantages in favour of the three-phase system. If 75 per cent. of the load is a lighting load and 25 per cent. is a load that requires little attention to regulation, as, for instance, an arc light load having its own regulator or a motor load, a three-phase generator has the further advantage that it can be operated as a single-phase machine, the lighting load being connected between two outside wires. In this case, the lighting load can be very easily regulated, while no attention need be paid to arc light or motor load, as that is supposed to take care of itself.

The Double-Trolley System.—It is a question which has for a long time engaged the attention of traction engineers whether under certain conditions the double-trolley system has advantages which would decide in favour of its adoption in preference to the single-wire system as ordinarily applied in America, on the Continent, and in this country. In Sydney, New South Wales, the latter system has been favoured up to the present, but we understand that the State Railway and Tramway Commissioners and their engineers have now definitely decided on a change over from the single to the double trolley system as being more suitable to the requirements of the tramway service in that city. The reasons which have moved the authorities to come to this decision are given in a report by the electrical engineer to the Sydney tramways, Mr. O. W. Brain, M.I.C.E. As most of our readers are doubtless aware, the essential difference between the two systems is that with the single solid wire the current is conducted back to the power station by the track rails, while in the double system it is returned by the second trolley wire, in exactly the same manner as it is supplied from the station by the single wire. In order that the return current should be carried back to the station by the track rails, it is necessary that these should be bonded or continuously electrically connected, this involving heavy expenditure both in capital cost and subsequent maintenance. Herein then lays the principal advantage of the double-trolley over the single-wire system. The experience at Sydney has been that with the greatly increased traffic, and the consequent larger currents which have to be employed, there is considerable danger in returning the current to the station over the track rails. In view of this fact, therefore, and of the still larger increase in the tramway current which it is anticipated will have to be provided for in the near future, it has been finally decided to discontinue the use of the track rails for the purpose mentioned, and to adopt the second trolley wire. It is quite recognised that the maintenance of the overhead wires in good electrical condition will under this system require closer supervision and more attention than the existing one ; but against this it is thought the advantage will be the saving in the fact that the whole of the work involved in the maintenance of the bonding will be entirely done away with. While the expenditure incurred

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with the double-trolley system has, no doubt, mainly stood in its way in the large cities where tramways are run by private enterprise, in the United States it is satisfactory to learn that the double trolley has been successfully used on systems which are much larger than that of Sydney. In some cases the local authorities have insisted upon its adoption on account of the interests concerned. The best-known instances of this are the cities of Cincinnati and Washington, the overhead systems of which are worked by the overhead trolley, the Congress itself having passed a special Act insisting upon it in the latter case.

Photometric Values of Arc Lamps.—Prof. C. P. Mathews presented his third report on the investigation of the photometric values of arc lamps to the members of the American National Electric Light Association at their recent Cincinnati convention. The first tests made were of five direct-current 6·6-ampere enclosed arc lamps, and the following results were arrived at: With no outer globe and opalescent inner globe, the watts per mean candle-power were respectively 1·07, 1·37, 1·24, 1·27, 1·3, and 1·28. With a clear outer globe and opalescent inner globe, corresponding values of watts per mean hemispherical candle-power were respectively 1·2, 1·29, 1·35, 1·24, 1·38, and 1·37. A conclusion arrived at is that for street-lighting the best distribution is obtained with closed base inner globes. Three 6·6-ampere alternating-current lamps were tested with the following results: with no outer globe and an opalescent inner globe, the watts per mean hemispherical candle-power were 1·86, 2·06, and 1·76; with clear outer and opalescent inner globe, the corresponding quantities were 2·25, 2·06, and 1·55. Three 7·5 ampere alternating-current series enclosed lamps tested gave these results: with no outer globe and an opalescent inner globe, the watts per mean hemispherical candle-power were respectively 2·28, 1·94, and 1·8. These figures show that while the alternating-current lamp taking 6·6 amperes is inferior to the direct-current lamp of the same current capacity in light-producing power below the horizontal, the use of a shade in the former brings down the specific power consumption to within 13 per cent. of that of the direct-current lamp. The mean power factor of the 6·6-ampere alternating-current lamps is ·88, and of the 7·5 lamps ·83. The results of tests of a 450-watt arc under varying conditions show that 450 watts expended between a given number of carbon points may produce widely different values of candle-power in useful directions. These variations depend upon whether the current is direct or alternating, the arc open or enclosed, the globe clear and opalescent, the arc shaded or otherwise, the current large or small. Another conclusion is that no advantage comes from the substitution of the 6·5-ampere arc with clear globe for the 9·5-ampere open arc in so far as distribution of light is concerned. Still another conclusion is that if the open and enclosed arc tested were suspended at the same height, say 25ft., they would produce equal illumination at a suspension of about 117ft. from the lamp, but beyond this distance the enclosed arc would have the advantage over the open as a street illuminant. The superior candle-power distribution of the enclosed arc is clearly and chiefly through the use of the opalescent inner globe. This globes becomes itself highly luminous, thus strengthening the intensities near the horizontal. Tests were also made of high and low grade carbons, the primary object being the determination of the relative candle-power obtainable when the carbons were burned in 9·5-ampere 450-watt open arcs. The high-grade carbons when solid gave more candle-power at each of the three angles of measurement. When, however, they were cored, they fell behind the low-grade carbon throughout one of the angles. This is doubtless due to the deep crater formed in the cored carbon. Although high-grade carbons give superior candle-power they showed somewhat shorter life when burned open, the difference being about 9 per cent. for the positive, but slight for the negative.

Mr. Marconi on Space Telegraphy.—Mr. G. Marconi, happily recovered from a recent attack of influenza, was able to deliver his promised lecture at the Royal Institution last Friday evening on the progress of electric space telegraphy. A typical Royal Institution audience gathered together on this occasion to hear the young inventor explain the apparent mysteries of wireless telegraphy. As Mr. Marconi said, however, in his opening sentences, it is not, after all, wonderful that man should devise a means by which he is enabled to apply electricity to convey messages through space, having regard to the fact that the light and heat waves from the sun travel through millions of miles of space, and sound also reaches the ear without any artificial conductor. In describing the apparatus employed, he remarked that it is now possible to establish a considerable number of wireless telegraph stations simultaneously in the vicinity of each other without the messages suffering any interference. A powerful transmitter giving off waves actuated near one of the receiving stations may, however, prevent the reception of messages to some extent. But the ordinary system of communication by wire and telephone may be subjected to similar interference. For example, it was found impossible at Cape Town, two years ago, to work the cables at certain times when the electric tramways were in operation. Describing the principle of the coherer, Mr. Marconi stated that it is by means of a magnetic detector that he has improved upon the coherer hitherto employed. He has found it to be more sensitive and reliable than the coherer, and it does not require so many precautions in the working. It may be possible, he said, with this system to receive messages at a speed of several hundred words a minute. At present, by the aid of the detector, 30 words a minute can be read. Incidentally, Mr. Marconi mentioned that there are no fewer than 40 land wireless telegraph stations in Great Britain and Europe equipped with his system, and over 40 vessels of the British navy carry similar installations. On two of the White Star Line steamships as much as £60 has been collected for the transmission of messages for passengers on a single trip. A most interesting point to which Mr. Marconi referred towards the end of his lecture is that at distances of over 700 miles the signals transmitted during the day often fail entirely, while those sent at night remain strong up to 1,551 miles, and are even decipherable up to a distance of 2,099 miles. This result may be due to the diselectrification at the very highly charged transmitting elevated conductor operated by the influence of daylight. He did not think, however, that the effect of daylight will be to confine the working of Transatlantic wireless telegraphy to the hours of darkness, as sufficient sending energy can be used during daytime at the transmitting station to make up for the loss of range at the signals. It is probable, however, that had he known of that effect at the time of the Newfoundland experiments, and had tried receiving at night time, the results would have been much better than those actually obtained. In conclusion, Mr. Marconi quoted from a leading article in the *Times* of Dec. 21, 1901, in which it was prophesied that wireless telegraphy would soon become a potent agent in cementing those ties between England and the Colonies, which other recent events have done so much to strengthen or even to create.

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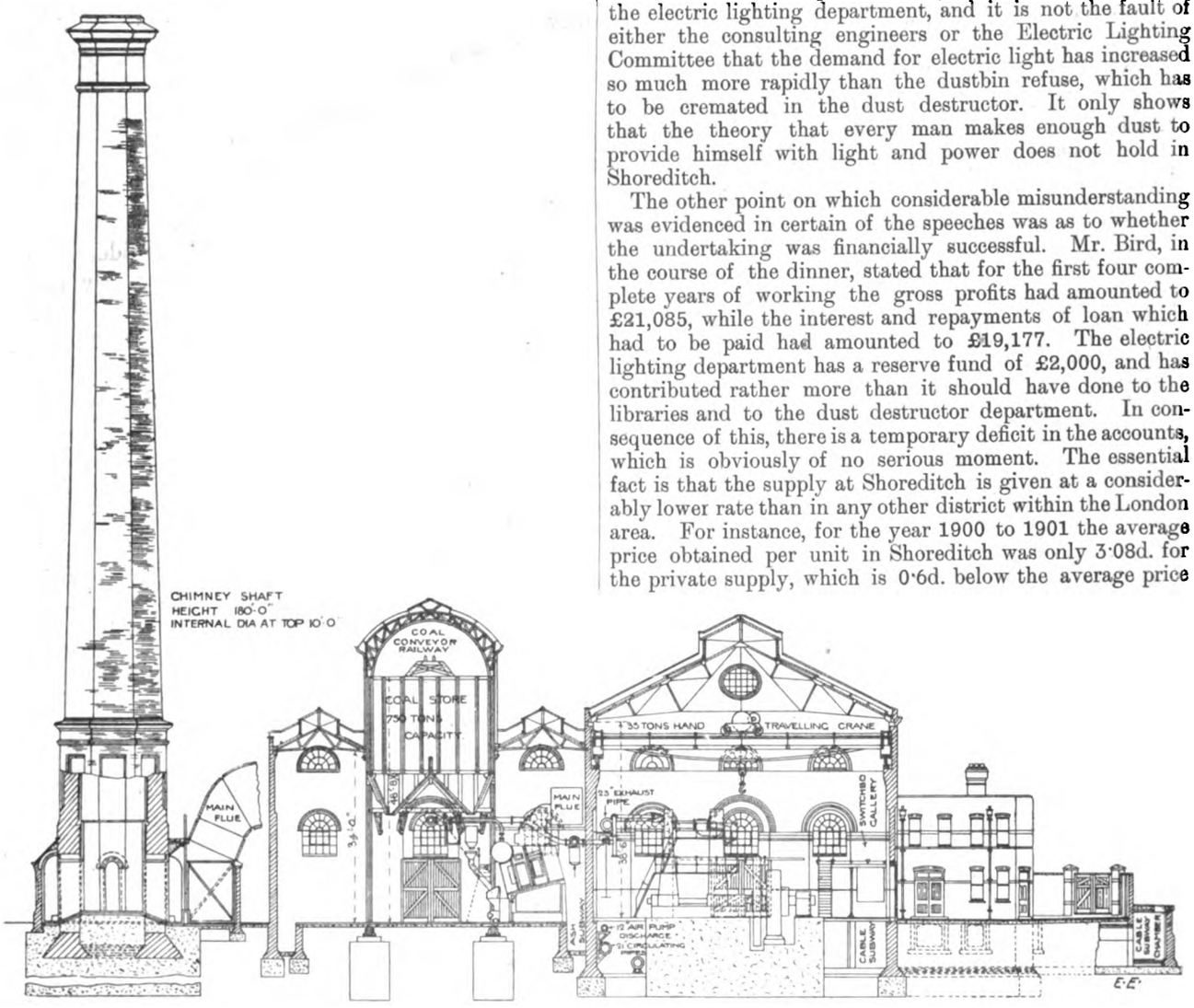
THE NEW SHOREDITCH ELECTRICITY WORKS.

On Monday last there was inaugurated the supply from the large new works which the Shoreditch Metropolitan Borough Council have had erected at Whiston-street, Haggerston. The opening ceremony in the afternoon was performed by Councillor H. B. Bird, the chairman of the Lighting Committee, and the same gentleman presided over the dinner which was given by the engineers and contractors at the Great Eastern Hotel in the evening. At both of the functions speeches were made which showed the superabundant energy possessed by the representatives elected to serve on the Shoreditch Borough Council. This energy was displayed in the shape of forcible criticism, and we gather that there is no fear of any undertaking ruled by the Council becoming moribund for want of opposition. We are especially pleased to note, moreover, that however keenly the details of the municipal undertakings at Shoreditch are criticised by councillors in opposition, the progress of these are not retarded in consequence. The opposition to the electric lighting schemes in the past has largely resulted from an incomplete knowledge of the facts of the case.

It was in 1897 that the first Shoreditch electricity works were opened by Lord Kelvin, and at the time the attention of all electrical engineers and municipalities was drawn to the combination of the dust destructor with the electric lighting works. There is no doubt that a few of the local people expected too much from the combination, and statements were circulated that the dust destructor would provide all the steam which would be required for the electric lighting engines. The results have shown, however, that the demand for electrical energy has increased at a rate quite unexpected, and in consequence new generating plant had soon to be installed, which required more steam than the destructor could supply. In consequence coal-fed boilers had to be used, and the opponents of the scheme unhesitatingly condemned the whole undertaking in consequence. The fact remains that the dust destructor as a dust destructor has been entirely successful, although handicapped by the limited space around it for the storage of clinker. It has also provided large quantities of steam for the electric lighting department, and it is not the fault of either the consulting engineers or the Electric Lighting Committee that the demand for electric light has increased so much more rapidly than the dustbin refuse, which has to be cremated in the dust destructor. It only shows that the theory that every man makes enough dust to provide himself with light and power does not hold in Shoreditch.

The other point on which considerable misunderstanding was evidenced in certain of the speeches was as to whether the undertaking was financially successful. Mr. Bird, in the course of the dinner, stated that for the first four complete years of working the gross profits had amounted to £21,085, while the interest and repayments of loan which had to be paid had amounted to £19,177. The electric lighting department has a reserve fund of £2,000, and has contributed rather more than it should have done to the libraries and to the dust destructor department. In consequence of this, there is a temporary deficit in the accounts, which is obviously of no serious moment. The essential fact is that the supply at Shoreditch is given at a considerably lower rate than in any other district within the London area. For instance, for the year 1900 to 1901 the average price obtained per unit in Shoreditch was only 3·08d. for the private supply, which is 0·6d. below the average price for the next cheapest supply within the London area. It may seem to the uninitiated that a saving of just over ½d. per unit is a comparatively small item, but for the year in question Shoreditch would have made a further profit of £5,600 if it had increased its price per unit by that amount, and if the Electric Lighting Committee had not adopted the correct policy which should guide all municipal undertakings—*i.e.*, that no profits should be taken from the undertaking for the reduction of the general rates. The indirect advantage to the borough of this cheap supply is much more than is indicated by the above figures, as it helps the increase in the cabinet-making industry, to which Shoreditch owes so much of its prosperity.

In the original station there was only room for 1,455 kw. of generating plant, and some two years ago it was seen that this would soon be insufficient to deal with the demand. It was accordingly decided to build new additional works, where coal could be got in more cheaply, and where water for condensing purposes could be obtained. A suitable site having been found at the corner of Whiston-street and Bath-place, Haggerston, on the banks of the



CROSS SECTION OF BOILER HOUSE AND ENGINE HOUSE

SCALE OF FEET.

FIG. 1.

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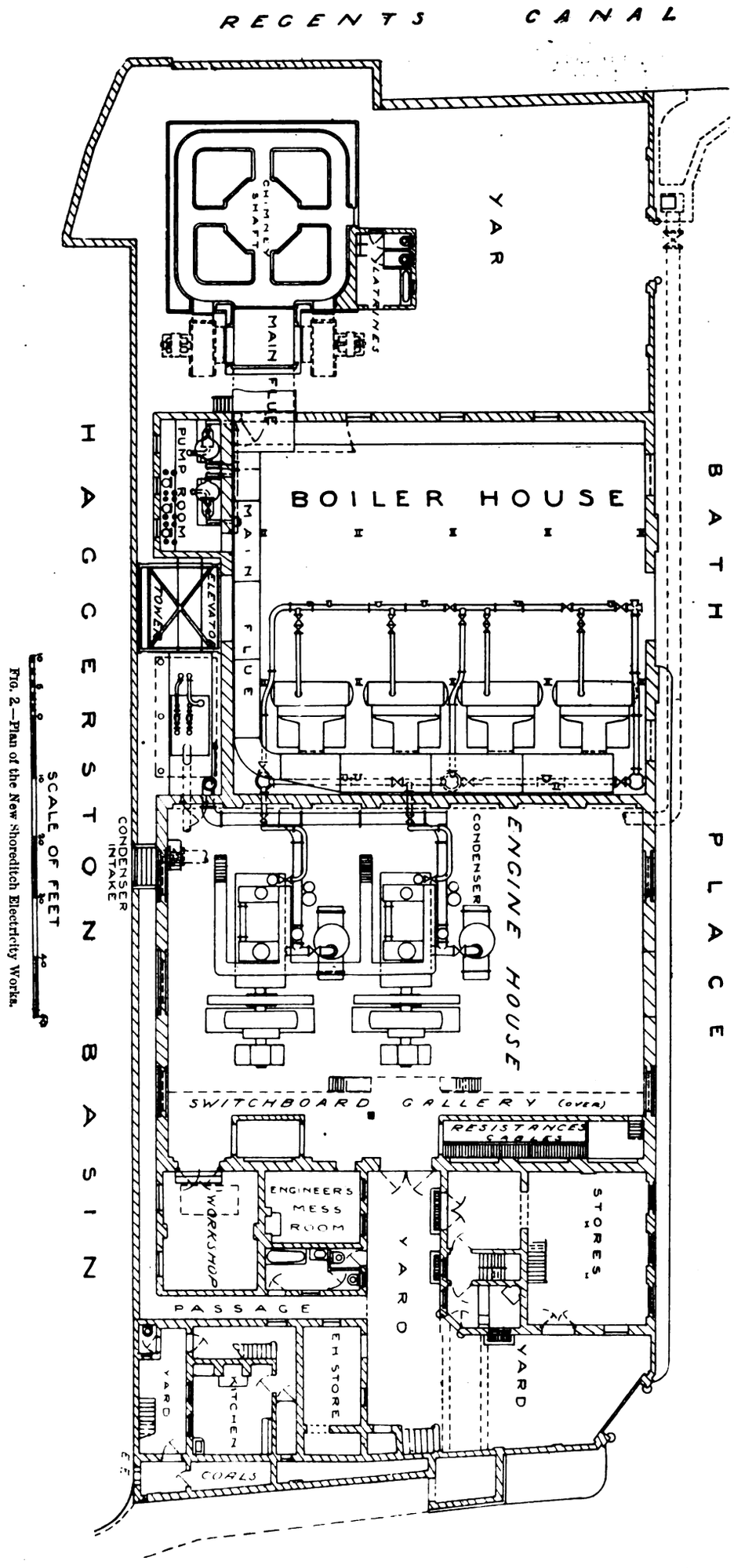

FIG. 2.—Plan of the New Shoreditch Electricity Works.

Regents Canal, the Borough Council instructed their consulting electrical engineers, Messrs. Kincaid, Waller, and Manville, to prepare a comprehensive scheme for the erection of a new power house which would provide for all

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the future needs of the district. The scheme proposed by them has been adopted by the Council, and the works, of which the following is a description, have been completed under the supervision of Messrs. Kincaid, Waller, and Manville and Mr. C. Newton Russell, the borough electrical engineer. The design of the new power-house, as will be seen by the description and drawings, is on a large scale, although only two units of generating plant have at present been installed, but the engine-house and boiler-house are capable of extension to an extent that will allow the present output being multiplied many times; to such an extent, in fact, that it is inconceivable that the demand for an electricity supply in Shoreditch can in the future exceed the facilities offered by the Whiston-street site extensions.

Buildings.—The generating station occupies a site of about 19,800 super feet in area, at the corner of Whiston-street and Bath-street, Haggerston, with frontages to the Regents Canal and the Haggerston Basin, enabling coal to be delivered by barge, and providing a supply of condensing water. The buildings (Fig. 1 and 2) consist of a boiler-house 68ft. by 62ft., with pump-room adjoining, engine-house 78ft. 6in. by 59ft. 6in, with basement into which the condensing water and other pipes are taken. A subway for the cables leading from this basement to a chamber under the pavement in Whiston-street is provided for the feeder cables leaving the station. A transformer-room containing the continuous-current transformers for supplying the network in the neighbourhood of the generating station is provided, with workshop and stores also adjoining the engine-room. The switchboard gallery extends the whole length of the engine house, and is 11ft. above the floor-level. Chambers are provided below the gallery for the reception of the shunt regulating and other resistances, and for the accommodation of the cables proceeding to the machines and circuits. A room for the engineer in charge at this level leads direct on to the gallery. A handsome room, with ante-room having separate approach, is provided for the members of the committee. Accommodation for a resident engineer has been provided in a small house at the corner of the site, with entrance from Whiston-street. Separate rooms are provided for the men employed in the engine-house and boiler-house respectively, and each have their necessary lavatory accommodation. The chimney shaft, 180ft. in height, with an internal diameter of 10ft. at the top, is placed in the yard at the rear of the site and adjacent to the canal. The buildings are faced externally with picked Fletton bricks, relieved with red Leicestershire bricks. The engine-house is faced internally with Fletton bricks, having glazed brick dado and strings running round the walls, with glazed brick arches to the openings. The engine-room floor is laid with vitreous mosaic. The foundations of the chimney shaft and the main wall of the buildings are taken down to the London clay, a depth of about 21ft. The contractors for the buildings are Messrs. Johnson and Sons, of Leicester, and for the chimney shaft, Messrs. Storrs and Son, of Stalybridge.

Boiler-House Plant.—The boiler-house plant (Fig. 3) consists of four water-tube boilers of Messrs. Babcock and Wilcox marine type, having solid-drawn steel tubes. Each boiler has a heating surface of 2,720 square feet, and is fitted with economiser containing 350 square feet of heating surface, making a total heating surface in the four boilers of 10,880 square feet, and in the four economisers of 1,400 square feet, thus making a total heating surface in the four boilers and four economisers of 12,280 square feet. It will be noted that the floor space occupied is very much less than with boilers of the "land" type. Three of the boilers are hand fed, having an ordinary grate area of 73½ square feet, which makes a total grate area in the three boilers of 220½ square feet. The remaining boiler is fitted with a double 4ft. patent chain grate stoker made by Messrs. Babcock and Wilcox. The grate area of this boiler is 68 square feet, the total grate area in the four boilers being, therefore, 288½ square feet. These four boilers combined will produce about 50,000lb. of steam per hour, and are arranged along one side of the boiler-house, the space on the opposite side of the boiler-house being available for the accommodation of additional boilers whenever they are required. The products of combustion are conveyed from the boiler to the chimney through flues constructed of steel placed overhead. The flues are lagged externally by magnesia, which is held in position by means of external plates. A chamber has been provided at the base of the chimney shaft to which the main flue is connected, and is

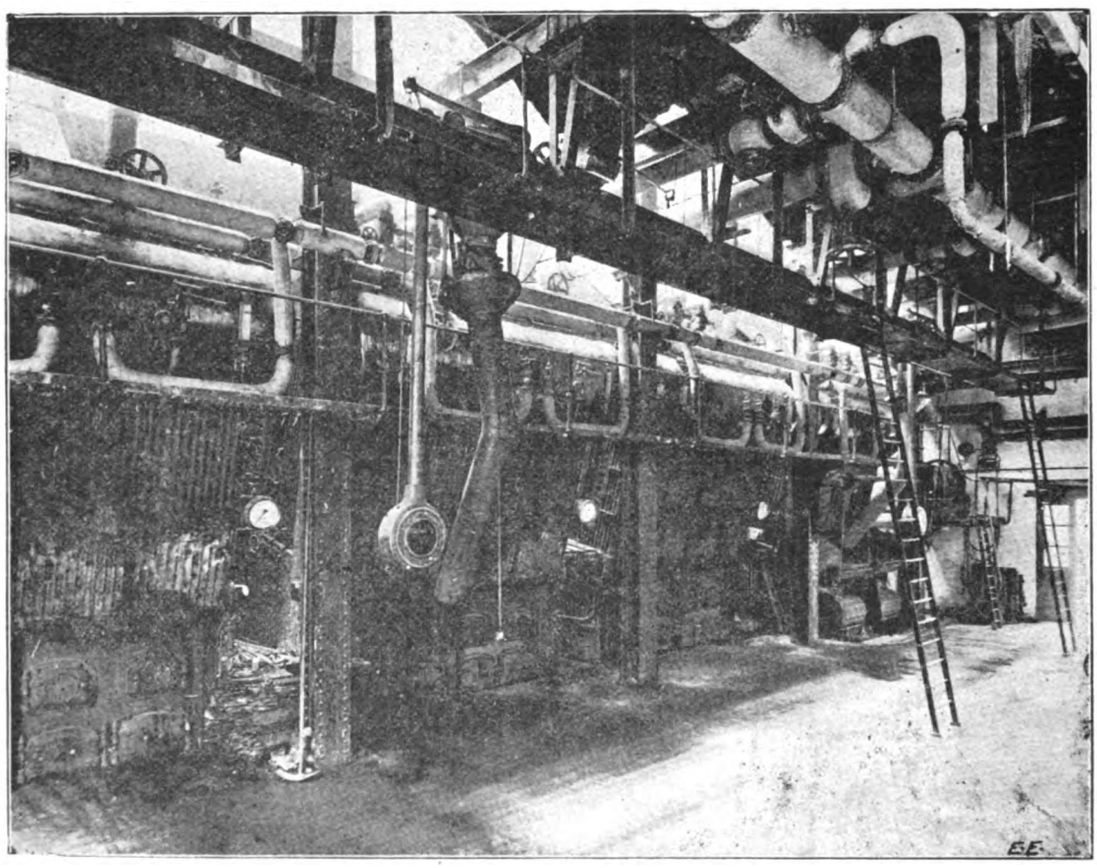

FIG. 3.—View of the Boiler-House, with Babcock-Wilcox Marine Boilers.

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so arranged that induced-draught apparatus can be added subsequently.

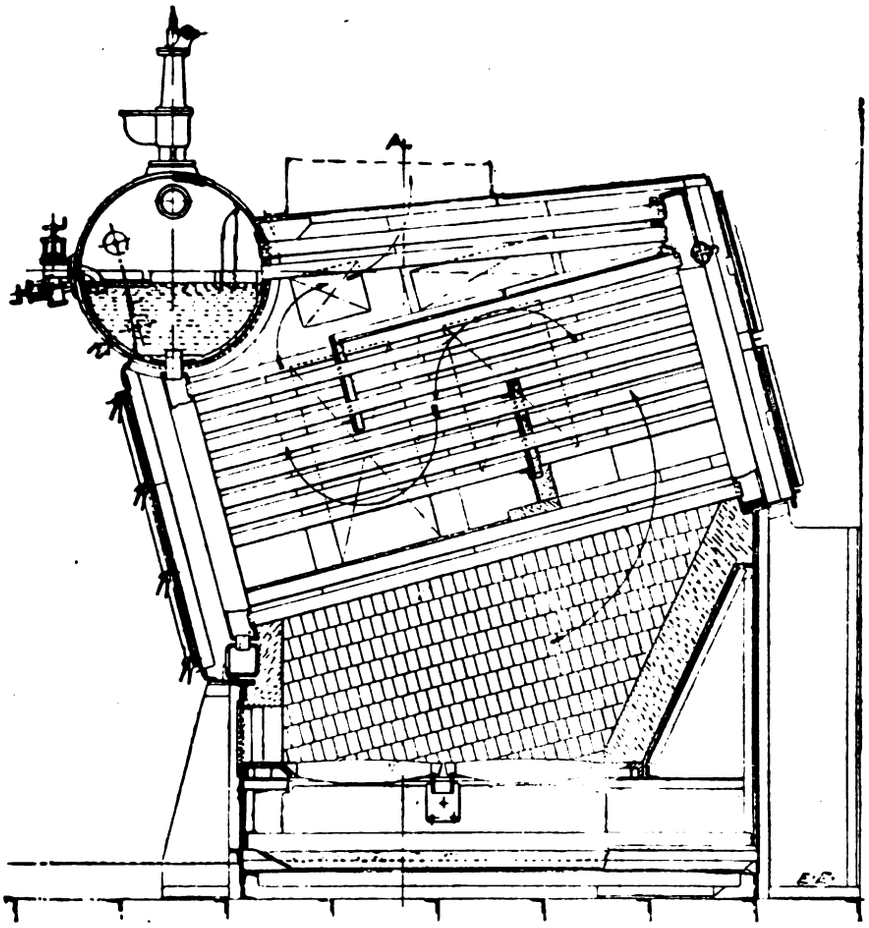

FIG. 4.—Section of the Babcock-Wilcox Marine Boiler.

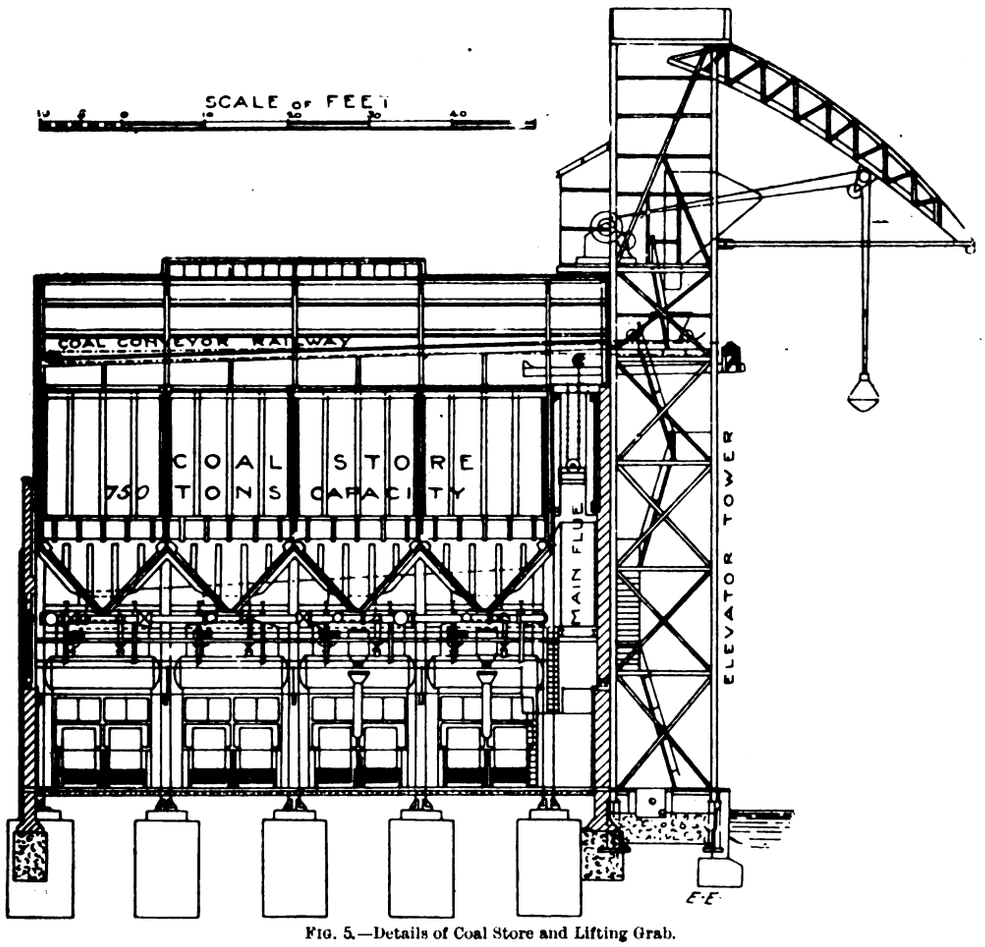

FIG. 5.—Details of Coal Store and Lifting Grab.

The boilers are supplied with coal from an overhead coal store (Fig. 5), having a total capacity of 750 tons, erected on steel stanchions above the stoking place in the centre of the boiler-house. Pockets with sloping sides are provided in the bottom of these bunkers to facilitate the discharge of the coal to the boilers. A special feature about the boiler-

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house is the arrangement by which the coal is lifted from barges on the canal alongside the generating station, conveyed to the bunkers and afterwards to the boilers. The coal is lifted from barges by means of a hinged grab or shovel of half a ton capacity, which is projected from a boom of parabolic form extending over the canal. This apparatus is situated at the top of a tower constructed of steelwork placed near the edge of the canal at the end of the boiler-house. The parabolic form of boom enables the bunkers are provided with regulating valves, one being placed opposite the centre of each boiler, which enables the flow of the coal to be controlled. The coal is delivered by means of these valves into a hopper having a weighing apparatus, so as to correctly register the amount of coal delivered to the boilers. At the present the coal for the boilers which have not been fitted with mechanical stokers will be delivered on the floor in front of the boilers as the fireman requires it. In the case of the boiler fitted with

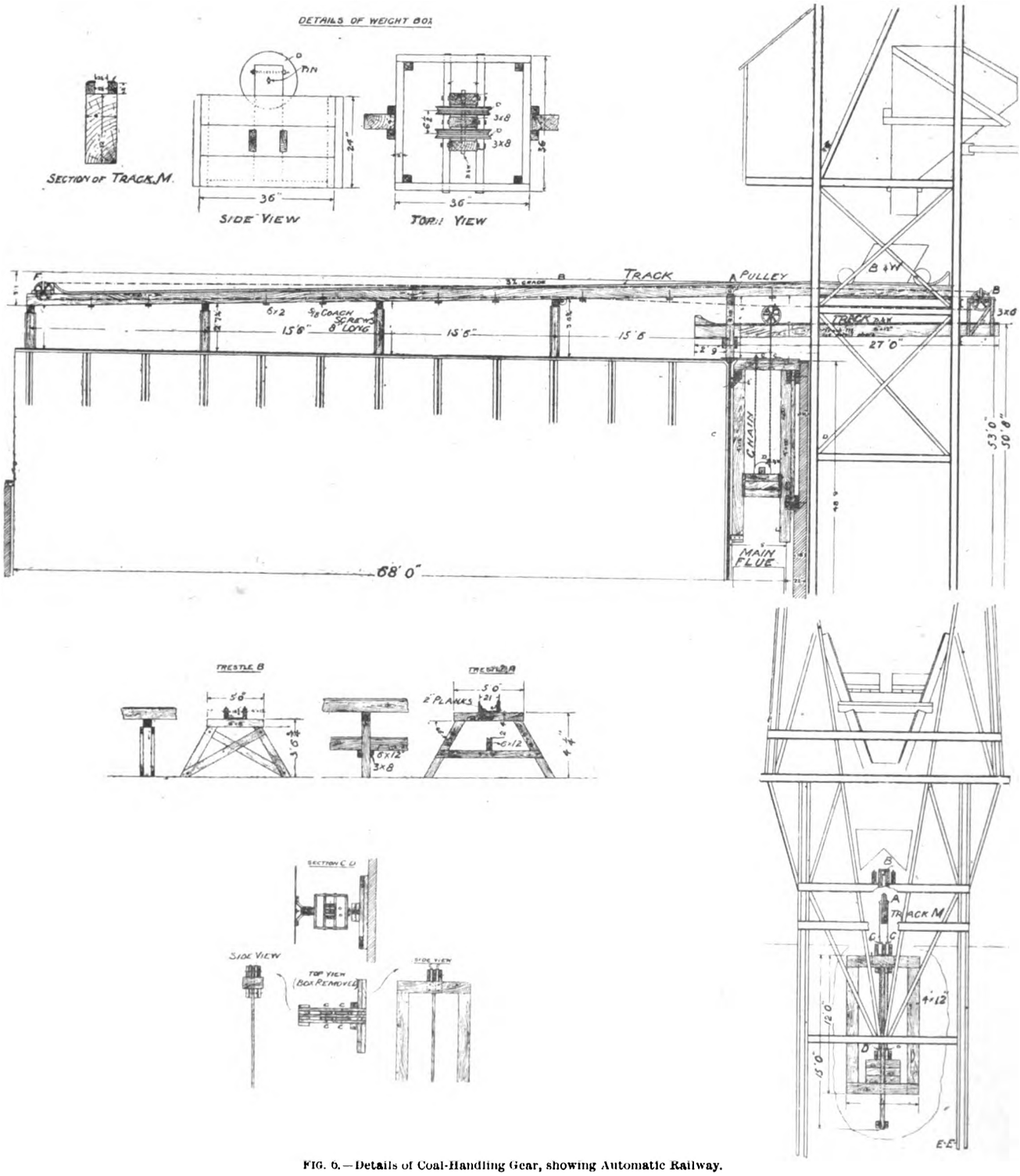

FIG. 6.—Details of Coal-Handling Gear, showing Automatic Railway.

load to be lifted vertically until it reaches its extreme elevation, when an inward movement takes place, at the end of which movement the coal is dumped into a hopper and delivered through a regulating duplex valve into an automatic wagon (Fig. 6), which, after being filled, is released and runs over the top of the bunkers, dumping the coal at any point where it is required. The hoist is driven by means of two electric motors of the enclosed type, supplied by the Westinghouse Company, the speed being regulated by a series parallel controller. Each of the openings at the bottom of the pockets beneath the coal a mechanical stoker, the coal will be delivered directly into the hopper in connection with the stoker.

The peculiar feature of this automatic railway (Fig. 6) consists in storing sufficient energy required by the loaded car descending an inclined track, the energy being utilised to return the empty car back to the place from whence it started after the load has been discharged. The loaded car runs down the inclined track, and when it has reached the end of its journey it has raised a counter-weight a certain height by means of the cable shown in the illustration, which the car picks up while running down the track.

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The weight rises only a limited distance, but when the car has dumped its load of coal, which is from 20cwt. to 25cwt., the weight falls, and whilst so doing pushes the car a certain distance back up the track, the momentum gained being sufficient to carry the car the remainder of the way. One man only is needed to operate the railway, who starts the car when filled, but does not accompany it. The car runs down the inclined track, dumps its load, and hands it automatically to the workmen. It runs with great rapidity, making the trip of 100ft., dumping its load, and returning in about 30 seconds. Gangways are provided in the boiler-house for access to the fittings in front of the boilers and to the stop-valves on the main steam range. The coal-handling apparatus has been supplied by Messrs. Babcock and Wilcox, being of the Hunt Company's special design. The whole of the steelwork, comprising the coal storage bunkers, elevator tower, and roof for boiler-house, together with the overhead flues, have been supplied by Messrs. Peirson and Co., St. Dunstan's-hill, E.C. The feed pumps are three in number, two of them being capable of delivering 2,500 gallons per hour to the boilers, and the third 5,000 gallons per hour. They are of the C. and J. Weir Company's make, and deliver to the boilers through the feed mains, which are in duplicate, each main being provided with a separate filter and water-meter. The suction pipes to the feed pumps are also in duplicate, one pipe being connected to the overhead feed storage tank, the other pipe being connected to the hot-well. The feed-water storage tank is constructed of cast-iron plates, and is capable of holding 12,000 gallons of water. This tank is divided into two sections to enable either section to be cleaned without interfering with the continuity of the supply of water to the pumps. The hot-well consists of a galvanised iron tank having a capacity of 1,500 gallons. A special feature in connection with the hot-well is that it is placed upon a weighbridge, so as to provide a ready means of measuring the water discharged from the air-pump when carrying out tests on the plant.

The main steam-pipe (Fig. 2) is arranged in the form of a ring placed in the boiler-house, the main pipe being 10in. in bore, constructed of mild steel, with the flanges shrunk on and riveted. Jointing is avoided as much as possible, and with this in view the branch connections are made by means of flanged outlets of mild steel, riveted on to the main pipes. The ring is divided up into sections by means of straight-through valves, so as to limit the effect of any failure to the particular section of the ring affected. All valves are of the straight-through pattern with cast-steel bodies. The whole of the steam and feed piping, feed pumps, storage tank, etc., have been supplied by Messrs. Aiton and Co.

Engine-House Plant.—The engine-house plant consists of two vertical slow-speed Corliss compound steam-engines (Fig. 7), each direct-coupled to a continuous-current dynamo of 800 kw. capacity. Each engine is provided with its own condensing plant, consisting of surface condenser with air and circulating pump driven direct from the main engine. The engines are designed to run at a speed of

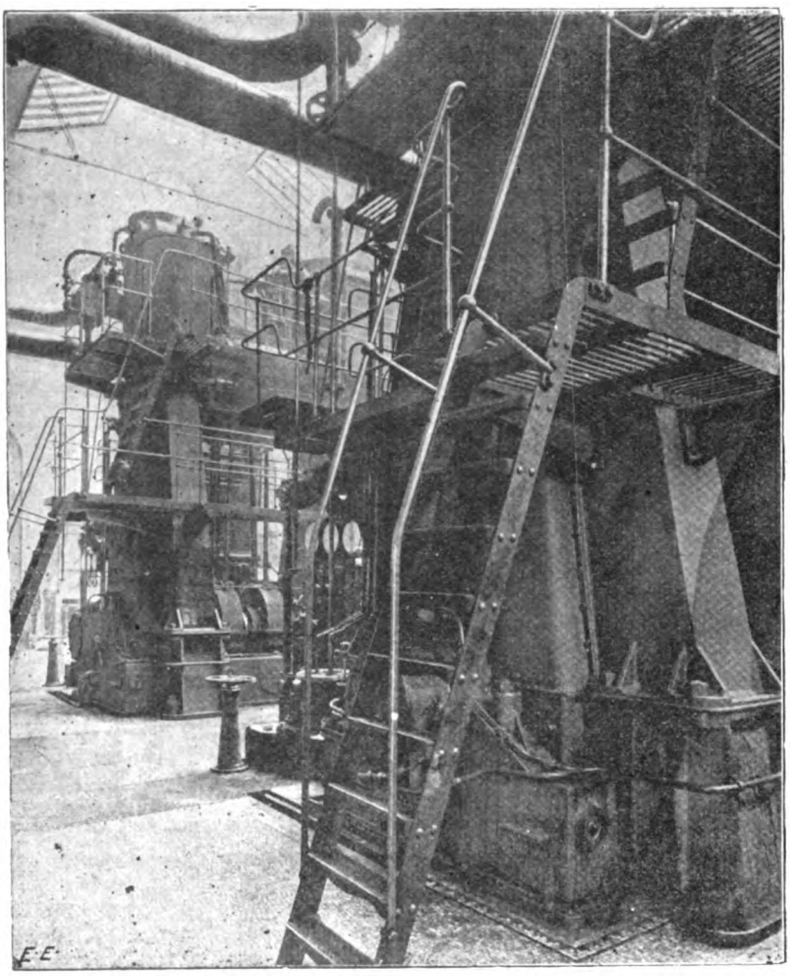

FIG. 7.—View of the Wallsend Slipway Company's Engines.

90 revolutions per minute, and are capable of developing from 1,300 i.h.p. to 1,400 i.h.p. The diameter of the high-pressure cylinder is 24½in., and the diameter of the low-pressure cylinder is 53in., stroke 42in. The crankshaft, generator bearings, connecting rod end and slides, are provided with forced lubrication under pressure, oil pumps being provided for this purpose working from the crank-shaft. The main standards are suitably enclosed to prevent oil splashing about, large doors and movable casings being provided to give access to the working parts. Both high and low pressure cylinders are both provided with automatic Corliss trip gear controlled by the governor, which is of Whitehead's isochronous type. In addition to this ordinary governor, an emergency governor of the inertia type is provided. The flywheel, weighing about 32 tons, is of the built-up type with steel tension arms. Steel rings are shrunk on the hub as an additional safeguard. Ladders and staging are provided for access to the valve gear and other working parts.

The generators (Fig. 8) are of the multipolar type, made

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by the Westinghouse Company. The armature and commutator are built upon a ventilating cast-iron sleeve, forced on the engine shaft under pressure. The field castings are divided in a vertical plane, and are mounted on cast-iron sole-plates. The rated load of each of the machines is 730 amperes and 1,100 volts. The machines, however, are designed to carry an overload of 50 per cent. for two hours, if necessary, above this rating. The armature is of the slotted-drum type, having a multiple winding so arranged that the circuits will not become unbalanced by a slight displacement of the armature from the centre of the fields. The brushes, which are of carbon, are adjustable by means of a hand-wheel and worm gear, and the arms carrying the brushes are supported at the end next to the field casting, so as to leave the commutator free from obstruction. The arrangements for ventilation are very perfect in this type of machine, and open ducts are provided for this purpose throughout the armature to the spider core and windings, the design of the spider being such as to set up a forced current of air through these ventilating spaces. The exhaust steam from each engine passes through an oil separator on its way to the condenser. The condensers each have a cooling surface of 2,700 square feet. The air and circulating pumps are driven by means of levers from the high-pressure cross-head. The air-pumps are of the Edwards single-acting type, the circulating water pumps being of the double-acting type. The circulating water is taken from the basin in connection with the Regents Canal, and is returned through pipes down Bath-place into the main canal. An alternative exhaust to atmosphere with automatic release is also provided. The engines have been manufactured by the Wallsend Slipway and Engineering Company, and they also supplied the generators, together with exhaust and water pipes in connection with the engines and the condensers.

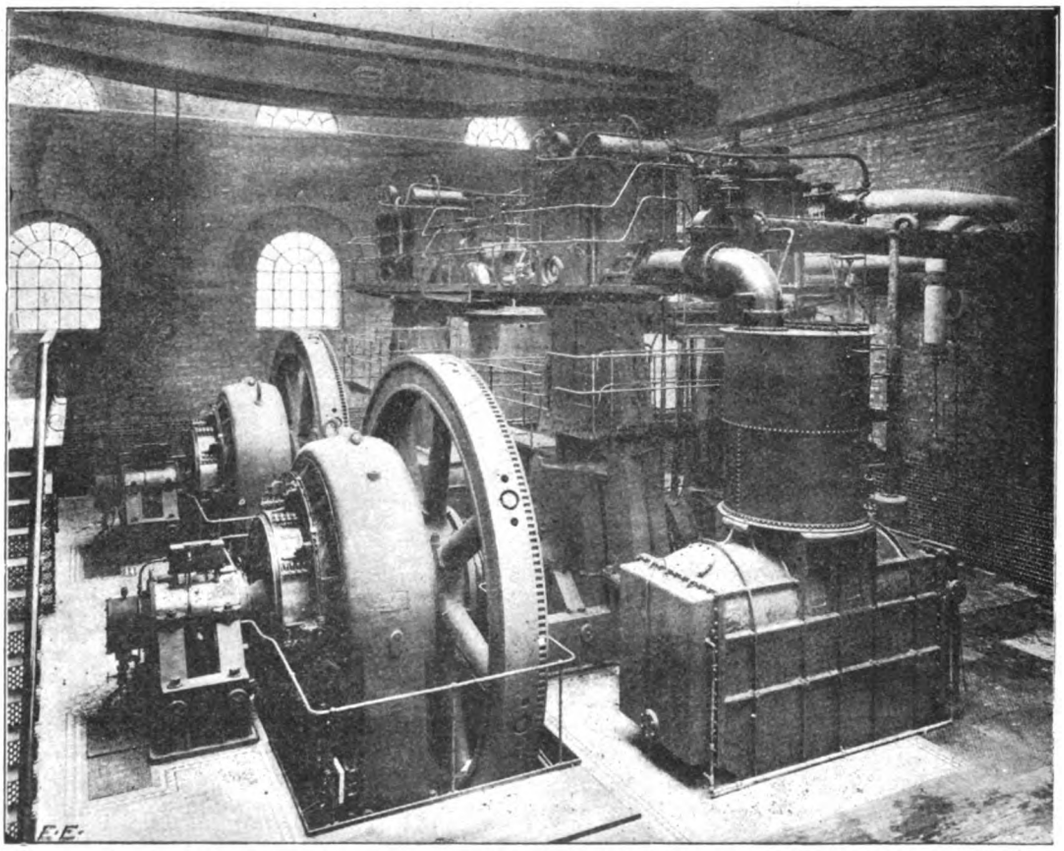

Fig. 8.—General View of the two 800-kw. Steam Dynamos, showing the Westinghouse Dynamos.

Switchboard.—As previously mentioned, the switchboard is placed on a gallery which runs the whole length of the engine-room, the high-tension portion being placed at one end, and the low-tension at the other. The high-tension board is divided into the following sections: (1) high-tension dynamo board (Fig. 9), comprising positive and negative dynamo panels for each generator, with paralleling panel in the centre; (2) high-tension trunk feeder board (Fig. 10), comprising positive and negative panels for two feeders; (3) high-tension transformer board, comprising panels for four transformers; (4) arc circuit board, with provision for three arc circuits. The low-tension board consists of positive and negative feeder panels for six low-tension feeders. This switchboard will be used in connection with the continuous-current transformers and for supplying the network in the neighbourhood of the station, and is arranged with plug system, whereby any transformer can be plugged on to any low-tension feeder. Both high and low tension switchboards have been supplied by Messrs. Cowans, of Manchester, the high-tension board being of their special design, the high-tension switches being mounted on horizontal slates, and the whole supported on an iron frame, which is placed against the face of the wall without the necessity of leaving a space behind for access to the working parts. All the main high-tension switches are provided with reverse-current cut-outs of the Andrews type, and the switches can also be opened by means of a hand trip gear. These switches break through about 1in. of water. The instruments are of Messrs. Evershed and Vignoles's make, with the exception of the voltmeters, which are of the Ayrton and Mather multicellular type. The recording instruments are by Messrs. Elliott Bros. A special feature in connection with the design of the switchboard is the chamber that is provided below the gallery to contain the various resistances and high-tension omnibus bars. The spindles for working the regulating resistances are brought up through the floor of the gallery, and are operated from a convenient height, cast-iron pillars and hand-wheels being provided. A light gangway is provided in the chamber below the board for convenient inspection of the various regulating switches and resistances. The high-tension omnibus bars, which are carried in the chamber below the gallery, as previously mentioned, are supported on oil insulators. In addition to supplying the switch boards for the Whiston-street generating station, Messrs. Cowans have supplied the trunk feeder panels at the receiving end of the trunk feeders at the old station in Coronet-street, and have supplied the additional switchgear for the two sub-stations at Reeves'-place and Evelyn-street respectively.

It will be seen from the above description that there are

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some essentially novel features in this latest undertaking of the Shoreditch Borough Council. The marine type of

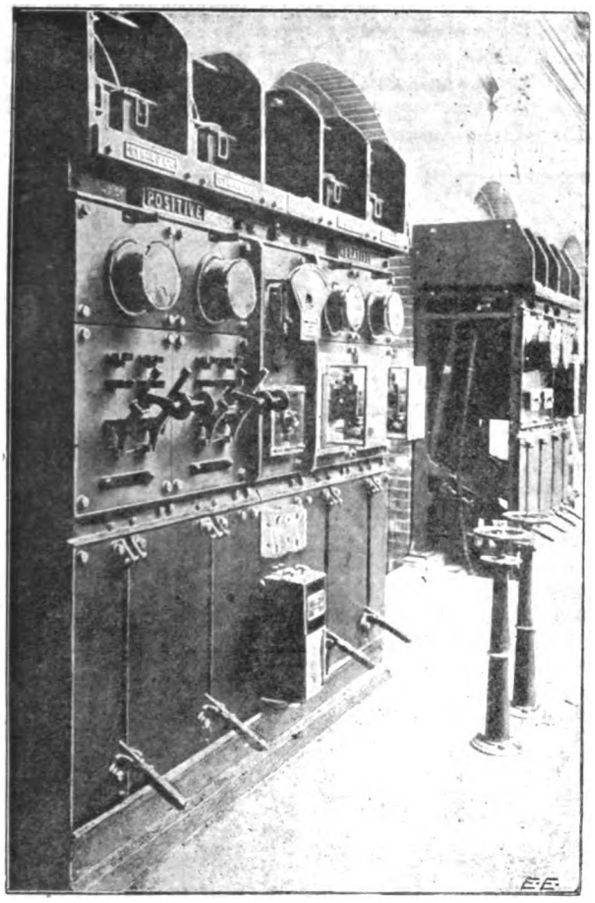

FIG. 9.—The Dynamo Board at Shoreditch.

Babcock and Wilcox boilers have, we believe, never before been utilised for service on land, and are expected to give

FIG. 10.—The Shoreditch Feeder Board.

the most efficient results, whilst the comparatively small ground space occupied by them in comparison with their steam capacity makes them eminently suitable for a large electric generating station. The automatic railway for handling and trimming the coal in the overhead bunkers is also a novel feature in this country. It will be noticed that the system of supply adopted for the new generating station is similar to that supplied by the Council in their first generating station—*i.e.*, high-pressure continuous-current—being generated at the power-house at about 1,100 volts, delivered to sub-stations located in various portions of the area, where the current is transformed down to the pressure required for the service to consumers' premises through continuous-current motor-transformers, consisting of machines with one field and a double-wound armature. The distribution from the sub-station through the streets to consumers' premises is on the two-wire system.

POWER DISTRIBUTION IN CALIFORNIA.

Through the courtesy of the Stanley Electric Manufacturing Company, we are able to give herewith a map which clearly shows the enormous development in electric power transmission and distribution which has taken place

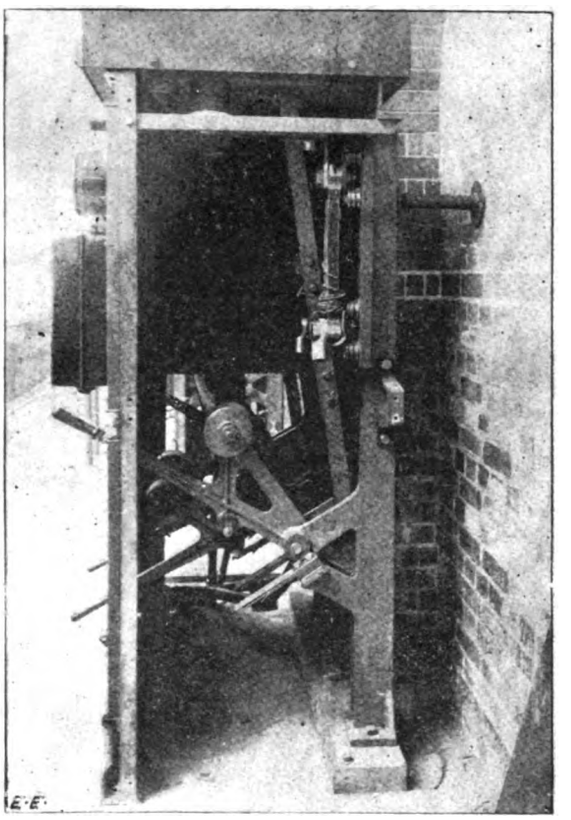

FIG. 11.—Side View, showing the Levers of the Cowans Oil-Break Switches.

in California. The lines on this map indicate the routes of the overhead electric wires of the two large companies which up to the present have been to a certain extent working in opposition. We understand, however, that these two companies—the Standard Electric and the Bay Countries Power Company—have been temporarily connected together, and that there is every likelihood of their becoming united into a single undertaking. The whole of the lines on the accompanying map are completed and ready for work, and they are working regularly throughout the 24 hours, with the following exceptions: the 46-mile line from Stockton to the Standard Company's power house at Electra, the line from Redwood City to San Francisco. We understand, however, that by the time we go to press these lines will be in regular service. The following are the details of the various sections of wire used on the lines indicated on the maps, and at the same time we give their lengths in detail. The sizes of the wires are given in circular mils, which is the square of the diameter in thousandths of an inch.

From Electra to Stockton, 46 miles. One circuit, 471,034 c.m., aluminium cable.

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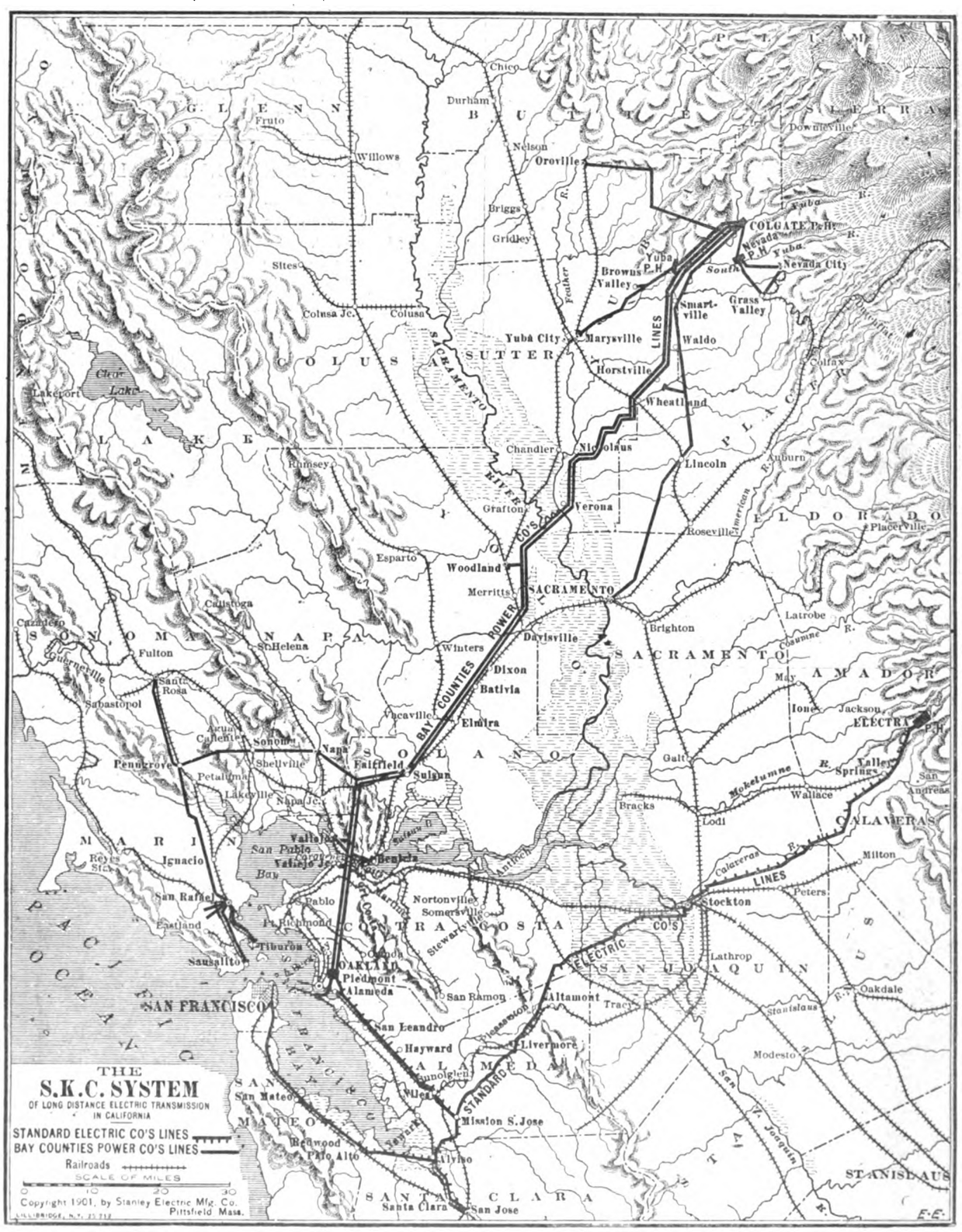
From Stockton to Mission San Jose, 49·6 miles. One circuit, 471,034 c.m., special aluminium cable.
From Mission San Jose to Oakland, 26·3 miles. One circuit, 188,230 c.m., special aluminium cable.
From Alviso to San Jose, 8½ miles. No. 1 B. & S. gauge aluminium solid.
From Mission San Jose to Alviso, 9½ miles. One circuit, 352,300 c.m., aluminium cable.
From Colgate to Oroville, 28 miles. One three-phase circuit of No 4 aluminium cable.
From Colgate to Nevada County power-house, seven miles. Two three-phase circuits
From Colgate to the old Yuba power-house, eight miles. Two three-phase circuits of No. 4 aluminium cable.
From old Yuba power-house to Marysville, 18¾ miles. Two three-phase circuits of No. 6 copper.



The Power Cable Routes of California.

From Mission San Jose to Redwood City, 16·3 miles. One circuit, 352,300 c.m., aluminium cable
From Redwood City to San Francisco, 32½ miles. One circuit, 352,300 c.m., aluminium cable.
From Electra to Oakland, 122 miles. One circuit, 352,300 c.m., aluminium cable.
From Electra to San Jose, 113·6. One circuit, 352,300 c.m., aluminium cable.
From Electra to San Francisco, 153·9 miles.
From Colgate to Sacramento, 61 miles. Two three-phase circuits of No. 4 aluminium cable.
From Colgate to Oakland, 132 miles. Two three-phase circuits. North circuit of No. 00 B. & S. gauge copper; south circuit of No. 0000 B. & S. aluminium cable, Colgate to Suisun, and No. 00 B. & S. gauge copper, Suisun to Oakland.

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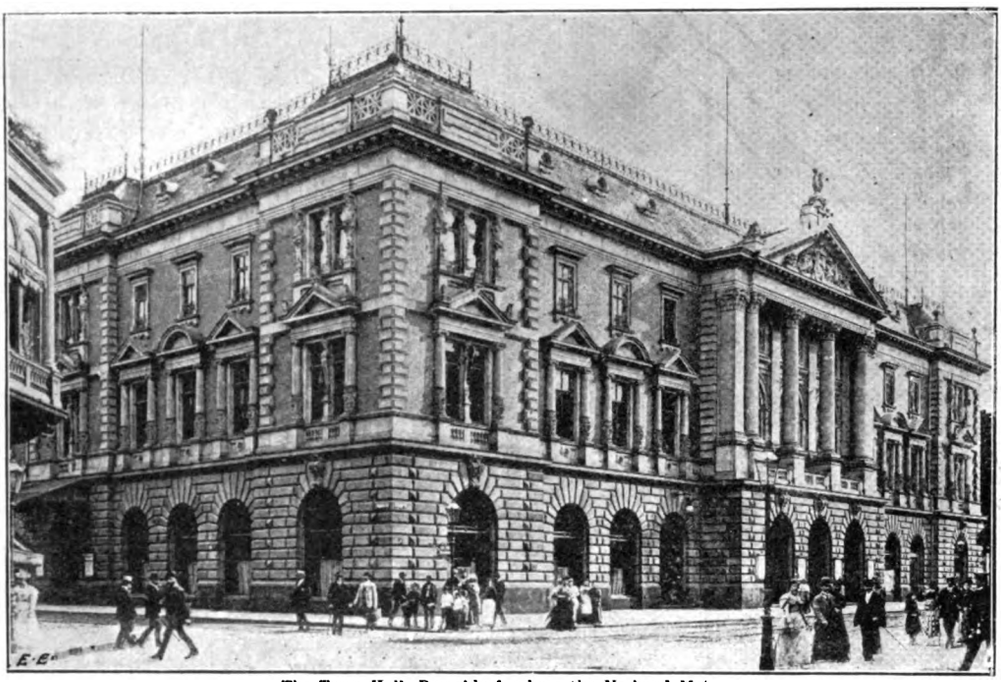
From Colgate to Cordelia, 107 miles.
From Cordelia to Penn Grove, 26 miles. One three-phase circuit of No. 4 B. & S. gauge three-strand aluminium cable.
From Penn Grove to Sausalito, 32 miles. One three-phase circuit of No. 4 B. & S. gauge three-strand aluminum cable.



The Town Hall, Dusseldorf, where the Verband Met.

From Penn Grove to Santa Rosa, 13 miles. One three-phase circuit of No. 4 B. & S. gauge three-strand aluminium cable.
From Colgate to Sausalito, 165 miles.
From Colgate to Stockton, 208 miles.
From Colgate to San Francisco, 211¾ miles.

A Typical Crossing, Dusseldorf.

These lines show what can be economically accomplished in a country where water power is cheap and fuel and transport dear.

PHYSICAL SOCIETY.—The ordinary meeting of this Society, announced for the 27th inst, will take place this evening at five o'clock, on account of the coronation festivities.

THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

TENTH ANNUAL MEETING, DUSSELDORF.

[BY OUR OWN CORRESPONDENT.]

The Verband Deutscher Elektrotechniker seem particularly adept in their choice of localities for their annual meetings. Düsseldorf, on the Rhine, where the tenth annual meeting of the Verband has just been held, is an attraction of itself, being known, in fact, as the garden town of Germany. Its many gardens and beautifully shaded lakes have won for it this reputation. To the casual visitor it comes as a surprise to learn that this charming and cleanly town is in close proximity to a thriving iron industry. But it is, nevertheless, the case, and it is only due to the happy chance which has situated the ironworks, with their attendant forest of belching chimneys, in the east that the town enjoys almost entire immunity from the disadvantages of its industry. The accompanying illustrations will serve to give some idea of the natural attractions of the place. Added to these, the town at present combines the attraction of an industrial exhibition

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of unusual extent and interest. Especially in the electrical and heavy engineering sections the exhibition is in a manner unique. To details we hope to proceed later. The proceedings of the Verband commenced on Thursday, 12th inst., when council and committee meetings were held in the morning and afternoon respectively, while in the evening the members present for the occasion, and their wives, were entertained by the town of Düsseldorf to supper in the Tonhalle. One of the accompanying illustrations shows an exterior view of this building, which provided magnificent accommodation for both the social and business meetings of the Verband. The evening was spent in social intercourse. Long-parted friends made merriment over the Rhine and Moselle wines, which, for once, took the place of lager, a full military band assisting in the entertainment. Naturally under such circumstances the guests departed with good appetites for the morrow's business. At all events, very good progress was made with the general business of the meeting on the following Friday morning.

In opening the meeting, the PRESIDENT (Prof. Hartmann, of Frankfort) referred to the Verband's especial indebtedness to the mayor and town of Düsseldorf for the welcome which had been extended to them. The coincidence of the exhibition enabled the Verband to combine the enjoyment of the beautiful with the appreciation of the useful. With regard to the sections of the exhibition which appealed to them most, although finality in design and application had been by no means reached, the progress made in electrical science was nevertheless very apparent. Turning to another question, the 10 years' existence of the Verband was not in itself a cause for jubilation, but they had some satisfaction in knowing that the necessity for electrical engineers to act in common accord was sufficiently appreciated. In industrial circles great hopes were held of the united action of electrical engineers, and these had been realised. With regard to scientific and technical progress, the Verband had cause to rejoice, although they had not reached the goal aimed at. In order that the supremacy of the electrical industry in Germany might be upheld, it was essential that constant improvement should be made. A few days previously a meeting of German electrical engineers had been held to form an association for the protection of the scientific interests of the profession. In conclusion, Prof. Hartmann pointed out that it was necessary that electrical engineers should pay more attention to their commercial training, an opportunity of which was offered latterly by the connecting of technical schools with commercial schools, and suggested that, perhaps, the time was not far distant when commercial schools would be attached to all universities.

Assurances of welcome to the town were subsequently addressed to the meeting by the mayor and others.

Mr. GISBERT KAPP, the general secretary of the Verband, then read the annual report. From this it appeared that the membership of the Verband had increased by 21 since the corresponding date last year, the total membership now amounting to 3,133. At the commencement of the present financial year the value of the Verband's assets stood at about £6,500. The book published by the Verband showing the duties imposed on the more important electrical articles by foreign countries had involved a loss so far of £20, the demand for copies falling considerably below expectations. The circulation of the Verband's official organ, the *Elektrotechnische Zeitschrift*, had increased by 8 per cent. since the corresponding date last year. At the end of the year 1901 its circulation, including the 4,087 copies distributed to members of the Verband and Elektrotechnische Verein, amounted to 7,700 copies.

(To be continued.)

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

The following is the text of the official programme of the seventh annual convention of the above association, to be opened in London on the 2nd of next month :

Meetings.—The meetings on July 2, 4, and 5 will be held at the Institution of Mechanical Engineers, Storey's-gate, S.W., and on July 3 at the Royal Agricultural Hall, Islington.

Tickets.—Applications for visitors' tickets and for advance proofs of papers, etc., must be made to the secretary of the association, Mr. C. McArthur Butler, St. James's Hall, Piccadilly, London, W.

Hotel Accommodation.—The Westminster Palace Hotel, London, S.W., will be the headquarters of the council during the convention.

WEDNESDAY, JULY 2.

General meeting, at 10 a.m., at the Institution of Mechanical Engineers. The Chairman of the London County Council (John McDougall, Esq.) has kindly consented to be present to meet and welcome the association. Presidential address by Mr. J. H. Rider, electrical engineer, London County Council tramways.

The following papers will then be read and discussed : (1) "Double-Current Generators and their Application," by Mr. E. T. Ruthven Murray, electrical engineer, Willesden Urban District Council ; (2) "High-Tension Continuous-Current Systems," by Mr. A. S. Barnard, city electrical engineer, Hull. The meeting will adjourn at 1 p.m.

At 2.15 p.m. prompt brakes will leave the Westminster Palace Hotel for the generating station of the Central London Railway at Shepherd's Bush. At 3.45 p.m. the brakes will be ready to convey the party to either of the following, afterwards returning to the Westminster Palace Hotel : the generating station of the Metropolitan Electric Supply Company, Limited, Willesden (this is a bulk supply station, generating and distributing two-phase alternating current at 10,000 volts) ; or to the works of the Incandescent Electric Lamp Company, Limited, Brook Green, W. (the "Robertson" incandescent electric lamp is manufactured at these works).

THURSDAY, JULY 3.

General meeting at the Agricultural Hall, Islington, by the kind invitation of the Tramways and Light Railways Exhibition Committee. The entrance to the exhibition is in Upper-street, Islington. Admission by special ticket. Members to meet in the committee-room of the exhibition at 10.30 a.m., where the Exhibition Committee will receive them, and the party will then proceed to inspect the exhibits. Luncheon will be served at 1 p.m. to members, by special invitation of the Exhibition Committee. At 2.30 p.m. an adjournment will be made to Berners Hall (in the building), when the following papers will be read and discussed : (1) "Steam-Turbines," by Mr. S. E. Fedden, city electrical engineer, Sheffield ; (2) "The Correct Type of Engine for Large Generating Stations," by Mr. A. A. Day, borough electrical engineer, Bolton.

FRIDAY, JULY 4.

General meeting, at 10 a.m., at the Institution of Mechanical Engineers. The following papers will be read and discussed : (1) "Some Notes *re* Earthing," by Mr. H. Faraday Proctor, city electrical engineer, Bristol ; (2) "Two *v.* Three Wire Distribution," by Mr. J. F. C. Snell, borough electrical engineer, Sunderland. The meeting will adjourn at 1 p.m.

During the afternoon the following works will be open for inspection : the generating station of the City of London Electric Lighting Company, Limited, at Bankside ; or the conduit tramway construction on the Tooting lines of the London County Council.

The association smoking concert will be held in the Banqueting Hall of the St. James's Restaurant on Friday, July 4, at 8 p.m. (evening dress).

SATURDAY, JULY 5.

Annual general business meeting, at 10.30 a.m., at the Institution of Mechanical Engineers, when all members, associate members, and associates are particularly requested to attend. Agenda : place of meeting for convention of 1903 ; election of president, officers, and council for 1903 ; annual report of the council ; balance-sheet for year ending Dec. 31, 1901 ; amount of annual subscription ; any other competent business.

BENEVOLENT FUND.

A special general meeting of the contributors to the benevolent fund of the association will be held at the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, S.W., at the close of the annual general business meeting, for the purpose of considering the following resolution, passed at a council meeting of the association held at the Westminster Palace Hotel, London, on Friday, Feb. 21, 1902 : "That it be a recommendation from this council to a special general meeting of the subscribers, to be held after the 1902 convention, to discontinue the benevolent fund and to hand over accrued donations and subscriptions to the like fund of the Institution of Electrical Engineers."

LEIGH ELECTRICITY WORKS.

The following is an abstract of the annual report of Mr. John Foster, engineer and manager, to the chairman, vice-chairman, and members of the Tramways and Electricity Committee on the work of the undertaking during the 12 months ending March 31 last :

Practically no money has been spent in regard to new extensions during the year except an instalment of £1,000 on the cost of the new steam dynamo, which was paid in March of this year. The total length of mains now laid is as follows : ·3in., 18 yards ; ·25in., 2,289 yards ; ·15in., 1,584 yards ; ·1in., 1,905 yards ; ·05in., 4,629 yards—a total length of 5 miles 1,625 yards ; the total number of services laid during the year being 49. The consumers now number 128 ; number of 8 c.p. lamps, 9,403 ; number of motors, 52 ; units sold, 150,610 (plus 438 public clock) ; maximum load in kilowatts, 140, with a load factor of 12·31 per cent. In commenting upon the progress made during the year I can only say that it is highly satisfactory, being 96 per cent. over the previous year,

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Analysis of Accounts for Year ending March 31, 1902.

Capital expenditure to March 31	£17,373 4 4
Revenue from electricity supply	1,989 17 2
Revenue from meter and motor rents and other sources	70 13 4
Total revenue	2,060 10 6
Total costs	1,150 9 3
Gross profit before providing for interest charges and sinking fund	910 1 3
Percentage of gross profit to capital (outlay during year being averaged)	6·43 per cent.
Interest on loans	419 2 10
Sinking fund	410 0 0
Percentage of sinking fund to capital (outlay during year being averaged)	2·89 per cent.
Financial result after payment of all charges (profit)	80 18 5
Capacity of dynamos, etc., March 31 (kilowatts)	200
Maximum load reached (kilowatts)	140
Load factor	12·31 per cent.
Number of 8-c.p. lamps connected March 31 (arcs, incandescents, and motors, equivalent in 8 c.p.)	15,853
Number of units sold and public clock	151,048
Units sold per 8-c.p. lamp (connections during the year being averaged)	13·8
Price charged—Private lighting	7d. and 2½d., or 5d. and 3d., less 10 per cent.
Power	3d. and ½d. and 1¼d.
Average price obtained—Private supply	4·13
Average price obtained—Power	1·45

Analysis of Costs.

	1902. £	s.	d.	Per unit sold d.
1. Coal and other fuel	221	8	7	·36
2. Oil, waste, water, and engine-room stores	82	5	8	·13
3. Wages of workmen	265	11	2	·42
4. Repairs, etc., of buildings, plant, etc.	66	0	10	·10
Works cost	£635	6	3	1·01
5. Rents, rates, and taxes	130	5	0	·20
6. Management expenses, salaries, etc.	196	9	4	·31
Total generation and distribution costs	£962	0	7	1·52
7. Interest and sinking fund costs	829	2	10	1·32
Total costs	£1,791	3	5	2·84
8. Lamps, carbons, and fittings	24	3	7	—
9. First annual instalment of 10 per cent. on capital cost of motors	84	3	8	—
10. Cost of altering fittings at technical school	80	1	5	—
	£1,979	12	1	—

In deciding upon the merits of the net profit for the past financial year, I wish to draw your attention to the two special charges numbered 7 and 8 in the above analysis of costs. In the first item I find that the instalment on the capital cost of motors has been based on the total cost at the end of March, 1902, whereas, if the instalment had been set aside from the time each bill for the motors was paid, this amount would have been reduced by at least £28. This amount, coupled with the £80. 11s. 5d. the cost of altering the fittings at the technical school, would increase the net profit to £189. 13s. 2d., which I think you will agree is highly satisfactory on the second year's working. The following is a summary of financial results: capital expended, £17.373. 4s. 4d.; average charge per unit, 3·17d.; gross profit, £910. 1s. 3d.; percentage to average capital outlay, 6·43 per cent.; interest and sinking fund, £829. 2s. 10d.; net result—surplus, £80. 18s. 5d. The gross profit is averaged on the mean of the capital outlay at March 31, 1901 and 1902.

SOUTHPORT ELECTRICITY WORKS.

The annual report of the Southport borough engineer for the year ended March 31 last states that during that period the growth of the undertaking has been satisfactory. The number of new consumers connected has been up to the average of the past few years, and the output of units for tramway purposes has steadily increased. During the year Nos. 3, 4, 5, and 6 boilers were reset upon their foundations owing to settlement having taken place. Undoubtedly the most important boiler house accessory that has been installed during the year has been the water-softening apparatus supplied by the Desrumaux Automatic Water Softener and Purifier Company, Limited. It is quite automatic in its action, and is capable of softening and filtering 8,500 gallons of water per hour, and requires the minimum of attention. Since it has been in operation its effects on the boilers have been most apparent; instead of requiring three weeks to scale a boiler after running 1,000 working hours, it is only necessary to brush the flues and sides and wash out, an operation taking one to two days only. Its equivalent value is at least two additional boilers under the old method of working. It should affect the working costs beneficially. There is at present installed the following plant of a total capacity of 4,000 h.p.: Lighting—(two) 125-kw. alternators, 250 i.h.p.; (one) 300-kw. alternator, 500 i.h.p.; (two) 600-kw. alternators, 1,000 i.h.p. Traction—(three) 200-kw. dynamos, 350 i.h.p. The Belliss 1,000-h.p. triple-expansion engine and Ferranti 600-kw. alternator were set to work early in November, and proved of very great service during the winter. The whole of the engine-room plant has been maintained in thorough working order, and has given very little trouble. A centrifugal pump, driven by either a continuous or alternating motor, has been installed, and is capable of returning the condensing water of 2,000 h.p. to the reservoir. By this arrangement the works are self-contained, from a condensing point of view, and thus are independent of the brooks if necessary. Owing to the existing six feeders from the works to the town being overloaded during the past winter, necessitating running at a high station pressure, and to increase the margin of safety, it has become necessary to lay four additional feeders, and this work is well in hand, and will be completed in the course of a few weeks. House transformers have been reduced to a minimum and consumers connected to the low-tension network. A new sub-station has been erected at the junction of Portland-street and Lord-street, and is the latest practice in this class of work, and has proved of considerable convenience. The lamp connections during the year amount to 7,087 8-c.p. lamps, and the additional consumers 111, making a total of 63,737 lamps and 1,021 consumers. Six motors have been connected during the year, equalling 7½ h.p. The total amount of cable now laid is as follows: Lighting, 58 miles 532 yards; pilot wires, 12 miles. Tramway, 11 miles 870 yards; pilot wires, 8 miles 880 yards. Telephone, 5 miles 680 yards. Five wiring installations have been carried out during the year, the total value of the contracts entered into amounting to £146. The surplus for the year, after paying all charges, amounts to £1,682, and as £1,754 was promised in relief of the rates, there is a deficit of £68. The deficit last year was £520, so together with the £2,000 promised towards the rates for the present financial year the department is committed to £2,588. This represents a gross profit of approximately £12,500. There are several charges included in last year's working which will not appear in the present year, and he anticipates that all demands will be more than met. The maximum amount the Electricity Committee will be able to hand over towards the relief of the rates is £2,000, until a substantial reserve fund has been built up to depreciate obsolete plant. The gross profit for the year is £10,704, as against £7,292 the previous year, being a return of 7·24 per cent. on the capital (outlay during the year being averaged). The interest charges require £4,317, and £4,705 goes towards the sinking fund. Since the inauguration of the undertaking the sum of £15,382 has been paid in reduction of debt. The units sold to ordinary consumers have advanced from 731,777 to 798,450, an increase of only 9 per cent. The units sold to the Tramways Committee amount to 416,043, and to the Southport Tramways Company 120,881. The actual increase of units sold for the year, including public lighting, is 438,437, or 43 per cent. The income per unit sold for all purposes has dropped from 3·36d. to 2·98d. The total working costs per unit sold have decreased from 1·65d. to 1·23d. There has been a reduction on each of the six items, coal having the largest decrease—viz., ·17d. The average price paid for fuel was 10s. 1d. per ton, delivered at the works, as against 13s. 6d. for the previous year. In competition for premier position for the lowest working costs amongst the municipal electricity supply undertakings, Southport now occupies fourth place, as against tenth last year. Owing to the decrease in the price of fuel, the better supply of water for the boilers, and the rearrangement of the distribution system in the town, the working costs for the present year should be amongst the best in the country.

EASTBOURNE ELECTRICITY WORKS.

The report of the borough accountant of Eastbourne for the year ended March 31 last states that the total income from the electricity undertaking, after making due provision for allowances and bad debts, &c., amounts to £15,258. 9s. 1d., and the total expenditure on the same account is £6,219. 8s. 1d., leaving a gross profit of £10,039. 0s. 3d. After defraying the interest and contribution for redemption of debt out of the above profit, there is a net surplus amounting to £3,262. 6s. 10d. This has been added to the profit of previous years, and the amount to the credit of this account is now £5,078. 9s. 7d., as shown in the balance-sheet. The capital expenditure in respect of which permanent borrowing has not yet taken place is £25,294. 5s. 9d., and, assuming that stock is issued on the same terms as last, the sinking fund and interest in respect of this expenditure will be £2,194 per annum, with a further prospective charge in respect of additional capital expenditure to which the Council are already pledged. This, however, will not reduce the profit at present standing to the credit of the revenue account, as it is proposed to make the contribution to the sinking fund out of the profits earned during the year ending March 31 next. It, however, forms an element in the consideration of any scheme for charging a reduced price or any other method of appropriating the profit, as in the near future the charges for sinking fund and interest, in addition to those already borne (and including the £2,194 already mentioned), will reach at least £3,100 per annum. The question of depreciation is one which should receive careful attention. At present no provision is made.

APPOINTMENTS VACANT.

Assistant Engineer.—The Oban Burgh Commissioners will shortly advertise for an assistant engineer at a salary of £100 per annum.

Assistant Superintendents (5), Indian Telegraph Department, commencing salary 4,200 rupees, June 30. See advertisement.

Clerk of Works, Batley Corporation electricity station, 50s. per week, June 27. See advertisement.

Distribution Engineer.—The London County Council will shortly advertise for a distributing engineer at a salary of £350 per annum.

Shift Engineers, Blackpool Corporation electricity works, £125 per annum, June 23; Hull Corporation electricity works, £78 per annum, rising to £130 in two years. See advertisements.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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ELECTRICAL LEGISLATION.

The deputation to the President of the Board of Trade from the Institution of Electrical Engineers on Wednesday last received a courteous hearing from Mr. Gerald Balfour, whose reply is given *in extenso* elsewhere in this issue. The members of the deputation, under the able leadership of Mr. James Swinburne, made a good case to show that the electrical industry in this country had been hindered by legislation. In his reply, Mr. Balfour clearly pointed out, what is equally true, that the electrical legislation of this country is no means the only factor to be considered when looking for the reason why England is to a certain extent behind America, Germany, and Switzerland. This, as he showed, is particularly the case with America, which is a new country, sparsely inhabited, and with towns growing up like mushrooms. The real difference, however, lies in the fact that new developments have few established interests to contend with in a new country as compared to those existing in an older country like our own, in which good progress has been made in other branches of engineering. Still, Mr. Balfour frankly admitted the need of modification in electrical legislation, both for electric lighting and power and for tramways. He stated that the Government had gone so far as to draft two Bills with this object, but that there is no hope of either being proceeded with this year. The one reason for this is evidently that strong opposition is expected to these measures on behalf of municipal authorities, and these authorities have large parliamentary influence. Thus, while there are cases in which local authorities have abused the veto given them by electrical legislation over tramway and electric lighting undertakings, it does not follow that this veto is always abused, and, hence, that the consent of the local authorities should not be required. There is no doubt that if this were done, and every case of new tram ways had to be fought out in a Parliamentary Committee between the tramway promoters and the corporations through whose areas the proposed tramways would pass the procedure of obtaining tramway orders would be even more cumbersome and difficult than at present. It seems to us that the power of dispensing with the consent of the local authority should be placed either with the Board of Trade, or with a small committee of the House of Commons to be appointed annually. If this were done, the committee would soon ascertain the cases in which the local authority was unduly obstructing a public convenience which ought to be granted. The result of the deputation, as far as the demand for a Royal Commission to consider the subject of electrical legislation is concerned, seems hardly likely to be successful, as the President of the Board of Trade does not see his way to recommend the Cabinet to appoint such a commission. There was, however, another matter brought forward in which there is more hope of immediate action than in any prompt change of legislation. The deputation urged that the electrical staff of the Board of Trade ought to be increased, and that the regulations issued by the same Board should be modified. At the present time the quality of the staff is all that can be desired, but the vast amount of routine work in connection with electrical inspection of new tramways, etc., and the holding of enquiries on accidents, completely occupies the staff, so that there is no time for the revision of regulations and for the due consideration of the needs of our rapidly-growing industry. As Mr. Swinburne directly pointed out, the existing regulations were drawn up for lighting and tramway schemes of a parochial scale, whereas they are now hampering the distribution of electrical energy over large areas, and of tramway systems providing intercommunication between numerous towns. We give

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elsewhere in this issue a map of the overhead lines for distributing electricity in California. These lines would not, in our opinion, have been provided for the distribution of energy over the enormous areas involved if the authorities of that State had insisted on the use of underground cables. The area supplied as a whole at the present time in California is, roughly, one hundred and eighty miles long by one hundred and forty miles wide, and it would be absurd to expect regulations drawn up for the control of an electrical system for a town to be applicable for such an area. We trust that the practical outcome of the deputation will be an increase in the electrical staff of the Board of Trade, and that as a result the regulations issued by that body may be promptly revised and extended to meet the requirements of the day. In the meanwhile, it is well to remember that, in spite of the *Times* and the half-penny papers, the electrical industry in this country is not in the state depicted by their expert writers. Taking electric lighting alone, we are far ahead of the United States and the Continent both as regards practice and the cost of supply. As regards power distribution, it is sure that California would not possess the system it does if coal cost there only a few shillings per ton, as it does in our manufacturing centres.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

AIR-PUMPS.

SIR,—In a letter in the current issue of your paper, "T Square" claims to have shown that the four "glaringly misleading statements" made by him, and to which I took exception, are substantially correct. With your permission I will reply to his "arguments" as enumerated by him.

Firstly, I denied his statement that 26in. of vacuum could "certainly not be obtained" with a jet condenser, and he now seeks to prove the truth of his statement by bringing forward what he calls a quotation from Seaton—viz.: "With a jet condenser a vacuum of 24in. is considered good, and 25in. is as much as possible." As a matter of fact, Seaton was referring to the old, now obsolete, marine-type jet condenser, and really wrote "24in. *was* considered fairly good, and 25in. *was* as much as *was* possible with most condensers." The kinder view to take of "T Square's" misquotation of Seaton in his own favour is to ascribe it to inexcusable carelessness. In spite of "T Square's" blind assertion to the contrary, it is a very simple matter to obtain a vaccum of 26in. with a jet condenser fitted with a single-acting vertical air-pump, and there are scores of condensers of the above type giving a vacuum of 27in. every day. As instance, a condenser recently erected by Benj. Goodfellow at Shaw and Jardine's cotton mills, Buttler-street, Manchester, and others which I could name. "T Square's" statement that 26in. of vacuum cannot be obtained with the above type of condenser, is tantamount to an admission that he knows nothing about the subject on which he is writing.

Secondly, I pointed out that "T Square" failed to take into account any air to be dealt with by the air-pump except such as "leaks in." All water that has been exposed any length of time to the atmosphere contains, mechanically mixed with it, a large percentage of air, as it would hardly pay to previously effect their separation. This mixture is, of course, drawn into the condenser. "T Square" says that this air "leaks in." I suppose that after the air has "leaked in" to the water and then into the condenser it "leaks" out again, with a little assistance from the air-pump, and that jet condensers are always "leaky" condensers. This, Sir, is childish quibbling.

Thirdly, "T Square" contests my statement that the dimensions given by him for the diameter of the air-pump is so small; his own figures contradict him. Thus he makes a great point of asserting that the speed of the pump bucket must not exceed that at which the water will follow it, and with this end in view he limits the speed of the bucket to 8ft. per second. The bucket, of course, having the same speed on the down stroke as on the up stroke, the water and air drawn in have to pass through the bucket valve, and he limits the speed through this valve to 10ft. per second. Now, it is a simple matter of arithmetic that in order to obtain this result the area through the bucket valve must be 80 per cent. that of the area of the bucket. "T Square" had better try to design an air pump bucket which will allow 80 per cent. of its area for the passage of water.

Fourthly, "T Square," having lately consulted Seaton, admits that in stating that if a double acting pump were used instead of a single-acting pump it need only be half the size of the latter, he was guilty of an assertion directly opposed to the true facts of the case.

Now, Sir, apart from the consideration of trespassing upon your valuable space, I have neither the time nor the inclination to argue with a person who persists in asserting that 26in. of vacuum cannot be obtained with a simple jet condenser, when he has only to enquire of the first engineer he may meet to find out that the thing is being done every day. Until he takes the trouble to ascertain the truth, or to prove that in the instance mentioned above 27in. of vacuum is not obtained, I shall take no further notice of his future effusions.

In conclusion, his awe-struck remark about my temerity in "launching out into print" is as quaint as his sketch. I should have thought that he would have written that I had "leaked" into print.—Yours, etc.,

E. COSGRAVE.

SIR,—May I venture to make a few remarks in connection with the rather heated controversy which is being carried on in your paper. I am at present with a firm who make a speciality of high-class mill engines, and these engines are almost invariably fitted with jet condensers. The above firm are at any time prepared to guarantee that their condensers will give a vacuum of 27in. when fitted with a vertical air-pump, and 26in where a double-acting horizontal air-pump is employed. If I may say so without giving the appearance of discourtesy, "T Square" has fallen into the not uncommon error of under-estimating the amount of air to be removed by his pump. Every 13 cubic feet of injection water may be assumed to contain one cubic foot of air. After the air has entered the condenser—the vacuum being taken at 26in.—it will expand to about eight times its original volume owing to the rise in temperature and fall in pressure which it undergoes (by Boyle's and Gay Lussac's laws). Thus for every 13 cubic feet of water injected into the condenser, eight cubic feet of air must be pumped out. The air-pump should be designed to deal with this volume of air as well as the water as a perfect pump, and *afterwards* be multiplied by the coefficient of efficiency.

I trust that "T Square" will take these remarks in the spirit in which they are written.—Yours, etc,

DRAUGHTSMAN.

SIR,—As disclosed by the correspondence, there is apparently an absurd difference in practice in regard to designing air-pumps. For instance, well-known authorities make a large allowance in capacity of pump upon the calculated amount of water for condensing a certain amount of steam, the usual thing being to allow five to six times the capacity of what is required by calculation for pumping the cooling and condensed water. On the other hand, the American practice appears to be based on the lines of what "T Square" gives.

Have English engineers been so tied to their grandfather's practice to be so far behind, or is it that the Americans cannot give the duty they guarantee to do, and obtain orders on false statements? Notwithstanding their small capacities, they will solemnly guarantee 26in. and 27in., and declare that in certain installations they are getting 28in. in ordinary work.—Yours, etc.,

June 17, 1902. PUZZLED.

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ELECTRICAL ENTERPRISE AND LEGISLATION.

An influential deputation representing the Institution of Electrical Engineers and the electrical industry generally waited upon the President of the Board of Trade on Wednesday at the offices of the Board of Trade, Whitehall-gardens, on the subject of electrical enterprise and legislation in this country. The deputation, headed by Mr. James Swinburne, president of the Institution, consisted of the following gentlemen: Lord Kelvin, Mr. Sydney Dobson, Mr. S. Z. de Ferranti (vice-president), Sir Michael Foster, K.C.B., M.P., Lord Greenock, Lieut. Colonel Crompton, C.B., Mr. H. E. Harrison, Mr. J. E. Kingsbury, Mr. Henry Lea, Mr. W. Langdon, Mr. A. J. Lawson, Mr. W. L. Madgen, Sir Henry Mance, Mr. H. A. Mavor, Mr. W. M. Mordey, Mr. S. Morse, Mr. W. H. Patchell, Prof. J. Perry, F.R.S., Mr. J. Clifton Robinson, Sir J. F. L. Rolleston, M.P., the Earl of Rosse, Mr. R. P. Sellon, Mr. C. E. Spagnoletti, Mr. A. A. C. Swinton, Prof. S. P. Thompson (past-president), Dr. R. Spence Watson, Major-General C. E. Webber, C.B., and Sir Thomas Wrightson, Bart., M.P. Lord Kelvin having formally introduced the deputation,

Mr. SWINBURNE laid before the President of the Board of Trade the general grounds on which it was urged fresh legislation should be enacted in relation to the electrical industry. He emphasised the fact that they did not come there to oppose municipal trading, but they earnestly asked to have checked the abuse of the legal powers at present enjoyed by local authorities, who, they urged, ought not to have power to prevent schemes even coming before Parliament on their own merits. As to compulsory purchase, they urged that that was now only a legal incubus on the industry. They also asked for simpler, more efficient, and less costly procedure in connection with Parliamentary Committees. In regard to the department of which Mr. Balfour was the head, they were well satisfied with the officers and inspectors of the Board of Trade, but they suggested that a more liberal supply from the Treasury should be made to enable a larger electrical staff to be maintained. The regulations of the Board of Trade governing the electrical industry were behindhand, and they asked that the subject of overhead wires generally might be reopened. The limits of size of converters and trunk mains also required revision. Though they would urge certain improvements in the Department itself, they were very much more concerned in the broader question of the effect of legislation on the industry, which had lagged behind compared with other countries and with other industries in this country. Municipalisation might be a good thing if carried out on sound principles, but without complaining of it, they felt that the powers of local authorities were capable of very serious abuse. They thought, therefore, the effect of municipal trading, as far as it concerned the electrical industry, should be investigated, so that his Majesty's Government might know whether it was a good thing, not for municipalities considered alone, but for the community at large, having regard to questions of engineering, local indebtedness, housing, rapid transit, and concentration in cities. In conclusion, the deputation urged the Government to appoint a Royal Commission to consider the whole question of electrical legislation.

Colonel CROMPTON supplemented the above remarks with a few instances of the manner in which municipal local veto had damaged the interests of private electrical enterprise. He was followed by Dr. R. SPENCE WATSON, Mr. SYDNEY MORSE, Sir MICHAEL FOSTER, and Mr. S. Z. DE FERRANTI, all of whom spoke of the evils of the absolute local veto possessed by local authorities in the matter of electric lighting and tramways, and complained of the inefficiency of the Board of Trade regulations now in force.

Mr. GERALD BALFOUR said he did not think there was any special question he wished to ask. He understood that the regulations complained of referred especially to overhead wires, voltage variation limits, and the one supply through one feeder. With regard to overhead wires, he thought he might say that the Board of Trade would be prepared to consider every case on its merits, and not lay down any hard-and-fast rules. As an example of this he mentioned the case of St. Helens, where overhead wires had been permitted for the purpose of supply. In respect to variation of voltage limits, he was not aware that this point had been brought before him on any previous occasion, but he might say that the Board of Trade was extremely anxious to meet the reasonable requirements of the promoters as far as possible, and he did not think they would find that the Board were anxious to place any unnecessary obstacles in their way whatever. With regard to any change in the regulations, he should be most anxious to receive from the committee of the Institution of Electrical Engineers which had considered this matter any suggestions they might have to offer, and he could promise that those suggestions would receive the fullest consideration at the hands of the Government. He did not quite understand, however, the suggestion that had been made, that the Board of Trade should increase its electrical staff, or in what particular way such an increase would assist the objects the deputation had in view. Of course, if it could be shown that the staff was insufficient for the work it had to perform, then it was a matter for consideration. He did not think, however, that an increase of the staff would enable the Board of Trade to march more with the times than it did, and, as he had already said, he did not know in what way such an increase would promote the objects the deputation had in view.

Mr. FERRANTI said that matters in the electrical industry were changed so much and developments had been so rapid in recent years, that the electrical staff of the Board of Trade had a very difficult task to keep up with it and to consider a change of regulations from time to time. He thought these regulations should be changed at certain periods, or at least modified so as to fit the circumstances of the case. With regard to the overhead wires, for instance, promoters did not want to stand the chance of the regulations being altered when a scheme was going commercially. He suggested that the regulations should precede the demand—that was to say, that the Board of Trade should investigate what was being done in other countries, and should see that the regulations did not in any way hamper the industry.

Mr. BALFOUR: You mean that the staff is so much overworked it cannot keep pace with the progress of the industry.

Mr. SWINBURNE thought the Institution would welcome the opportunity of being at liberty to furnish the Board of Trade with a statement of the regulations they should like to have considered.

Mr. BALFOUR: I should be very glad to have such a statement.

Mr. SWINBURNE: In answer to what you have said, sir, I think the mere fact that things are in such a position is in itself an admission that the electrical staff of the Board of Trade is insufficient to keep up with the times and to originate regulations.

Mr. PATCHELL said it was the uncertainty of the regulations which tied them up For instance, they thought they were restricted by the regulations in the amount of voltage they were entitled to use, and also as to what thickness of insulation to fit that voltage was required. At the present time the regulations as regards extra-high tension were in a state of uncertainty, and it was not clear whether they applied to extra-high tension or only to high tension. Another matter was as regards the earthing of the neutral point of the three-phase system. From an engineering point of view this was bad.

Mr. BALFOUR: You urge that the regulations are not so precise as to carry their meaning on the face of them?

Mr. PATCHELL said that was so

In the course of some further discussion Mr. BALFOUR stated that the regulations were only meant to apply to ordinary cases, exceptional cases being dealt with on their merits. It was impossible to do this if any hard-and-fast rules were laid down.

Mr. PATCHELL suggested that as what Mr. Balfour called exceptional cases had become quite ordinary cases by the development of the industry, the time had now come to consider a change of the regulations.

Mr. BALFOUR then made his reply on the question of

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legislation. He said: Lord Kelvin and Gentlemen,—I fully recognise the very great importance of the subject which you have brought before me to-day, and to a very large extent I am in sympathy with much that has been said by the various speakers who have addressed me. I am afraid it is an undeniable proposition that the electrical industry in this country is behind what it is in America, in Germany, and, perhaps, some other of the Continental countries. I doubt, however, if that backwardness is to be entirely, or, perhaps, even chiefly, attributed to defects in our legislation, or to oppressive regulations or to the abuse of their powers by local authorities. I do not for a moment mean to contend that the legislation applying to the electrical industry is not susceptible to considerable amendment, or that our regulations may not in some instances have proved too restrictive, or that the local authorities have not abused their powers. I doubt moreover whether that really accounts for the comparative backwardness of this country in electrical industry in relation to other countries, such as America, Germany, and Switzerland. This must always be recollected: America is a new country, very sparsely inhabited, with towns growing up like mushrooms, above all, with comparatively few established interests to contend with. The field is open, and capital can rapidly flow in through those channels. Things are different in this country. It is an old country, with a very dense population, with a large number of strongly established interests, and established interests always produce that instinct of conservatism which we have very strongly developed in this country. I believe it is these fundamental conditions rather than any actual legal enactments, which have tended to retard the development of the electrical industry in Great Britain as compared with the same industry in other countries. But, while I hold that view, I do not for a moment contend, as I have already said, that changes in the direction indicated might not be of a very beneficial character. It appears to me, however, after listening to the various speakers, that the really important question is not so much that of any impediments thrown directly by the Legislature in the way of the development of the industry, as of the power which the Legislature has given the local authorities to veto schemes. Now, with regard to this matter I have got to consider two branches of the subject—electric supply and electric traction. In the case of electric traction on tramways, so far as these matters are still determined by the provisions of the Act of 1870, the local authority has an absolute veto—an absolute veto as regards provisional orders—and by a Standing Order of the House of Commons, it also possesses an absolute veto upon any measure which it is proposed to promote by Bill. To some extent the evils flowing from that state of things have been limited by the adoption in many cases of light railway procedure, even where the scheme is, in the proper sense of the term, a railway on the road or a tramway. But it is true that the Light Railway Commissioners, and also the Board of Trade, have considered themselves more or less bound by the legislation laid down in the Tramways Act and the Standing Order. I do not think that they have gone to the length of giving to the local authority absolute veto, but undoubtedly they are influenced by the legislation on this subject. As regards traction, this subject has been investigated of late by a departmental committee appointed by the Board of Trade, on which both promoters and local authorities were represented. As the result of the deliberations of that committee a Bill has been drafted which, I think, will go very far to meet all the reasonable objections which have been urged against the present powers of the local authorities to-day. I trust that that measure when introduced will prove satisfactory to both parties—both to promoters and local authorities. But, gentlemen, it is idle to conceal from ourselves that the local authorities represent a very great power in this country, and they can see that it is strongly to their interest to possess, if not absolute veto, a *locus standi* which will enable them to have their views freely expressed. I would remind you, as an illustration of the difficulties attending this matter, that the other day when an attempt was made to alter the Standing Order in the House of Commons, the motion giving effect to that view was received in so hostile a manner that practically the mover of it did not bring it to the vote. I only remind you of that to show the difficulties which stand in the way so long as local authorities take so strong a view of the powers which ought to be reserved to them in connection with these enterprises. Nevertheless, in spite of that refusal of the House of Commons to alter this Standing Order, I have considerable hope that the compromise arrived at by the Committee, and now embodied in the Bill to which I have referred, will be found satisfactory to all parties, and be an adequate solution of this difficult question. As regards electrical supply, the case is somewhat different. The House of Commons Committee of 1898 has already sat on the question of electrical supply, and has made a series of recommendations. Where an enterprise for the purpose of electrical supply is promoted by Bill, I believe that the committees of Parliament now usually act upon the recommendations of that committee, but legislation would be required in order to enable the Board of Trade to adopt the recommendations of that committee in connection with provisional orders. We have also got a Bill ready to give effect to the recommendations of that committee. I cannot hold out much hope, I am afraid, that we shall be able to pass either that Bill or the other Bill to which I have referred during the present session, which, as you know, is already occupied with important measures. But it is the desire of the Board of Trade, when opportunity may offer, to introduce and to press both of these measures, and, therefore, I think you will see that we are by no means insensible to the recommendations you have brought forward, and that of our own accord we have already taken preliminary steps to introduce fresh legislation. I would say no more about the regulations, because that matter has already been referred to in the discussion we have had. I will only repeat that the Board of Trade will always be happy to listen to any suggestions that may come from so important a body as that represented here to-day, and that we are really as anxious as you can be to secure that the public interest shall be properly served by the development of that great industry which you represent.

Mr. SWINBURNE pointed out that what the deputation was asking was that a Royal Commission should be appointed to consider the whole subject.

Mr. BALFOUR said he would be quite ready to consult his colleagues on the matter. It was a question for the Cabinet, not for him, and he would put the views of this deputation before it. At the same time, he did not feel in a position at the present time to say that he should recommend his colleagues to adopt that suggestion.

Colonel CROMPTON reminded the President that he had said nothing in his reply upon the question of the electrical staff of the Board of Trade.

Mr. BALFOUR: That is a matter which I will carefully consider.

Mr. SWINBURNE having thanked Mr. Balfour,

The deputation withdrew.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

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QUESTIONS.

491. Explain in detail why triple-concentric, lead-covered cables cannot be used for three-phase work. What advantages are obtained by using three-core cables for this work?—E. M.

492. Is there any remedy, other than a metallic return, for reducing the cross-talk of a single earth-return telephone circuit, whose line runs parallel for 10 miles with other telephone wires, which have in no way any connection to the telephone in question. Loud noises, and other conversations, are heard even better than its own.—S. B. W.

ANSWERS.

Question No. 485.—Why is the iron regulating resistance of a Nernst lamp enclosed in a vacuum tube?

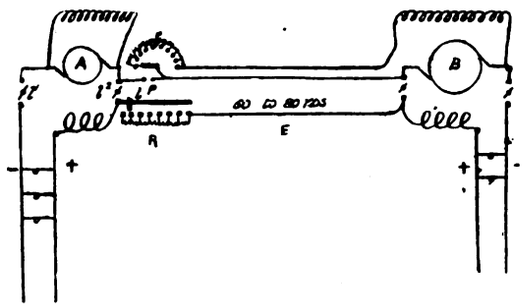
Best Answer to No. 485 (*awarded* 10*s.*).—It is a well-known fact that an ordinary electric incandescent lamp consists of the filament, composed of some substance treated with carbon to make it conductive, which is enclosed in a vacuum in a glass bulb; this is for the reason that when the filament became incandescent, it shall not be burnt up. Now, nothing can burn without the presence of oxygen, so if all the oxygen be exhausted from the bulb, it cannot be burnt up. Air contains oxygen as well as several other gases, nitrogen, carbon dioxide, argon, etc., to a greater or less extent, so all the air is exhausted from the bulb, and then the filament cannot be burnt up or oxidised. Exactly the same is the case in the iron regulating resistance in the Nernst lamp. When the current is switched on this gets hot, and when hot would be more readily oxidised than when cold if exposed to the air. So this, like the filament of a lamp, is enclosed in a vacuum. Though the heated iron wire may not get hot enough to burn up straight away if in air, it would gradually get oxidised right through, and then would act like a complete break in the circuit, as it would not conduct, and being in series with the glower, this would go out. It also might fall to pieces. The substances of which the glower is composed have a *negative* coefficient of resistance—that is, are more conductive the hotter they are—so if a current were passed through this alone, it would burn out very quickly. To counteract this, something must be put in series with it with a slightly bigger *positive* coefficient of resistance—that is, the resistance of the latter body increases slightly more than the resistance of the glower diminishes for a given rise in temperature of the glower. This being so, it is impossible, with the voltage for which the glower is designed, for the current to get so big as to burn the glower out. The substance satisfying these conditions as to slightly greater *positive* coefficient of resistance than the glower's *negative* coefficient is iron; hence the regulating resistance of a Nernst lamp consists of iron wire in a vacuum tube.—E. R. ALEXANDER.

Answer to No. 485 (*awarded* 5*s.*).—If the iron were not enclosed in a vacuum tube, it would tarnish and oxidise very rapidly, even if the air surrounding it were always dry. Black scales of oxide would be formed on its surface, and it is very doubtful whether its life would ever be so long as 24 hours before it failed. It has to be remembered that the temperature of the fine iron wire is very nearly red heat when the current is passing. For example, in the one-ampere size of Nernst lamp sold by the Electrical Company, Charing Cross-road, for use on 200-volt circuits, the iron regulating resistance takes 20 volts and the luminous rod or glower 180 volts. Hence 20 watts, or half the power taken by an 8-c.p. lamp, is expended in the iron wire, and therefore its temperature is very high, and it would oxidise in the open air with great rapidity. When enclosed in a vacuum tube I have never known one to fail, and have had one in circuit with three different glowers for over 1,000 hours, and the only sign of wear is the tarnishing of the brass cap at the end of the glass tube.—J. C. R.

Answer to No. 485 (*awarded* 5*s.*).—The resistance of the filaments used in Nernst lamps varies inversely with the current, in the same way as the resistance of the arc does. Consequently, if the potential difference applied to filament increases ever so little, the current will increase; this will cause a decrease in the resistance of the filament, leading to a further rise in current, and so the lamp becomes unstable. Similarly, if the potential difference decrease a little, the current will decrease and resistance increase, causing a further reduction in the current, the lamp again becoming unstable. To obviate this instability, a steadying resistance in series with the filament is necessary, acting in the same way as the steadying resistance in an arc lamp. In order that this resistance shall be as compact as possible, it is made of iron and run at such a current density that it is maintained at a red heat. It has to be sealed in a vacuum tube to prevent oxidation and consequent change in resistance. In the latest form of Nernst lamp a different form of resistance is used, which does not need to be enclosed in a vacuum.—PERCY H. HARDING.

Question No. 486.— I have two dynamos in separate engine-houses, distant about 60 or 80 yards, both compound-wound, one 200 volts, 100 amperes; the other 250 volts, 200 amperes. I might say that the engine driving the larger machine doesn't govern very accurately, the variation in voltage being as much as 15 or 20. Can I run the two in parallel at 220 volts? If so, I should like all necessary diagrams and particulars; if not, the reasons why. Of course, I mean for each machine to remain where it is. The machines are by different makers.

Answer to No. 486 (*awarded* 7*s.* 6*d.*).—In reply to question by "Doubtful," No 486, I think the following method is the nearest solution of this problem. In the accompanying diagram, A is the dynamo designed to give 100 amperes at 200 volts—total output, 20,000 watts; and B, the one to give 200 amperes at 250 volts, or 50,000 watts.



"Doubtful" must not forget that compound-wound dynamos, if well designed, only work satisfactorily under the conditions they were designed for. He wants A machine to give 20,000 watts at a potential of 220 volts, which means about 90 amperes at 220 volts, but this reduction in the amperes would mean a corresponding reduction in the ampere-turns of the series coil, and this, instead of reducing, we want to increase. B machine is required to give 50,000 watts at a potential of 220 volts. This works out about 227 amperes at 220 volts. This increase of the amperes would mean an increase in the ampere-turns of the series coil, if we neglect increased lost volts in armature and cross ampere-turns. What is wanted to neutralise these two effects, which act in opposition to the present requirements, and which are in themselves exactly opposite in their action, is some means whereby the increased current in dynamo B can be made to give increased excitation to dynamo A, without in any way increasing the ampere-turns of its own series coil. The first thing to do is to insert a resistance in the shunt of B machine, so that it may be cut down to 200 volts on open circuit. The series coils of A machine must now be put in parallel with the series coils of B through a variable resistance, R.

Suppose it is desired to parallel A with B: the latter we will assume is already carrying load at 220 volts and, say, 225 amperes, to obtain which the shunt resistance, r, had to be inserted to compensate for the over-compounding effect due to the increased amperage. Run up A machine to full speed and voltage—viz., 200 volts—turn switch, l, to first contact of R; this puts current through series coil of A and increases its potential, which can be adjusted by means of rheostat, R, to the same potential as B The effect of shunting current past the series coils of B will cause a drop of potential on B, which must be compensated for by cutting out all the shunt resistance, r. As soon as the potential of A is the same as B, switches l^1 l^2 can be made, and the two dynamos will now divide the load in proportion to their horse-power, the lead, E, simply acting as an equalising bar in the usual way. It is possible the dynamos will not show the same self-regulating properties as when running separately, owing to the change in potential and

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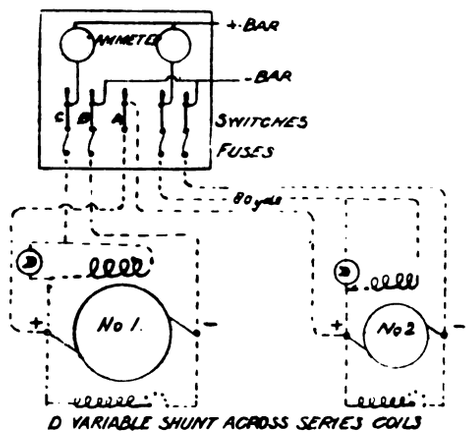
current creating an alteration in their characteristic curves. If there were no losses, the voltage when the two are in parallel would be $\frac{200 + 250}{2} = 225$ volts, but owing to increased drop in armature of B machine and cross ampere-turns of same (which through the shunting of increased current past its series coils and round the series coils of A) is not compensated for, we may safely allow a drop of five volts.

The above arrangement will allow of A machine being paralleled with B, B machine being put in parallel with A, B run independently at 200, 220, or 250 volts; but A can only be made to give 200 volts unless in parallel with B. I have placed resistance, R, and shunt rheostat, *r*, in the engine-house of A dynamo, because I think it will be most suitable; but it can be placed in engine-house of B if desired, thus saving 60 or 80 yards of shunt lead and return. "Doubtful" will require a paralleling voltmeter with jack terminals to fit into terminals, *p*, also 60 or 80 yards of armoured cable, say $^{7}/_{20}$ S.W.G., and the two resistances referred to above.—J. C. S.

Answer to No. 486 (*awarded 7s. 6d.*).—To run the machines in parallel, the first thing to do is to so alter the machines so that they will each give 220 volts at their terminals. This may be accomplished in several ways: (1) by fixing smaller diameter pulley on No. 2 and larger diameter pulley on No. 1, thus increasing the speed of No. 2 to give the 20 extra volts, and reducing speed of No. 1 to reduce volts from 250 to 220; (2) by reducing the air-gap between the armature and pole-pieces of No. 2 and increasing same in No. 1, if the design of the machines permits; (3) by increasing and decreasing the speed of the engines; (4) by inserting resistance in the shunt field of No. 1 and removing it from No. 2.



D VARIABLE SHUNT ACROSS SERIES COILS

We will now assume that the two machines give 220 volts on open circuit, and that the series coils will maintain this pressure at full load; a switchboard similar to the accompanying sketch should be fixed preferably near the larger machine, as we shall then only require mains between the engine-houses to convey the energy from the small machine. Three cables of sufficient cross-section to carry 100 amperes without appreciable loss will have to be run from No. 2 to the engine-house containing No. 1 machine and coupled up as shown on sketch. The cable coupling the positive brushes of each machine directly together is termed an equaliser, as it equalises any difference of potential between these two machines and keeps the same pressure across their shunts; but it also prevents any reversal of polarity in either machine, and when the switch A is closed (which should be the first operation) current from the running machine is sent round the series coils of the standing machine, and ensures the polarity being the same in each case. An ammeter should be coupled in circuit with each machine so that the attendants can observe if they are each taking their respective load, and a variable resistance should be connected as a shunt across the series coils to adjust the load on each machine. The hunting of the large engine should be stopped. It may be that a larger flywheel is required, or the valves and governor require adjusting. If No. 2 is loaded up, and it is required to couple No. 1 in parallel, run up No. 1 to about normal speed, close switches A and B, then adjust the field of No. 1 so that its voltage is about equal to that of No. 2, then close switch C, and adjust the shunt across the series coils so that No. 1 gets its share of the load.—A. C.

Answer to No. 486 (*awarded 5s.*).—The arrangement proposed of working the two dynamos in parallel is possible, but would be costly to carry out, and not eminently successful in operation. In order to understand what connections are necessary, and why the working would not give the best results, it will be advisable to consider the necessary equipment for working two compound dynamos under normal conditions in parallel. Fig. 1 shows the ordinary connections for running two compound dynamos in parallel. The connections are as follows: positive or negative terminals of both dynamos are directly connected to one 'bus bar; the corresponding compound terminals are connected to the other 'bus bar, a switch, S S^1, being inserted in each lead, while, lastly, the two machines are further connected by a lead joining together the brushes not directly connected to the 'bus bars, a switch being inserted in this lead. This lead is shown in the figure by the line *h h*. Suppose, first of all, that this lead is omitted when the machines are both running in parallel, the currents in the various parts will flow in the direction shown by the arrows, but let dynamo A slow down, motoring of this machine will at once take place, and it is easy to see that the current will flow through the series turns in the wrong direction, and so reverse the polarity of the magnets. In order to prevent this, the equalising bar, *b b*, is inverted; the resistance of this must be negligible compared with the resistance of the compound coils of either machine. The reason of this is obvious: in case current flows from one machine to the other, it must be made to flow along this equalising bar, and not through the 'bus bars, in order to prevent reversal of magnetisation.

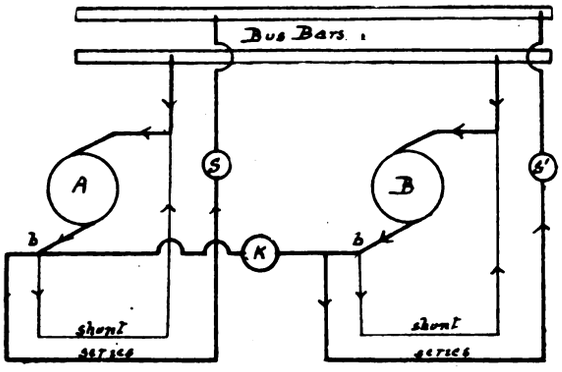


FIG. 1.

This is where the arrangement proposed will be expensive. The paralleling operation must be conducted at a switchboard. If the distance between the two dynamos is small, the leads representing the equalising bar may be comparatively light; but if the distance is 80 yards, the leads must be excessively heavy. A lead consisting of $^{61}/_{16}$'s would carry 200 amperes under normal conditions; this would have a resistance of 0·0095 ohm, which is a serious matter in paralleling operations. Assume that the resistance of the series turns on one machine is ·002 ohm, then the resistance of the circuit through these coils and the 'bus bars is 0·002 + 0·0095 = 0·0115 ohm; while through the equalising bar the resistance is 0·0095 ohm; or the ratio is as 100 : 82. Under these circumstances the resistance of the equalising bar is not negligible, and a heavier cable, say a $^{91}/_{13}$, having a resistance of 0·0032 ohm for 80 yards, must be used; this will greatly affect the cost, and even this size of cable errs on the light side, as the ratio of the two paths is then as high as 100 : 36.

Supposing, however, that this is done; if dynamo A is running, and it is required to switch B in in parallel, the switches K and S^1 must be open and the dynamo run up to the same voltage as that generated by A, switch K must then be closed, and afterwards switch S^1. To withdraw B from parallel the operation must be reversed. Assuming that B is the large dynamo, what will be the result of so working? In the first place, you can't have two machines—one at 200 volts and the other at

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250 volts—working in parallel, and, therefore, the voltage of B must be brought down to 205 by means of a shunt resistance. As long as the load is steady the machines will run satisfactorily, but as soon as the load varies, owing to the bad governing of the engine driving B, the trouble will begin. If one machine slows down, the other takes an undue share of the work, and assists in driving the slow machine as a motor, thus speeding it up (1) by lightening its load, and (2) by assisting in its driving. Under standard conditions this will so adjust matters that no difficulty arises, but with B having an irregular drive, if the load is largely altered there is a great probability of the two machines not properly adjusting themselves to the new conditions and one machine becoming grossly overloaded, and so blowing the fuses.

To sum up the matter: if a heavy equalising bar (or rather equalising lead) is put in, the two machines will with steady loads run satisfactorily in parallel, but not well with a variable load unless the engine driving B is made to govern properly. Though, perhaps, apart somewhat from the question, the writer does not see the advantage of paralleling the dynamos; probably each has at present its own circuit, and it is very easy to arrange these so that either or both circuits may be supplied from one or other machine at will. All that is necessary is to bring a pair of leads from each dynamo to each switchboard, and to connect the 'bus bars of each switchboard to either machine at will by means of a two-way double pole switch, as shown in Fig. 2, which diagrammatically shows

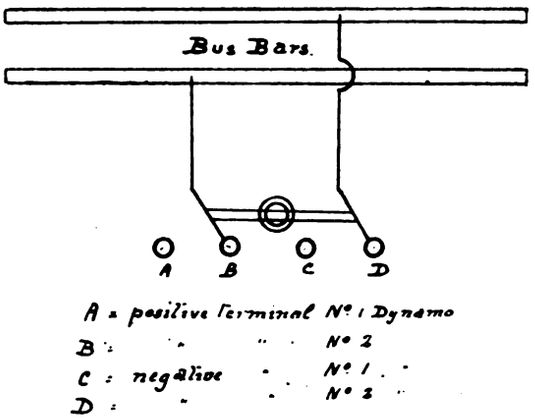
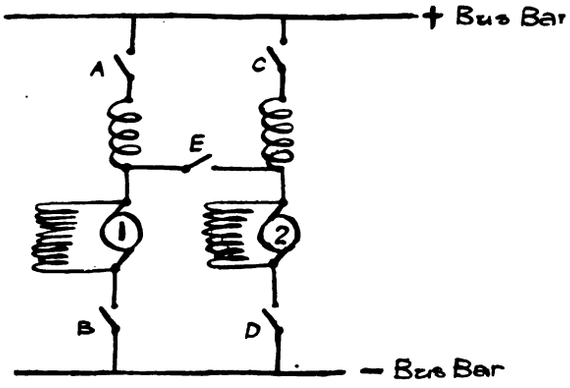


FIG. 2.

the arrangement of either switchboard. With such an arrangement there will be no danger of putting the machine in parallel, while all the ordinary conditions of working will be met.—M.

Answer to No. 486 (*awarded* 5*s.*).—The question proposes something which in ordinary practice could not be done. Two compound machines which have to run in parallel must be specially designed to do so. They must have the same characteristic—that is, their total volts at the same proportion of full load in each must be the same. Further, the resistances of armature and series must in the two machines be inversely proportional to the outputs, so that at the same proportion of full load in each the volt drop in armature and series may be the same, and thus the terminal volts would be the same. This would ensure the two dynamos taking up the load at a rate proportioned in each to their total possible output. If this does not happen to be so, then trouble arises. Suppose, for instance, that the internal resistance of the larger machine were less than would be required by the above rule; then, supposing the total volts in each to remain the same, it would take more than the correct proportion of the load to bring down the terminal volts to the same value as those of the smaller machine, and the smaller machine would be doing less than it should, until finally it would cease to give any current at all. As it is very improbable that two machines by different makers, made independently of each other, would possess the desired characteristics, it would not be advisable to run these two in parallel. A further difficulty would be caused by the bad governing of the engine, as when the volts varied by the large amount given, the dynamo would alternately be giving out no load and full load, and possibly large over-load, and if there were, as is usual, automatic minimum cut-outs at B and D, it would be the rule for these to be continually falling out. These are a necessity, for otherwise, if for any reason the volts of one of the dynamos fall so low that it gives no current, it would thereafter start to run as a motor, which is undesirable, and therefore it should be arranged that the dynamo is cut out at no load automatically.

A further reason why the dynamos should not run in parallel is because of the distance between them. In running compound dynamos in parallel, there must be an "equalising connection" between the brushes which are connected to the series winding—which must be arranged so as to be all on one pole of the machine—and this connection should be of negligible resistance. The connection is put there so as to keep the current in each series winding flowing in the same direction, and to prevent thus the reversing of the magnetism, or its abnormal weakening, if the volts of one machine fall very much, and cause it to take a reverse current. But if the resistance of the path through E is considerable, compared with the resistance of the series winding, there would in the case of any inequality be such a drop in volts along E as would make an appreciable current go along the path A C as well, and this would defeat the object of putting E in at all. Now, the resistance of a cable 60 or 80 yards long must be large compared with the resistance of a series winding, unless the cable is made so large as to be much too costly. Hence, for all three reasons named—the



dynamos being by different makers, one engine governing badly, and the dynamos being far apart—it would be most unwise to trust to their running in parallel for more than, say, five minutes without burning up.—T. C.

TRADE NOTES AND NOVELTIES.

The Premier Lamp.

The Premier Electric Lamp Company have forwarded to us an interesting little booklet which deals with the lamp manufactured in this country by them. The booklet in question is intended to educate the public in the selection of incandescent lamps, and to teach them that any judgment based on the cost alone or on the life of the lamps is absolutely useless. The Premier Lamp Company claim for their standard lamps an efficiency of 3·2 watts per candle If, however, the lamps are to be used on tramcars, the firm advocate a 3·75 watt per candle-power, on account of the arduous conditions under which these lamps have to work. The following figures as to the variation of the candle-power and efficiency of the Premier lamp, with slight variations in voltage, will be of interest, especially to those consumers who get higher voltage at their terminals than is declared by the undertakers:

Volts.	Candle-power.	Life in hours.	Efficiency.
100	16	1,000	3·2
102	17¾	680	3·0
104	20	450	2·8
106	22¼	300	2·6

The Howard Conduit.

We recently described the Howard Conduit Company's system of asphalt conduits and troughing for underground mains. We are pleased to hear that the orders for these and the accessories to be used with them are coming in well. These troughings and conduits have been, or are being, laid at the following places: Windsor, Trafford Park, Bournemouth, Nottingham, Eccles, Lancaster, etc.; and they have also secured the contract for one year's supply of their asphalt troughing from the Salford Corporation, and the whole of the troughing for the Leatherhead electric lighting scheme. The firm have just issued a new catalogue, which is worthy of careful study on the part of all mains engineers.

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LEGAL INTELLIGENCE.

BOURNEMOUTH TRAMWAYS DISPUTE.

The case of the Attorney-General *v.* the Mayor and Corporation of Bournemouth was heard before Mr. Justice Swinfen-Eady in the Chancery Division of the High Court on Friday. The action was taken at the instance of the Poole and District Electric Traction Company, who claimed an injunction to restrain the defendant Corporation from constructing a certain tramway, on the ground that the statutory power of the Corporation to construct the particular tramway was determined. On Aug. 6, 1900, an Act of Parliament was passed to empower the plaintiff traction company to construct and work tramways between Christchurch and Bournemouth. On the same date an Act was passed confirming an order authorising the Bournemouth Corporation to construct tramways in their borough. One of the tramways (No. 2 in the Act) authorised by the traction company's Act was the same in position as one (No. 6 in the order) authorised by the Corporation's provisional order. But the company were prohibited from commencing at once to construct this tramway, and their right to construct it at all was to cease if the Corporation constructed their tramway (No. 6) within two years from the confirmation of the provisional orders. By the Tramways Act, 1870, Section 18, it is provided that the powers given by a provisional order to make a tramway are to determine, among other events, if within one year from the confirmation of the order, or within such shorter time as is prescribed in the same, the works are not substantially commenced. The plaintiff company contended that the Corporation had not substantially commenced the works within the prescribed period, because nothing had been done on the ground, no work had been done on the street towards making the actual tramway, and no buildings had been commenced for a generating station or other purpose in connection with the working of the tramway. The Corporation, however, had acquired a site for works and offices, and had contracted with the British Thomson-Houston Company for dynamos and machinery to be put in hand immediately by agreement actually executed April 18, 1901, and by agreement dated May 10 had contracted with the British Westinghouse Company for the supply of tramcars to be put in hand at once. Preliminary work in the preparation of plans of buildings had been also made, and steps taken to procure the necessary loan.

For the defendant Corporation, it was contended, in the first place, that as no notice of any finding of the Board of Trade had been published in the *London Gazette* of any default by the Corporation in substantially commencing works, and notice in the *London Gazette* was made by Section 18 of the Tramways Act conclusive evidence of such default, no other evidence of default was admissible.

Mr. Justice Swinfen-Eady, in giving judgment, said that in his opinion the works which had to be substantially commenced within a year from the passing of the confirmatory Act were not confined to works on the ground where the tramways were to be laid and the land acquired for generating stations and other purposes necessary to work the line. It might be desirable that the actual laying of the tramways should be postponed as long as possible, so as not to interfere before it was necessary with street traffic. However that might be, in his Lordship's judgment the works mentioned in Section 18 of the Tramways Act, and which were defined by an incorporated section of the Lands Clauses Acts as works authorised by the special Act, included the construction of machinery and works done elsewhere for the purpose of equipping the tramway. Here the Corporation had acquired land, had well within the year entered into a contract with a responsible firm of manufacturing engineers for the supply of dynamos and machinery to be constructed abroad, and had entered into a similar contract with other responsible manufacturers for the supply of tramcars. He also decided in the defendants' favour on the other point.

Judgment was accordingly entered for the defendants.

PERSONAL INJURY CLAIMS.

In the Dublin Nisi Prius Court last week, before the Lord Chief Justice and a special jury, an action was heard at the suit of George Thomas Hill against the Dublin United Tramways Company. The plaintiff claimed £1,000 damages for personal injuries alleged to have been sustained by a collision between one of the defendants' trams and a bicycle which plaintiff was riding at the time. Defendants denied that plaintiff had sustained any injuries, personal or otherwise, and pleaded negligence on the part of the plaintiff, and that the occurrence was the result of an accident.

The jury found for the plaintiff, and awarded £100 damages, and udgment was entered accordingly.

In the Liverpool County Court, on Monday, Judge Shand and a jury heard a claim by Mr. F. Hartley, a solicitor, against the Corporation for damages in respect of injuries sustained, as alleged, through being jerked off a tramcar.

The **Plaintiff** stated that on the evening of March 24 he took a Smithdown-road car at the corner of Whitechapel to proceed to his home in Chatham-street. Trusting to the car stopping at the usual station at the corner of Myrtle-street and Catherine-street, he made ready to alight, and was standing on the platform holding the upright bar. The car, however, failed to stop, upon which the plaintiff determined, in his own mind, to alight at the next stopping-place. He alleged that the car was driven round the corner in a negligent fashion, and at such a speed as to cause a considerable jerk, the result of which was to throw him into the street. Not only did he fall into a heap of mud, but sustained some laceration of the face, as well as injuries to his wrist and leg. He claimed £30 as damages for the injuries, and, in addition, the sum of seven guineas, the amount of his doctor's bill.

The jury returned a verdict in favour of the plaintiff for the amount claimed.

UNLICENSED CAR DRIVERS.

At the Liverpool City Police Court this week, Fred H. Kent, tram conductor, was summoned by the Corporation for having on the 6th inst., without lawful license, driven an electric car in Walton-vale so as to endanger the lives of persons; and Wm. Anderson, tram driver, was summoned for aiding him in the same without a lawful excuse.

Mr. E. C. Sanders, who prosecuted, stated that the defendant Kent was up to recently a conductor on the Corporation electric cars. He had been off duty for some weeks, and had been told by his doctor that it would be better for his eyes if he was a driver instead of a conductor. Before a person was allowed to drive, it was necessary to get a permit from the general manager. On the day named he asked a driver on this route to let him drive, but was refused, as he had no permit. In the other instance, Kent represented that he had a permit, and on this the driver allowed him to operate, but shortly afterwards stopped him.

The Bench characterised it as a serious case, and fined Kent 40s. and costs, and Anderson 5s. and costs.

A STREET-BOX EXPLOSION.

Before Judge Addison, K.C., in the Southwark County Court on Monday, Elizabeth Ruler, a married woman, sued the Mayor and Corporation of Southwark to recover damages for personal injuries sustained by her on April 1 by an explosion, which it was alleged was brought about owing to the negligence of the defendants in the control of certain electric wires and cables.

Mr. Drury, for the plaintiff, stated that on the night of April 15, at about half-past nine o'clock, she was at the corner of Long-lane and Great Dover-street, Borough, when suddenly she saw a very bright light, heard a noise, and was knocked down. At the same time the cover of an electric light street box was projected through the air. The plaintiff endeavoured to rise, but she fell again, and did not remember anything more until she found herself in bed at her home some time later. She had not been able to do any work since, and the doctor considered that it would be unwise even for her to go out alone. There was no dispute that the electric cables belonged to and were controlled by the Borough Council, and therefore all he had to do was to show that the accident happened, the onus being upon the defendants to show that it resulted from causes over which they had no control.

At the conclusion of the evidence the case went to the jury on the point as to whether the plaintiff had made out her case in regard to the accident to her.

After a short deliberation the jury found for the defendants, and his Honour gave judgment accordingly with costs.

SUNDERLAND TRAMWAYS CASE.

Before Judge O'Connor in the Sunderland County Court, John Elrick, builder and contractor, sued the Mayor and Corporation of Sunderland for £29. 11s. 4d. damages to his horse and cart sustained in a collision with an electric car in October last.

The Corporation admitted liability for the accident, the only question being the damage sustained by the horse, and eventually his Honour found for the plaintiff for £22. 3s. 10d.

COMPANIES' MEETINGS AND REPORTS.

ELECTRICAL POWER DISTRIBUTION.

The general meeting of this Company was held at Hamilton House, Victoria-embankment, on Monday, Mr. Emile Garcke presiding.

In moving the adoption of the report, the **Chairman** referred first to the paragraph which dealt with the offer made by the British Electric Traction Company. He explained the circumstances which led to the formation of the Company to do work which at the time was considered to be outside the scope of both the British Electric and the Brush Companies. The initial risks and responsibilities were undertaken by himself and three other directors. They received 200 deferred shares, for which they paid cash, but which were entitled to certain rights after a very ample dividend had been paid. When it was found that the existence of those shares was a bar to the raising of necessary additional capital, an agreement was arrived at that the Company should have within 10 years the right of extinguishing the special privileges attached to those shares by the payment of £10,000 in cash. This was the position when the British Electric and the Brush Companies decided to take a large interest in the Company's further development. The terms offered were recommended as fair and impartial. As managing director of one company and chairman of the other, he had received a few protests from shareholders in each company, complaining that their respective companies had not been fairly treated. The shares of the Electrical Power Company cost the shareholders £11 each, both ordinary and preference. The shareholders were under the scheme to exchange an ordinary share for a British Electric share, which now stood in the market at £14, and they were asked to exchange a preference share for a British Electric preference share, which now stood in the market at about £12¼. The offer which the British Electric Company made to the Electrical Power Company left the matter open for each share holder to accept or decline. If he did not accept the exchange of shares he would be in a still smaller minority than he was at present.

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The British Electric Company and the Brush Company held 14,000 out of the 15,000 ordinary shares, and about half the preference shares in the Electrical Power Company. The latter possessed Acts of Parliament to carry on work in an important industrial centre in the county of Durham and in North London. They possessed 17 electric lighting and three tramway and light railway orders, while three provisional orders had received the sanction of the Board of Trade, but were awaiting parliamentary confirmation. In the short time they had been at work they had erected eight electrical power stations in various parts of the country.

Mr. W. L. Madgen seconded the motion, which was adopted.

CHADBURN'S (SHIP) TELEGRAPH.

The annual general meeting of shareholders in the above Company was held at Liverpool on Friday, Mr. William Chadburn presiding.

The **Chairman,** in moving the adoption of the report (*vide* last issue), said it would be noticed that the profits available for dividend, £8,765, were somewhat less than at the end of the previous year. The shareholders would remember that at the last annual meeting he had intimated this would probably be the case, and explained the reason, which was that in last year's accounts it had happened that a good many contracts had been completed just in time to bring the profits within that year's accounts. During the past year this had not been so fully the case ; but he was happy to assure them that the business as a whole was quite as satisfactory as when they met last year, and, indeed, the auditors, who had gone most exhaustively into the position of the Company, reported that the year just ended was as good as any previous year. Under the circumstances the directors felt justified in paying a dividend at the same rate as last year. Since the close of the year a number of contracts had been completed, some for large ships representing a considerable amount of money, but those could not be brought into last year's accounts. They would, however, come into the next accounts

Mr. J. Orford seconded the motion, which was carried.

BRITISH ELECTRIC TRACTION.

The ordinary general meeting of the shareholders of the above Company was held at Hamilton House, Victoria-embankment, on Monday, Sir Chas. Rivers Wilson presiding.

The **Chairman,** in moving the adoption of the report (which will be found in our last issue), remarked that the business of the Company had extended in almost every direction. Notwithstanding the larger capital on which they had had to pay, they had maintained the dividend at 9 per cent., and had increased the carry forward by about £6,000. With regard to their 55 undertakings, it would be seen that full details of them were published in the report, and the Board did all in their power to place before the shareholders the fullest information concerning the operations of the Company. Concerning the schemes in hand, the most important was that in connection with the electrification of the North Metropolitan Tramway Company's system, together with the light railways in the North of London. That scheme was one of the largest which had ever been contemplated, and when completed they would have 130 miles of electric tramways in the North of London. Referring to the arrangements with the Brush Company and the Electric Power Distribution Company, the Chairman said that some of the shareholders might hold the opinion that the capital was being increased too quickly. Still the new business which the Company was developing was of a very profitable character, as was shown by the fact that they were not only increasing their traffic receipts, but also the receipts per mile. They were earning a larger net profit on a larger capital. The Board proposed to increase the capital by £1,000,000 in ordinary shares and £1,000,000 in preference shares, which would give them the power to issue £1,000,000 debenture stock and so double the existing capital. It was proposed to issue 20,000 shares to the present shareholders, and that distribution would be in the nature of a bonus, as they would be allotted at par. There had not been an increase in the dividend, though the profits had advanced, and the directors thought it right, therefore, that the shareholders should have the advantage of the new allotment of shares at par, and they had arranged that coupons for fractions of shares should be issued in order that the small shareholders should have the advantage of the new shares.

Mr. Emile Garcke seconded the resolution, which was put and carried unanimously.

On the motion of the **Chairman,** a resolution for the increase of the capital of the Company from £2,000,000 to £4,000,000, divided into 400,000 shares of £10 each, by the creation of 200,000 new shares of £10 each, was also carried unanimously.

The retiring directors (Mr. C. Shirreff B. Hilton and the Hon. Sir Charles W. Fremantle) were re-elected, and the meeting terminated with a vote of thanks to the chairman and directors.

PERTH ELECTRIC TRAMWAYS.

Presiding over the ordinary general meeting of this Company at 3, Laurence Pountney-hill, on the 12th inst., **Mr. E. Heasman** congratulated the shareholders on the progress made by the undertaking. For the first three months of the year seven miles of lines were in operation, and this was ultimately increased to 13 miles, the average mileage being 11½ in the period. The total revenue earned was £60,268, representing average receipts of over £67 per mile per week. For the first 21 weeks of 1902 the average gross earnings per mile per week were over £68. With the increasing prosperity of the city of Perth, the Board felt certain that the undertaking would continue to be very valuable. The working expenses showed a satisfactory ratio o the receipts, being a little over 60 per cent. for the period under review. This ratio of expenses was applicable to different sections of comparatively short mileage. The present average ratio of working expenses for the first 21 weeks of the current year was only 52·6 per cent., and therefore as the traffic increased it was only reasonable to suppose that a greater reduction in this respect might be looked for. The growth of traffic necessitated addditional rolling-stock and motive power. For this purpose, and for the construction of further sections, the Board had spent £102,109 on capital account during the 18 months under review. The Board had issued £169,197 of the 5 per cent. first mortgage debenture stock out of the authorised issue of £200,000, and after providing for the interest on this amount up to Dec. 31 last, and for the interest on loans and for trustees' fees, the Company had a balance of £7,354 standing to the credit of profit and loss account. At the end of June, 1900, they had a balance on the debit side of profit and loss account amounting to £2,957. At Dec. 31 last this debit balance was wiped out, and £4,396 remained available for distribution. The dividends on the preference shares at the rate of 6 per cent. per annum, which had accumulated since the date of their issue up to the end of 1901, amounted to £5,921, and the Board now proposed to pay off this amount. There would then be a balance of £1,124 to be carried forward. He concluded by moving the adoption of the report.

The motion was seconded by **Mr. R. C. F. Ogilvie,** and adopted.

BRUSH ELECTRICAL ENGINEERING.

The following has been published by Mr. Broadhurst, the secretary and assistant manager of the above Company : "The Brush Electrical Engineering Company, Limited, have received an offer from the British Electric Traction Company, Limited, for an exchange of shares in the following proportions: one fully-paid £10 ordinary share of the British Electric Traction Company for 10 £2 fully-paid ordinary shares of the Brush Electrical Engineering Company ; one fully-paid £10 preference share of the British Electric Traction Company for six £2 fully-paid preference shares of the Brush Electrical Engineering Company, Limited. A circular communicating this offer to the shareholders of the Brush Electrical Engineering Company will be issued at once."

KALGOORLIE ELECTRIC LIGHTING AND POWER.

The report of the directors covering the period from Oct. 1, 1900, to Dec. 31, 1901, states that the contract with J. G. White and Co., Limited, electrical engineers and contractors, for the erection of a complete electrical power transmission plant will soon be completed. The time for the completion of the contract was July 29, 1902, but such excellent progress has been made that the directors were enabled to supply power to the Kalgoorlie Electric Tramway Company on May 1. The shareholders have already been informed of the contract entered into with that company for the supply of power for 10 years. The tramway was formally opened to the public on May 20. Enquiries have been received from users of power for more than double the amount at the Corporation's disposal. These are now being carefully considered by the Corporation's representatives in Kalgoorlie with a view of entering into such contracts as will be most advantageous to the Corporation. Further capital being necessary for subsidiary machinery, including rotary transformers, motors, hoists, pumps, etc., the directors, under the powers given to them by the articles of association, have created an issue of £50,000 6 per cent. debentures, of which a portion has been placed.

ELECTRIC AND GENERAL INVESTMENT.

The directors of this Company recommend the following dividends for the year ended May 31 : on the ordinary shares a dividend of 5s. per share, of which 2s. per share was paid on account in December last, leaving 3s. per share to be distributed, and a bonus of 2s. per share. The trustees for the ordinary shares' reserve fund propose to distribute out of the proceeds of investments sold and dividends received 1s. per share, making a total present distribution of 6s. per share, or 30 per cent., or a total distribution of 8s. per share, or 40 per cent. for the year. Founders' shares, a dividend for the year of £50 per share. The trustees for the founders' shares reserve fund propose to distribute out of the proceeds of investments sold and dividends received £10 per share, making a total present distribution of £60.

CALLENDER'S CABLE AND CONSTRUCTION.

The report of the directors for 1901 states that the accounts show a balance at the credit of profit and loss for the year's working of £71,978, to which must be added £10,855 brought forward from 1900, making together £82,833. From this must be deducted : interest on calls paid in advance, £28 ; interest on debentures, £4,050 ; dividend on preference shares, £10,000 ; appropriation for depreciation of plant, machinery, and furniture, £7,134 ; carried to machinery renewal fund, £3,000 ; leaving an available balance of £58,621. The directors propose a dividend to the holders of ordinary shares, Nos. 1 to 30,000, at the rate of 10 per cent. per annum, clear of income tax, being 10s. per share, whereof 5s. was paid on Nov. 1, 1901, and 5s. on Saturday, £15,000 ; a bonus of 5s. per share, £7,500 ; further payment of a special bonus of 5s. per share, £7,500—carried forward, £28,621. The total payment to the holders of the first 30,000 ordinary shares in respect of 1901 will, therefore, for dividend and bonus be 20s. per share. The business transacted during the past year was once again in excess of that of all previous periods. The directors state that, in spite of the keen competition in all branches of the Company's trade, the factory is now fully employed. The following circular is appended to the report : "We regret to say

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that certain differences have arisen between the Company and W. T. Henley's Telegraph Works Company, Limited, as to the terms of the proposed amalgamation, which, in the opinion of both Boards, render it impracticable—at any rate, for the present—and the negotiations have, therefore, by mutual consent been treated as at an end."

NEW COMPANIES REGISTERED.

Thornton and Atkinson, Limited.—Capital, £3,000. Objects: to carry on the general business of engineers and metal founders of H. and A. R. Thornton at the Providence Foundry, Cleckheaton, Yorkshire, and also that of J. N. Atkinson, at Boro' Mills, Bradford, Yorkshire, under the style of the Bradford General Electric Company, etc.

Clubbe and Southey, Limited.—Capital, £2,000. Objects: to acquire and continue the business of A. W. Southey, and to acquire and turn to account certain patents; as mechanical, general, electrical, and mechanical engineers, builders and owners of electrical vehicles of all kinds, etc.

Hanson-Walsh Engineering Company, Limited.—Capital, £5,000. Objects: to acquire as a going concern the business of engineers of J. T. Hanson at Parkwood Mills, Longwood, Yorkshire, and to carry on business as manufacturers of machinery of every description, as electricians and electrical engineers, manufacturers of wires, cables, dynamos, and all apparatus used in connection therewith, etc.

Chloride Electrical Storage Syndicate, Limited.—This Company have changed their title into Chloride Electrical Storage Company, Limited.

Motor Manufacturing Company, Limited.—Capital, £80,000. Objects: to adopt an agreement with a company having a similar title, and generally to carry on business as ironfounders, electric and water-supply engineers, etc.

Scottish Automobile Company, Limited. — Capital, £100. Objects: to acquire inventions, etc., and to carry on the business of manufacturers of motorcars, etc.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Chester.—The Corporation invite tenders for accumulators and booster. Tenders by July 7.

Shanghai.—The last day for receiving tenders for the proposed municipal tramway and motor 'bus service is June 30.

Madrid.—The Department of Agriculture require a number of meters and instruments valued at £1,000. Tenders by June 30.

Whitworth.—The Urban District Council invite offers from firms willing to provide a service of electrical trams in Whitworth. See advertisement.

Sunderland.—The Corporation invite tenders for the supply of permanent way, overhead equipment, and cables. Tenders by July 9. See advertisement.

West Ham.—The Council invite tenders for 50 double-deck electric tramcars, complete with electrical equipment. Tenders by July 8. See advertisement.

Romford.—The Urban District Council invite tenders for the construction and maintenance of electricity supply works in the district. Tenders by June 30. See advertisement.

Valparaiso.—The Municipality are inviting tenders for electric lighting and tramways. We understand that particulars may be obtained from the Chilian Consul. Tenders by Sept. 1.

Bury.—The Tramways Committee invite tenders for the supply and delivery of rails and fishplates, fishbolts and nuts, tiebars, points and crossings, and sole or anchor plates. Tenders by June 24.

Leskovatz (Servia).—The Société d'électricité de Leskovatz require two turbines of 200 h.p. and two dynamos for three-phase current; also accessories for a power installation with a radius of 11 miles. Tenders by July 1 (14).

Bexley.—The Urban District Council invite tenders for points and crossings and boilers. Specifications, etc., may be obtained from the engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W. Tenders by July 7.

Lowestoft.—The Corporation invite tenders for the construction of tramways, rails, fishplates, and bolts, and permanent-way construction. Specification, etc., may be obtained from Mr. R. Beattie Nicholson, town clerk, Lowestoft. Tenders by July 12.

Launceston (Tasmania).—The Corporation invite tenders for polyphase generating, transmitting, and distributing plant and apparatus, transforming apparatus, reconstruction of existing plant, and enclosed arc lamps and accessories. Tenders by Sept. 15. See advertisement.

Willington Quay.—The Willington Quay and Howdon Industrial Society, Limited, invite tenders for supplying and fixing electrical apparatus as required for power and light at their Bewick-road premises. Specification, etc., can be had on application. Tenders by noon on July 4.

Falkirk.—The Corporation invite tenders for storage batteries, generators, transformers, switchboard, cable work, crane, lamps, and fittings. Specifications can be inspected at Messrs. Burstall and Monkhouse, 14, Old Queen-street, Westminster. Tenders by July 14. See advertisement.

Kirkcaldy.—The Corporation invite tenders for wiring the central station. Specification, etc., can be obtained from Mr. Wm. L. Macindoe, town clerk, or seen at (but not obtained from) the office of Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. Tenders by 21st inst.

Gillingham.—The Urban District Council invite tenders for the supply and erection of two water-tube boilers, steam and exhaust piping, condenser, cooling tower, high-speed engines, three triphase alternators (250 kw. each), switchboard, underground cables, arc lamps, crane, and well. Tenders by July 17. See advertisement.

Ipswich.—The Corporation invite tenders for the supply, delivery, and erection at the generating station, Constantine-road, Ipswich, of engines and dynamos, storage battery, overhead hand travelling crane, feeders, mains, and road work, permanent-way construction of tramways, and arc lamps. Tenders by July 5. See advertisement.

London, S.W.—The London County Council invite tenders for the supply, delivery, and erection at the Council's temporary generating station at Loughborough Junction of steam, exhaust, feed, and other piping, valves, etc. Specifications and other particulars may be obtained from the County Hall, Spring-gardens, S.W. Tenders by July 8.

Epsom. The Urban District Council invite tenders for the supply and erection of semi-marine dry-back boiler, with fittings, etc.; ejector condensers, circulating pumps, and pipework; spray cooling pond; steam, feed, and drain pipes, etc.; and one 150-kw. steam dynamo (vertical enclosed high-speed engine) and switchgear, etc. Tenders by July 18. See advertisement.

Nuneaton and Chilvers Coton.—The Electricity Committee invite tenders for the supply and delivery of private lighting cables (paper), public lighting cables (rubber), joint-boxes and compounds and 20 arc lamp columns, with incandescent brackets, complete with arc and incandescent lamps, cut-outs, switches, resistances, and all other accessories. Tenders by June 30.

Bury.—The Tramways Committee invite tenders for the work required in the construction of the permanent way in several parts of the borough—viz.: Fairfield section, Bolton-road section, Heywood-street and Knowsley-street sections. Specifications, etc., can be obtained on application at the office of Mr. Arthur W. Bradley, borough engineer and surveyor. Tenders by June 24.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board invite tenders for the supply, delivery, erection, and construction of three 500-kw. steam-driven, direct-coupled three-phase alternators, etc.; three 50-kw. steam-driven, direct-coupled continuous-current exciters, etc.; and permanent way, including copper bonding and conduits for cables. Tenders by July 7. See advertisement.

Toddington.—The Urban District Council having obtained a provisional order enabling them to supply electricity within the urban district of Toddington, invite tenders from persons and companies able to carry out electrical undertakings, stating terms upon which they would be willing to take over such provisional order, and to submit a scheme of electric lighting for the district, with particulars of cost. Tenders by July 12. See advertisement.

Sydney (New South Wales).—Messrs. Preece and Cardew are authorised by the Municipal Council of Sydney, New South Wales, to invite tenders for supply, delivery, laying, and erection of a complete system of high and low pressure cables, and of arc lamps for street-lighting. The contract will include cast-iron pipes, wood troughs, high and low pressure cables, joint-boxes, frames and covers for street boxes arc lamp-posts and brackets, arc lamps, controlling gear, telephone instruments, etc. Tenders must include the whole of the material laid and erected complete. Tenders for a portion only of the work will not be considered. Copy of the specification, general conditions, and form of tender may be obtained from Messrs. Preece and Cardew on payment of a deposit of £5, which will be refunded on receipt of a bona fide tender and the return of the specification and general conditions. A duplicate copy of the specification and general conditions can be obtained on payment of £1. Sealed tenders, endorsed "Sydney Electric Lighting," are to be addressed to Messrs. Preece and Cardew, and delivered at their offices, 8, Queen Anne's-gate, Westminster, London, S.W., before 12 noon on 23rd inst.

RESULTS OF TENDERS.

Oban. The tender of A. and J. Stewart and Menzies, Glasgow, has been accepted for cast-iron pipes for carrying the cables.

Natal-Durban Railway.—Messrs. D. Bruce Peebles and Co., Edinburgh, have secured the tender for the electrical generating plant in the Government railway shops, at £8,371.

Portsmouth.—The Town Council have decided to purchase 310 electricity meters from the Newcastle-on-Tyne Electric Supply Company, at £600.

Dundee.—Messrs. Willans and Robinson have received an order through Messrs. Dick, Kerr, and Co. for one 1,200-h.p. triple-expansion engine for the Corporation.

Guildford.—Messrs. Willans and Robinson have received an order from the Electric Light Company for a 240-h.p. compound engine for direct coupling to a Newton dynamo.

Canterbury.—The Town Council have accepted the tender of E. J. Philpot, at £25, for wiring the Beaney Institute, according to design submitted for illumination on Coronation Day.

Central London Railway.—This company have accepted the tender of the British Thomson-Houston Company for equipments for 64 motorcars and 160 trailers. Details appear in another column.

Manchester.—The Tramways Committee of the Corporation have just placed an order for 34,000 copper railbonds with Messrs. Robert W. Blackwell and Co., Limited, 59, City-road, London, E.C.

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Metropolitan District Railway.—The contract for a switchboard to control the 10,500-kw. 11,000-volt generators and other accessories for the generating station of this line has gone to the British Thomson-Houston Company. Details of the plant appear in another column.

London County Council.—The Historical Records Committee have received the following tenders for the supply and fixing of a special battery in connection with the emergency electric light installation at the Horniman Museum: Pritchetts and Gold, £66. 4s. (accepted); Chloride Electrical Storage Syndicate, £73. 5s.; Electrical Power Storage Company, £76. 8s.; Drake and Gorham, £83.

General Post Office.—Messrs. Willans and Robinson have received an order from the General Post Office for four 250-h.p. compound engines for direct coupling to Siemens dynamos for the General Post Office Savings Bank, West Kensington. They have also received an order for two 360-h.p. engines for direct coupling to dynamos by Dick, Kerr, and Co. for the telegraph factory, Mount-pleasant.

Walsall.—The Town Council have accepted the following tenders: Babcock and Wilcox, supplying and erecting one of their water-tube boilers, with fittings and superheater, £1,080; Electrical Power Storage Company, supplying and erecting a battery of accumulators, £1,117. 16s.; Walsall Electrical Company, for the wiring for the lights at the Hospital-street sub station, for wiring the casing for the cables for the machines, and for supplying and fixing a telephone, £30. 3s. 4d.

BUSINESS NOTES.

TRACTION.

Naples.—The employés of the tramway company here have gone out on strike.

Yarmouth.—The new electric tramway was officially inspected on Wednesday.

Govan.—The Social Democratic Federation are agitating for cheaper fares on the tramcars.

Hipperholme.—It is proposed to extend the electric lighting and tramways from Stump Cross to Hipperholme.

Whitworth.—The District Council are advertising for offers of parties desiring to run electric trams into the district.

Brighton.—The members of the Electric Tramways Committee have decided to visit Norwich to inspect the tramways in that town.

Huddersfield.—The electric cars have commenced running on the Birkby section of the Corporation tramways to Almondbury and Honley.

North Somerset.—A proposal is on foot to construct a light railway through certain parts of North Somerset, commencing at Clutton.

Prestwich.—The negotiations between the District Council and the Salford Corporation are proceeding successfully with reference to the tramways.

Stroud.—The Light Railway Commissioners have arranged to hold a local enquiry into the proposed light railway scheme some time before August.

Croydon.—The Town Council have decided to oppose the application which has been made for powers to construct a light railway from Dulwich to the Crystal Palace.

Barrow.—A special meeting of the Town Council has confirmed a resolution of the General Purposes Committee to lease the tramways to the British Electric Traction Company.

Maidstone.—The Rural District Council have decided not to oppose the proposed tramways from Maidstone to Barming, but the scheme is being opposed by a body of ratepayers who do not welcome the proposed line.

Buxton.—The several schemes which have been placed under the notice of the respective local authorities for constructing a light railway from Grindleford Bridge to Bakewell have not so far taken any definite shape.

Harrow.—A special meeting of the Council has decided to oppose the new scheme for the construction of a light railway through the district unless protective clauses are inserted in the order to meet the wishes of this Council.

Adelaide.—Every preparation is being made by the Westinghouse Company for the introduction of electric tramway traction into Adelaide, Australia. The necessary plans and designs for the laying of the lines are now being drawn.

Colne.—In regard to the Colne and Trawden light railway, it is stated that the promoters have agreed to the conditions named by the Council. There is every reason to believe that the company intend to proceed with the building of the railway.

Subways in the City.—An agreement for the construction of a subway between the stations of the Central London Railway and the City and South London Railway in front of the Mansion House has received the approval of the Common Council.

Exeter.—The Exeter and District Tramways Bill, conferring additional powers on the Exeter and District Tramways Company (but not for lines within the borough), has passed the preliminary stages of the House of Lords, and is ordered for third reading.

Hindley.—The Urban District Council are considering an offer from the South Lancashire Tramway Company to lease the present tramway from the Council if purchased by them, and to apply for necessary powers to the Board of Trade as to alteration of gauge, etc.

Bath.—Sir Frederick Bramwell is conducting an arbitration at the Surveyors' Institute, Westminster, as to the price to be paid by the Bath Corporation in the compulsory purchase of the tramway undertaking of the Bath Road Car and Tramways Company, Limited.

Chatham.—The Chatham and district electric tramways were opened on Monday by the Mayor. The line was constructed under a light railway order by a syndicate of capitalists incorporated under the Companies' Act. The capital of the undertaking is £50,000.

Ashby.—At the last meeting of the Council the hope was expressed that the light railway scheme would receive the fullest consideration, since it affected Ashby very much more than the previous one, the suggested route going through a very important part of the town.

Doncaster.—The Corporation are pushing forward the section of the electric tramway to the racecourse, and it is hoped that it will be completed in time for the Agricultural Show on July 2 and 3. Major Druitt, of the Board of Trade, has arranged to inspect the line on July 1.

Stalybridge.—The members of the Tramways Committee of the Stalybridge, Hyde, Mossley, and Dukinfield Tramways Board have decided to visit Hanley, London, Portsmouth, Southampton, and Loughborough for the purpose of inspecting various types of overhead equipment and cars.

Twickenham.—The London United Tramways Company had a trial trip over the extension of their line to Twickenham, the first part of the route from Isleworth to Hampton Court, on Wednesday. The cars will run from the Tube terminus at Shepherd's Bush, *via* Brentford and Isleworth, to Twickenham to-day (Friday).

Canterbury (N.Z.).—We understand that the agent of the British Electric Traction Company at Auckland has made proposals to the Canterbury Municipal Council to provide the city with electric tramways. The question which now arises is as to the system to be adopted. The overhead system seems to be the one most favoured at present.

Middlesex.—It is stated that the Middlesex County Council are about to commence the construction of the electric tramways, in respect of which parliamentary sanction has been obtained. The Council's Finance Committee are providing £1,000,000 for the first part of the scheme. This is exclusive of the cost of generating stations and equipment.

Isle of Thanet.—A short time ago there was a great outcry against the light railway company for running their cars at an excessive speed. Now complaints are being made at the slow speed at which the cars travel on certain parts of the route, and the Broadstairs Urban District Council have started a correspondence with the company on the subject.

Private Bills.—In the House of Lords the Birmingham and Midland Tramways Bill, the Erdington Tramways Bill and the Scarborough Tramways Bill have been read a third time, and the following a second time: Metropolitan District Railway Bill, the Wrexham District Tramways Bill, and the Croydon and District Electric Tramways Bill.

Hanley.—The Town Council have sealed a petition to the House of Commons praying for the insertion in the Bill now being promoted by the North Staffordshire Tramways Company and the Potteries Electric Traction Company of a clause empowering the local authorities affected to jointly purchase the generating stations of the company as part of their undertaking.

Burton.—It is decided to provide a shed for 20 tramcars and out-offices at the depôt in Horninglow-street at a cost of £5,750. The Council are opposed to the Midland Railway Company's application for a light railway from Ashby to Burton. An attempt is to be made to confer with the Midland Company on the matter to see if an arrangement could not be arrived at.

Portsmouth.—The Town Council have issued their annual statement on the tramway undertaking. What with the loss of traffic through reconstruction, the cheapening of the fares, and the heavy capital and sinking fund charges, a deficit has to be met. The total receipts for the year were £50,663, and working expenses totalled £29,871 £5,183 being the year's deficit.

Bilston.—Sufficient progress has been made with the tramway scheme, which is to connect Bilston with neighbouring towns, to enable some trial trips to be made. The new section runs from the Fighting Cocks, on the boundary line of Wolverhampton and Sedgley, to Bilston, but it is expected that a week or more will elapse before the Board of Trade inspection takes place.

Newcastle.—The Tramways Committee have sanctioned the purchase of £1,500 worth of tools for the repairing of trams and construction of tramcars. Eight open cars for the summer months are now ready, and will be run as soon as the weather permits. In the course of the summer other similar cars will be put on the lines, making 25. A motor wagon or repairing tower is to be purchased at a cost of about £400.

Wandsworth.—With reference to the County Council's tramway proposals, a letter was read at the last Borough Council meeting to the effect that no undertaking could be given to proceed continuously by day and night with the construction of the proposed double line of tramways across Putney Bridge. The Council decided to present a petition to the House of Lords, if necessary, with a view to obtaining the required undertaking.

Unopposed Bills.—The Chairman of Ways and Means in the House of Commons on Wednesday had under consideration the following Bills, which are now unopposed: the Tyneside Tramways and Tramroads Bill, the Northumberland Electric Tramways Bill, and the Newcastle-upon-Tyne Corporation Tramways Bill. In each case, after formal evidence had been heard, the Bills were passed and ordered to be reported to the House.

Newport (Mon.).—The Tramway Bill which the Corporation are promoting in this session of Parliament has been passed by the com-

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mittee of the House of Lords of which Lord Hawkesbury is chairman, with the exception of a proposal for a short length of tramway over a level crossing. The powers thus obtained will enable the Corporation to double the existing lines, and to carry them to the borough boundary and to apply electric traction.

Southport and Lytham Tramroad Bill.—This Bill has passed Lord Brougham's Committee of the House of Lords, the preamble being proved last Friday. The object of this Bill is to extend the time limited for the acquisition of land and the completion of works under the Southport District Tramway Act, 1899, and the Southport and Lytham Tramroad Act, 1900, for authorising the issue of preferred and deferred half shares, and for other purposes.

Tyneside Tramways Bill.—The Court of Referees sat at the House of Commons on Wednesday to hear an application made by the North-Eastern Railway Company for the rehearing of their claim to be heard in committee against the Tyneside Tramways and Tramroads Bill. The Court decided not to rehear the case, the chairman stating that it would be a dangerous precedent to allow a case to be reopened simply because arguments had not been sufficiently pressed.

Manchester.—In connection with the order recently placed by the Corporation with Messrs. R. W. Blackwell and Co. for 54,000 copper railbonds, we understand that these bonds are of the well-known "Crown" and "Chicago" types, which have been used to such a great extent in this country. This order, taken in conjunction with an order placed by the Manchester Corporation last year for 50,000 railbonds, should constitute a record for railbond orders in this country.

London United Tramways.—Mr. Compton Rickett's Select Committee of the House of Commons is still taking evidence on the Bill promoted by the London United Tramways Company, who seek powers to make extensions of their system at Richmond, Kew, Mortlake, Barnes, and Hammersmith in one direction, and at Malden, Wimbledon, and Merton in another direction. So far only those lines affecting the Richmond and Wimbledon districts have been considered by the committee.

Ashton-under-Lyne.—The Council have appointed a deputation to confer with the Stalybridge and Dukinfield Tramways and Electricity Board as to the question of joint running powers. The question of constructing the proposed lines in Old-street and Scotland-street has been referred to a sub-committee for consideration. The proposed appointment of a tramway manager has also been referred to a sub-committee. Tenders are to be invited for the necessary rails for the tram shed.

Bradford.—A new experiment is being tried on one of the sections of the city tramways in the shape of overlapping 1d. stages. Heretofore the distance between Saltaire and Forster-square has been divided into two stages only—one on either side of the Frizinghall boundary. These stages are retained, but a 1d. fare is charged for the journey between the Branch Hotel and the Park gates. Should the experiment of overlapping stages prove successful, it will probably be extended to other routes.

New South Wales.—The quarterly report of the Railway and Tramway Commissioners for the term ending March shows an increase in revenue from the tramways of £21,000, the total sum amounting to £172,000. The following are the official figures for the quarter: miles open, 103½; revenue, £172,877; expenditure, £131,672; tram miles run, 2,244,851; earnings per tram mile, 1s. 6½d.; expenditure per tram mile, 1s. 2d.; percentage—expenditure to earnings, 76·17; number of passengers carried, 28,624,112.

Shields.—The North and South Shields Electric Railway Bill, to which there is now no opposition, was under the consideration of the Chairman of Ways and Means in the House of Commons on Wednesday. By the provisions of this Bill the promoters will be enabled to carry into effect a scheme for uniting North and South Shields by means of an electric railway carried in a tunnel beneath the river. After evidence of a formal character had been heard the Bill was passed, and was ordered to be reported to the House.

Southport.—At the last meeting of the Town Council it was stated that the Corporation tramways were 7¾ miles long, apart from those leased. The passengers carried last year numbered 3,318,000, and the average fare per passenger was 1·13d. Suggestions had been made from time to time that the Council should adopt a universal 1d. fare, but experience had shown that a 1d. fare was only suitable in a central zone, where passengers were constantly getting in and out. Outside that zone, where passengers were fewer, the 1d. fare would be a decided loss. The gross profits amounted to £6,569, which was equal to 6½ per cent. on the capital outlay.

Nottingham.—A trial was on Monday afternoon made of the Sherwood-rise route, which was completed a short time back. By this line a connection has been established between the Sherwood and Bulwell sections. Residents on the western side of the city will, under the new arrangements, be enabled to join the Sherwood-rise cars at Basford Midland Station, and come straight through to Station-street without changing. The trial was attended with excellent results, both the line and the overhead equipment being found entirely satisfactory. The date of the Board of Trade inspection has not yet been fixed, but it is not expected to be long delayed.

Dundee.—At a meeting of the Works Committee on Monday it was pointed out that the laying of the permanent way for the Constitution-road tramway, for which the time limit expired that day, had not yet been completed. The burgh engineer explained that an allowance was generally made in respect of bad weather. Several members said that, while they might not be willing to impose the contract penalty, they thought the work had been undesirably protracted, and one member suggested that the contractor should be asked to meet the committee and explain the cause of the delay. It was, however, agreed to leave the matter to the Tramways Committee to be dealt with.

Plymouth.—Major Pringle, Board of Trade inspector, has inspected the short length of line connecting the Corporation tramways with the Plymouth, Devonport, and Stonehouse Company's system at Derry's Clock, and passed it for traffic. Under their agreement with the Plymouth and Devonport Company the Corporation have power to run cars over the company's line as far as the borough boundary, and the connection between the two systems has been made with the object of running a through service of cars from one end of the borough to the other. Plans have been prepared for the construction of a terminal line at the Octagon, but the work, which will necessarily take some time, has not yet been commenced.

Surrey.—The City and Surrey Electric Railway Company have acquired a City terminus for their proposed tube in King William-street, and a working agreement has been entered into with the South London Company for the joint use of their tunnel under the Thames. Starting from King William-street, the route proposed is parallel to that of the existing South London line to a point a little south of the Borough Station, then branching westward through St. George's-circus by Lambeth, Kennington, the Oval, and Lorn-road to Brixton. From there the line will pass through Streatham, Norbury, Thornton Heath, and Croydon to Warlingham. One branch then proceeds east to Westerham, and the other west to Redhill and Reigate.

Metropolitan Railway.—It is reported that an arrangement has been concluded between the Metropolitan and Great Western Railway Companies whereby the forthcoming electrification of the former line will be extended over the joint line of the two companies as far as Hammersmith, so as to give the electrical trains of the Metropolitan a through run between Hammersmith and the City. The electrification of the Metropolitan route is being pushed forward with all possible speed now that all difficulties with the Great Western Company have been overcome. Another important improvement will be the enlargement and remodelling of Baker-street Station, which will greatly facilitate the working both of the main line and circle trains of the Metropolitan Company.

Hyde.—It is announced that the laying of the rails for the Gee Cross tramway scheme is to be commenced almost immediately. This scheme will complete a continuous service of electric trams between Hyde and Stockport *vid* Bredbury. To proceed with the scheme an agreement was required between the Corporations of Hyde and Stockport, the Bredbury and Romiley Urban Council, and the Oldham, Ashton-under-Lyne, and Hyde Electric Tramways Company. After much delay the agreement has been signed, and the Stockport Corporation have just extended their tramways for a distance of about 400 yards to the Bredbury-Hyde boundary. It has been arranged that the tramways company shall carry out the Gee Cross scheme, which is a little over a mile in length, and is expected to cost about £8,000.

Cavehill and Whitewell Tramways Bill.—Notwithstanding the vigorous opposition of the Belfast Corporation, the above measure has succeeded in passing through committee both in the House of Commons and in the House of Lords. In the latter case the preamble of the Bill was passed before Lord Newton's Select Committee last Monday. The Bill empowers the tramway company to lease the lines to the British Electric Traction Company, who will immediately proceed to apply electric traction to the same. The opposition of the Belfast Corporation was based on the ground that as they will in time to come acquire and electrify the street tramways in the city they should also control the lines outside the city, and thus be able to give an uninterrupted service to Whitwell by connecting up the two systems.

London County Council.—The County Council have decided to appoint a distribution engineer, at a salary of £350 a year, on the electricity staff of the tramways department. In order to carry out the duties of the position, the Highways Committee are of opinion that the person appointed should have had experience (*a*) in the actual manufacture and laying of electric cables on various systems, (*b*) in the theory and practice of electric testing, (*c*) in the locating and repairing of faults, and (*d*) he should also be accustomed to the charge and control of men. The Highways Committee at the usual weekly meeting of the Council on Tuesday asked for authority to expend £2,700 on the acquisition of a site in Brixton-road for the erection of a transformer station in connection with the electric tramway scheme.

Wellingborough.—Difficulty has arisen in connection with the Wellingborough and district tramways scheme over the route between Higham Ferrers and Irthlingborough. According to the Act obtained by the promoters, the line would, instead of following the road, be taken across some low-lying fields in the Nene Valley between the two towns, but these meadows are so often flooded that the cost of this route, in consequence of the number of arches required, would cost over £20,000. Hence the promoters have decided that unless they can take the line along the road they will be compelled to drop the scheme altogether. The difficulty is that if the line is taken this way the Nene bridge at Higham Ferrers Station must be widened. The question then comes in as to who should widen the bridge, and is at present the subject of controversy.

Aberdeen.—An open-air meeting has been held to discuss the question of running cars in the city on Sundays. The following resolution was adopted: "That this meeting of citizens beg to urge upon the Aberdeen Town Council the necessity for the institution of a service of Sunday cars which can be fully taken advantage of by all members of the community who desire to do so; also, that this meeting call upon the Council to provide a service of early cars for workmen, and to adopt at the same time a proportionate scale of ½d. fares over the entire system." The Town Council have resolved to join other corporations in a representation to the Board of Trade in connection with certain new regulations proposed to be made by that department in regard to speed indicators, the erection of guard wires over trolley lines, and other matters. On Monday the Town Council decided, by 20 votes to 12, to run the cars on Sundays.

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Central London Railway.—The company have just closed a contract with the British Thomson-Houston Company covering 64 motorcar equipments and 160 trail-car equipments. The equipment for each motorcar is to consist of two B.T.-H. 125-h.p. traction motors, one motor truck of the swinging bolster type with 33in. wheels, one motor-driven air compressor with a capacity of 35 cubic feet of free air per minute, one automatic governor, arranged to cut in the compressor at 80lb. air pressure in the main reservoir and to cut it out at 90lb. pressure, and one complete B.T.-H. master train-control equipment for the motors. Each trail-car equipment consists of the necessary control circuit cable and wiring material for the controller train line required for this system. Each train will consist of two motorcars and five trailer cars, the motorcars being at each end. We understand that the trains are now equipped with small chemical fire extinguishers.

Hull.—The members of the Corporation Tramways Sub-Committee on Friday conducted some trials of three life-saving guards for the tramcars. A "dummy" boy, weighing 2½ stones, and a "dummy" man, weighing nine stones, were utilised for the test, and there were three guards. The first subjected to practical examination was one recently patented by Mr. Robinson Burn, a local man. In this case, immediately the object came against a shutter in the front of the car the shutter went up, and down came a net faced with a roller, which rolled the bodies into the net. The next test was with the Tidswell guard. In this case the results are said not to have been so satisfactory as with the Burn's patent, because the bodies were pushed along some distance instead of being immediately taken up, as in the first case. The third guard tested did not give satisfactory results, and the sub-committee subsequently met and passed a resolution in favour of Mr. Burn's guard. The guard will accordingly be fitted to one of the cars and subjected to Board of Trade inspection.

Whitefield.—The proposed tramway agreement with Salford has been carefully considered in committee, and the clerk was instructed to further revise the same so as to provide that the Council should have a voice in the fixing of the fares and a minimum car service; that a service of through cars should be provided to the Council's satisfaction; that the Corporation should apply for powers to run the cars down the Bury New-road through Strangeways to Manchester, and failing obtaining the same should grant the Manchester Corporation running powers over their lines between the Grove Inn and Prestwich; that running powers should only be granted by Salford to any other corporation or company upon terms to be approved by the Council, or, failing agreement, to be settled by the Board of Trade; and, in addition to other matters, that all arrangements between the Salford Corporation and any other authority or company relative to the user of the tramway shall be subject to the approval of the Council, with the right to refer to the Board of Trade in case of difference.

The District Railway.—The British Thomson-Houston Company, Limited, have recently closed a contract with the Metropolitan and District Railway for the switchboard to control the 10 5,000-kw. 11,000-volt generators and other electrical auxiliaries in their generating station. We understand that it will consist of 47 black enamelled slate panels, divided as follows: four generator exciter panels, one exciter feeder panel, two rotary converter panels, one direct-current generator panel, one storage battery panel, two direct-current feeder panels, one low-tension transformer panel, three induction motor panels, 12 feeder panels, 10 generator instrument panels, and 10 generator controlling panels. All generator and feeder circuits are to be controlled by B.T.H. high-tension oil switches, type H, mounted in fireproof brick compartments, which are capable of opening a dead short-circuit of the entire station, and which are to act as automatic circuit breakers in the feeder circuit, being capable of adjustment within wide limits. They will also be capable of opening the circuit in case of reversal of current, thus forming an automatic circuit breaker without the interposition of high-tension fuses.

Walsall.—Particulars to hand state that the total length of lines open for traffic at present is 6 miles 17 40 chains. The undertaking was originally the property of the South Staffordshire Tramways Company, but was purchased by the Corporation in 1901. The tramways are worked on the overhead trolley system. The Corporation have leased the lines for three years to the South Staffordshire Tramways (Lessee) Company, Limited, and the term will expire on Dec. 31, 1903. The Corporation then intend to work the lines themselves, in conjunction with certain extensions. These are provided for under the Walsall Corporation Act, 1900, whereby the Corporation are authorised to construct 15 miles 5·90 chains of tramways. Contracts are now being signed for the construction of about 7¾ miles. The borough electrical engineer (Mr. Alexr. Wyllie) has superintended the arrangements for the electrical equipment on the overhead system of the lines, and the borough surveyor (Mr. R. H. Middleton) has got out the plans and specification for the track. The contracts have been let as under: permanent way, Messrs. Wm. Griffiths and Co., of London; electrical equipment (overhead), Messrs. Robert Blackwell and Co., Limited; cables, Callender's Cable and Construction Company, Limited, of London.

Bingley.—The District Council have agreed to terms with a syndicate with regard to tramways through Bingley. The proposed line would run from Shipley to Keighley. The agreement provides that the company shall construct the tramway and put up the equipment from the Shipley boundary to the extent of the Bingley district, a total length of 3¼ miles. The company will take current from the Council for running the tramways at a price in excess of the cost of the Council. The District Council shall apply for a provisional order next October for powers to construct tramways, and the cost of the provisional order will be paid by the company, the order when obtained to be transferred to the company, who will be granted a lease to work the tramways for a period of 21 years, the term to be extended by subsequent powers to 30 years. The company will also pay to the Council £500 a year for 30 years, this sum to include £100 per mile for the maintenance of the track, interest at ½ per cent. on £27,000, and £40 for contingencies. In addition, the company will contribute £2,000 towards the cost of making the new road past the parish church, for which the Council will have to obtain parliamentary powers. At the end of the lease the whole of the plant, with the exception of the cars and the car-sheds, will become the property of the Council.

Kensington.—The Law Committee reported at the last meeting of the Borough Council that as a result of negotiations they had come to a provisional agreement with the promoters of the Central London Railway Bill, embodying not only the usual protective clauses, but also what they deemed to be satisfactory terms for the surrender of a portion of the Wood-lane depôt to the company. The same committee reported that they had received a communication from the Council's solicitors, stating that they had been in negotiation with the promoters of the Metropolitan District Railway Bill with regard to the proposed route for the conduits and mains for the electrification of the company's railway, and had provisionally agreed a special clause for insertion in the Bill, providing that plans and sections of all works proposed to be constructed, showing the streets along which the proposed conduits and mains were to be laid, should be approved by the Board of Trade. The proposed clause also provided that no enlargement or alteration of the works should be made without the similar approval of the Board of Trade, who before giving such approval should have regard to the safety and convenience of the public, and should consider any representations made to them by the local authorities. They had instructed the Council's solicitors to withdraw the opposition to the preamble of the Bill, provided that the special clause above referred to was inserted, together with other clauses to be agreed for the protection of the Council.

Sunderland.—The annual report of the Tramways Committee during the financial year just expired states that the success of the system has been very marked. The traffic receipts, the number of passengers carried, and the mileage run show a large increase. The figures compared as follows: 1901—receipts, £22,256; passengers carried, 5,035,935; mileage run, 397,562. Last year the figures were respectively £56,243, 13,596,808, and 1,170,202. Since the inauguration of electrical traction in Sunderland there have been no accidents causing loss of life, broken limbs, or grave damage to persons or properties. The patent guards have been found to work very satisfactory in practice. On one occasion, in High-street, a girl stepped in front of a car, was knocked down, the lifeguard saved her, and she was picked up with practically no injnry. Experiments have been made with patent dry seats, but the entirely satisfactory outside dry seat has yet to be found. Some time ago it was resolved to fit up a car with the "Never-wet seat" for the purposes of experiment, and as this was considered to be the best seat tried, the 10 double-deck cars on order will be fitted with it. Everything possible has been done to maintain the various properties of the committee in a high-class condition. The overhead line was inspected weekly, and any weak places that were discovered were immediately put right. The financial condition of the undertaking is represented as follows: The traffic and other receipts for the year ending March 31, 1902, were £57,307. 16s. 3d. The expenditure was—working expenses, £30,719. 2s. 11d.; interest and depreciation, £18,846. 6s. 2d., leaving a net profit of £7,742. 7s. 2d. The car miles run were 1,170,207; units of electricity consumed, 1,232,910; passengers carried per car mile, 11·6; income per car mile, 11·75d.; expenses per car mile, 10·16d.; net profit per car mile, 1·59d. The percentage of gross profits on capital expended was 11·89d., and net profits on capital 3·46d. The average receipts per day for the year were £154. 0s. 8½d. The capital account shows an expenditure of £233,540, while the net revenue account shows that £500 have been transferred to the compensation fund, £12,159. 3s. to the depreciation fund, and £7,000 carried forward in aid of the borough rate.

LIGHTING AND GENERAL.

Octacamund (India).—A large electric lighting scheme is in preparation.

Paisley.—The salary of Mr. Parkinson, the electrical engineer, has been increased by £50.

Norwich.—The Corporation Electricity Bill has been read a second time in the House of Lords.

Stalybridge.—Arrangements are being made for the purchase of a site for a generating station.

Long-Distance Telephones.—Berlin, Berne, and Rome will be connected by telephone in August.

Strathpeffer.—We understand that an electric lighting scheme is shortly to be introduced at Strathpeffer.

Newport (Mon.).—It is intended to place electric arc lights in the bell tower of the town hall on Coronation Day.

Coatbridge.—The Scottish House-to-House Electricity Company, Limited, are about to lay further mains in the burgh.

City of London.—A report asking for authority to spend £700 in lighting the City School by electricity has been adopted.

Change of Address.—The Mica Boiler-Covering Company, Limited, have removed to Cornwall-buildings, 35, Queen Victoria-street.

Ware.—Mr. H. Wall Wilkinson has been instructed by the Urban District Council of Ware to prepare a report on electric lighting.

Battersea.—The Borough Council have obtained sanction to a loan of £456 for lighting the baths, Latchmere-road, with electricity.

Aylesbury.—The Urban District Council have applied to the Board of Trade for an extension of their electric lighting provisional order.

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Bootle.—The lighting of the whole borough will soon come before the Council. On the whole they appear to be in favour of electric lighting.

Thomas Parker, Limited.—The directors have resolved, subject to final audit, to declare a dividend of 10 per cent. for the year ending April 30, 1902, and to carry the balance forward.

Whitehaven.—From the applications for current for power received by the Town Council, it appears that there is every prospect of a considerable amount of custom during the daytime. .

Concert.—The Electrical Trades Union held a grand Bohemian concert at the Finsbury Town Hall, Rosebery-avenue, W.C., during which a new banner was unveiled by the Mayor of Poplar.

South Wales Electrical Power Distribution Bill.—This Bill, which has already passed a committee of the House of Commons, has been ordered to be reported for third reading in the House of Lords.

Paris Embassy.—At the fête on Saturday night at the British Embassy in Paris the gardens were exquisitely illuminated by 3,000 electric lamps enclosed in translucent celluloid flowers of every variety and colour.

Fareham.—The Portsmouth Corporation are including Fareham in their telephone area, and have asked the necessary permission to erect poles. The Urban District Council will take no action until detailed plans arrive.

Cleckheaton.—The District Council intend to apply for sanction to borrow a further £6,000 for electricity purposes. The charges for electricity for lighting and motive purposes have been fixed at 5d. and 2d. per unit respectively.

Heywood.—The Electric Lighting Committee have decided to supply current where the mains are now laid at 3d. per unit for illumination purposes at the Coronation, consumers to provide their own fittings and devices.

Aberystwyth.—The Postmaster-General last Friday received a deputation appointed by the conference held at Aberystwyth on May 29 to consider the extension of the telephone through Montgomeryshire to that town.

Wireless Telegraphy.—Communication by wireless telegraphy has been established between Rome and the island of Caprera, off Sardinia, 250 miles distant. The system is that perfected by Captain Bononio, of the Italian navy.

Bournemouth and Poole Electricity Supply Co.—The transfer books and register of holders of debenture stock of this Company will remain closed until the 30th inst., inclusive, preparatory to the payment of the interest due on July 1, 1902.

Manchester.—The Electricity Committee have decided to supply electric current at ordinary rates of charge to consumers who desire to temporarily increase the number of their lamps. etc., for outside illuminating purposes during the Coronation week.

Taunton.—The Town Council have decided to apply to the Board of Trade to sanction the alteration of the financial year so as to make it in future terminate on March. 31, and be in accordance with the financial year of the Corporation's general accounts.

Colne.—The Electrical Committee have decided to adopt an alternative system of charging for current for lighting purposes, and in future consumers will have the option of adopting the maximum demand system or the flat rate of 4½d. per unit system.

Bexhill.—Messrs. Preece and Cardew have resigned their positions as the Council's consulting engineers. We understand that Mr. Robert Hammond has been appointed to report upon the present position and future requirements of the electric light works.

County of London and Brush Provincial Electric Lighting Co.—The transfer books and register of holders of debenture stock of this Company will remain closed until the 30th inst., inclusive, preparatory to the payment of the interest due on July 1, 1902.

Electric Lighting and Traction Company of Australia, Limited.—The transfer books of the £75,000 5 per cent. debenture stock will remain closed from the 17th to the 30th inst inclusive for the preparation of interest warrants for the half-year ending June 30, 1902.

Limerick.—The Borough Council have obtained an opinion of Mr. Browne, K.C., according to which the Corporation are in a position to delegate their powers and duties under the Limerick electric lighting order to the Gas Committee, provided the leave of the Board of Trade is obtained.

Bangor.—The borough accountant has negotiated a loan of £5,480 for refuse destructor purposes. The electrical engineer (Mr. Price White) in his last report states that at the end of the month of April there was an increase of 58 per cent. in the number of units of electricity sold.

Thirsk.—The Parish Council have adopted the following resolution: "That in the event of the Northern Counties Electrical Company erecting works at Thirsk or Sowerby, this Council will adopt electricity for lighting the street lamps at a price not exceeding the price paid for gas for one year."

Halifax.—On Coronation Day an electric searchlight is to be erected on Beacon Hill. It will be of the Admiralty type, and extremely powerful, taking a current of 100 amperes at a pressure of between 70 and 80 volts. The current will be taken from the tramway wires on Southowram route.

Jandus Arc Lamp.—In addition to the Davy Construction Company, who, as already announced, have recognised the Jandus master patents, we understand that the Reason Manufacturing Company have recently signed an agreement by which they also have become licensees of the Jandus Company.

Portsmouth.—An estimate is being prepared for providing communication between the floors of the town hall by means of a passenger lift. It is stated that the cost of the lift installed at the Pearl-buildings is only ½d. a journey, and the tramway direct current can be used to work the lift should its erection be decided upon.

Truro.—A proposal that Messrs. Crompton and Co., Limited, should be permitted to put up and work an electric light installation in the city at their own cost and risk, giving, if desired, the Corporation the option of purchase at stated periods, has been referred to the special committee, of which Mr. Trevail is the chairman.

Dumfries.—The Town Council have rescinded a former resolution binding them to carry through the proposed installation themselves. Before proceeding further they await the report by Prof. Capper, and several members have indicated a strong desire to have a direct reference to the ratepayers before any further important step is taken.

Gravesend.—We understand that to-day an agreement between Messrs. Multon and Wallis and the Corporation for the completion of the building of the generating station will be submitted. The Town Hall and Market Committee recommend that the town hall and its buildings and offices and the market be lighted with electricity.

Coronation Illuminations.—The Electrical Company, Limited, have been entrusted with the order for the illumination of the Canadian arch in Whitehall, London. More than 5,000 incandescent lamps will be used for this purpose. This is probably the most important electrical illumination for the Coronation festivities in the whole of the United Kingdom.

South African Appointment.—The Kimberley Borough Council have selected, from 14 applications for the appointment of electrical engineer, Mr. J. Mordy Lambe, of Rondebosch, chief assistant electrical engineer to the Cape Peninsula Lighting Company, Limited. Mr. Lambe was formerly with Messrs. C. A. Parsons and Co., Heaton Works, Newcastle-on-Tyne.

Lytham.—The Urban District Council have resolved to apply to the Board of Trade for an extension of time for the completion of the works under the electric lighting order. Mr. T. Parker, to whom the tenders have been referred, has informed Messrs. Dick, Kerr, and Co. of this resolution, stating that the Council are not at present in a position to enter into a contract.

Aberdeen.—The Town Council on the 16th inst. adopted a report of the Watching and Lighting Committee recommending that the Council do not adopt the Kitson lamps, erected experimentally in Union-street, it being deemed inadvisable to take over the lamps, seeing that they had an electric station, and that Union-street was lit with electric light from Castle-street to Bridge-street.

Wandsworth.—At the last meeting of the Borough Council the receipt of a letter from the London County Council emphasising the necessity of establishing testing stations for the supply of electricity in the borough was reported, and the town clerk was instructed to forward to the London County Council a list of premises where periodical tests of the pressure of electricity can be made.

Blast by Electricity.—At a new freestone quarry opened up lately by Messrs. A. and J. Frame at Patterton, near Thornliebank, a special blast was recently conducted by Messrs. Fleming and Co., 31, Robertson-street, Glasgow. Five holes, about 36ft. deep, were drilled and charged with special gunpowder and fired simultaneously by electricity, the result being most gratifying to all concerned.

W. T. Henley's Telegraph Works Co.—We are informed that certain differences have arisen between this Company and Messrs. Callender's Cable and Construction Company, Limited, as to the terms of the proposed amalgamation, which in the view of both Boards render it impracticable at any rate for the present, and the negotiations have therefore, by mutual consent, been treated as at an end.

Colwyn Bay.—Mr. Tudman in his last report states that the units generated at the electric light works last month were 5,518; maximum load, 135·1 kw.; current consumed by street arcs, 307; promenade arcs, 770; number of consumers connected up to date, 90. A recommendation to supply the whole of Greenfield-road and Lawson-road, at an estimated cost of £274. 2s., is before the Electric Light Committee.

Burton.—With respect to the profit of £545. 6s. 8d. for the past year in the electric light department, the sum of £520 is to be repaid to the gasworks department on account of the £1,020 advanced by the latter department, and the balance of £25. 6s. 8d. carried to a new account to be called a renewal fund. The quantity of electric light sold during the past month was 11,006 units, showing an increase of 3,811 units.

Bermondsey.—The Council have approved of the proposal of the London Electric Supply Corporation to lay mains of high and low tension along Tooley-street, Tower Bridge-approach, Horselydown-lane, Gainsford-street, and Queen Elizabeth-street. The County of London and Brush Provincial Electric Lighting Company have obtained permission to construct a transformer box in Lambeth-road under their Southwark order.

Huddersfield.—The committee recently appointed to consider a proposal to establish in Huddersfield works for the manufacture of electrical machinery and appliances have had several meetings, and we understand that the negotiations with Messrs. Kolben, of Prague, are not progressing favourably. Messrs. Witting have opened negotiations for the amalgamation of their business in London with the proposed Huddersfield business.

Brierfield.—The charges for electricity are to be on a sliding scale, the maximum charge being 4½d. per unit, and a discount of 5 per cent. will be allowed to consumers if account be paid within 14 days from day of demand. This means that if a consumer uses 3,000 units per year the cost will go down to 4½d. per unit, 5,000 4d. per unit, 8,000 3¾d. per unit, 10,000 3½d. per unit. If over 10,000 units are used the charge will drop to 3¼d. per unit.

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Hammersmith.—The estimates of the electricity department for the year ending March 31, 1903, show an expected income of £26,197, and a prospective net profit of £1,507. Since the previous Council meeting 20 additional consumers have been connected, representing a maximum of 862 8-c.p. lamps, the present number of consumers now taking current from the mains being 1,042. A main is to be laid in Blythe-road at a total estimated cost of £95s. 4s. 1d.

Feltham.—At the last Parish Council meeting it was stated that the clerk had placed himself in communication with the General Post Office authorities with reference to the establishment of a telephone call office at Feltham, who had replied that Feltham was in the Windsor call area, and that it was thought the business likely to be done there would not justify the extension asked for. It was decided to further communicate with the authorities on the subject.

City and Guilds of London Institute.—Entrance examinations will be held in September for the courses of instruction at the institute's Central Technical College, Exhibition-road, which are for day students not under 16 years of age; and at the City and Guilds Technical College, Finsbury (Leonard-street, City-road, E.C.), for day students not under 14, preparing to enter engineering and chemical industries, and for evening students. Full particulars appear in another column.

Twickenham.—The District Council have decided, in accordance with the terms of the existing agreement with the National Telephone Company, three months' notice be given them of the Council's intention to terminate the same, that an agreement be entered into with the Post Office authorities for a private wire at a charge of £8. 10s. per annum, with charge for additional calls. Statutory notice of intention to lay electric light mains in Cresswell-road, Morley-road, and Alexandra-road has been received.

General Electric Company's Fire.—We are informed that the directors of the General Electric Company (1900), Limited, owing to the large stocks held at their branches, and the exceptional facilities for manufacture at their various works, are enabled to efficiently cope with the strain which the recent fire has put upon their resources, and all orders can be executed with promptitude. We are asked to state that as some order sheets may have been lost, customers noticing a delay should forward copies to ensure prompt dispatch.

Cardiff.—The borough electrical engineer (Mr. Arthur Ellis), in his report for the month of May, 1902, shows, as compared with May, 1901, an increase of 33 per cent. on lamps connected and an increase of 33 per cent. in units generated. The estimated revenue for the month was £909. 18s. 4d., as against £696 for the corresponding month—an increase of 30 per cent. The public and private supply had been fully maintained, and no complaints had been received. Experiments are being made with arc lamps placed on tramway poles.

Hebburn.—The Northern Counties Electricity Supply Company having submitted a plan showing the various streets comprising the whole of Hebburn Quay and Hebburn New Town in which they purposed laying down cables for electric lighting, it was found that the number of streets specified exceeded the number set out in the compulsory area. The Post Office authorities are to be served with notice of the electricity company's intention to lay the cables. We understand that the District Council have rejected the plans of the company for a power station.

Oban.—The rate for current for lighting has been fixed at 6d. per unit, and for power 3d. per unit. The charge for meter rents will be as follows: for 10-ampere meter, 2s. 9d. per quarter; 25 amperes, 3s.; 50 amperes, 3s. 6d.; 100 amperes, 4s.; 150 amperes, 5s. 6d.; 200 amperes, 7s. 6d. Provided 38 8-c.p. lamps are guaranteed for premises along the route, an armoured cable is to be laid in Soroba-road from the high school to near the railway bridge, and the public lamps in that section of Soroba-road are to be lighted by electricity. Mr. S. Williams, Corporation electricity works, Ayr, has been nominated as assistant engineer.

Stock Exchange.—Applications have been made to the committee to appoint a special settling day in the Bournemouth and Poole Electricity Supply Company's 7,500 6 per cent. cumulative second preference shares of £10 each (issued at £1 per share premium), £4 paid, of which £3 is capital and £1 premium; and to allow the following securities to be quoted in the official list: British Insulated Wire Company's further issue of 10,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 70,001 to 80,000; and the County of London and Brush Provincial Electric Lighting Company's further issue of 10,000 6 per cent. cumulative preference shares of £10 each.

July "Smart Set."—The *Smart Set* for July opens with a novelette by Edward S. Van Zile, entitled "Clarissa's Troublesome Baby," a clever and amusing story reminding us—we forget the title for the moment—of the delightful yarn about the old man who grew 10 years younger week by week until he dwindled into a tiny baby. The short stories have all a good special point in one direction or another, so that selection would be invidious. Mr. Gilbert Parker, M.P., contributes a timely article, "The Crowning of the King," in which he discusses the significance of the Coronation of Edward VII.; and the Duchess of Somerset contributes an interesting essay, entitled "Relating to Toasts Past and Present." Much that we have said of previous numbers holds good of the present one, which contains 50 signed contributions, besides numberless bits of humour in prose and verse scattered throughout the number.

Islington.—At to-night's meeting a report from the Lighting Committee will be submitted stating that from the accounts of the electricity undertaking for the year ending March 31, 1902, it will be seen that during the year there has been a further capital outlay of £43,508. 4s. 7d., and that the total capital invested now stands at £365,842. 12s. 10d. The total expenditure on revenue account amounted to £24,639. 17s. 8d., and the income for the year to £41,308. 8s. 3d., leaving a gross profit of £16,668. 10s. 7d. It is satisfactory to note that after payment of interest and redemption of debt there remains a net profit on the year's working of £1,402. 6s. 6d. The accounts are supplemented by the report of the electrical engineer and by some figures, which will be found of considerable interest. It is proposed to lay a low-tension distributing main, at a cost of £51, in Holloway-road.

New Issue.—An issue is being made of 49,500 £1 shares in the Peking and North China Electrical Corporation, which has a capital of £100,000. The objects of the company are to carry on the business of generators and distributors of electric energy in China, and to take over the concessions, etc., of the Siemens und Halske Aktien-Gesellschaft, Messrs. H. Mendl and Co., and the Chinesische Elektricitäts-Gesellschaft, M.B.H., who have acquired from the Imperial Chinese Government the right to establish an electric lighting station at Peking. The prospectus states that prior to the Boxer rising an electrical plant was established at Peking, and installations had been made in the Legation quarter, but a few days after the station had commenced supplying current the Boxers destroyed the buildings and books. This company will acquire the land on which that station stood, value at £2,000, and the plant, machinery, and stock at present in Peking, and Crompton and Co. have undertaken to establish the electrical plant and act as managers to the company in the Chinese capital.

Newton Abbot.—The Urban Electric Supply Company are erecting works in Teign-road, Messrs. Parker Bros. having secured the contract. The building is of brick, with red cornices, and will contain four large offices, engine-room, boiler-room, battery-room, showrooms, stores, and workshops. A temporary chimney will be constructed of steel plates for use until the brick stack is erected. Babcock-Wilcox boilers are now at the station awaiting delivery, and they will be put in forthwith. The high-speed engine, 100 h.p., and running at about 450 revolutions a minute, is by Messrs. Belliss and Morcom, Birmingham. The supply will be on the three-wire system, and batteries are to be installed to ensure a continuous and steady supply. The company will commence to lay the mains about the end of July, and hope to be ready with the light by next winter. Each of the mains consists of three conductors of copper, insulated with vulcanised bitumen supported on bridges in a wood trough, which is then run in solid with refined Trinidad bitumen, and the whole covered by a continuous layer of hard tiles. The boxes to be put in at the feeder point where the feeder joins the distributor will be of the pillar type set in the footway on the kerbstone. Those at other points where the distributors join one another are cast-iron boxes, with covers sealed by an oil lute and set in brick pits in the footway with separate street covers filled in with concrete. Electric energy is to be supplied by these mains by direct current of low potential on the three-wire system, the pressure at the consumers' terminals being 240 volts, and the pressure in the outers of the cables 460 volts to 530 volts, according to the load. Mr. F. C. Pay, A.I.E.E., is the resident engineer.

Harrogate.—The Corporation have received an elaborate report upon the proposed reduction in charges. In his introduction the chief engineer (Mr. Geo. Wilkinson) says: "The net profit of the electricity supply business for the past year exceeds £1,600. In view of this fact you may wish to make some modification in the rates. The business is at present prosperous enough to allow of some concessions being made to consumers, but in considering same it is as well to bear in mind that during the coming year interest and sinking fund has to be paid on an increased capital expended upon plant and machinery, which is not at present profitably employed, also the undertaking will be called upon to pay an income tax of about £400 during the year. The rates we have at present in force are as follows: Lighting and general—(1) uniform 6d. rate; (2) 6d. rate for the first hour, as shown by the maximum demand indicator, and 4d. afterwards; (3) 6d. and 2d. for consumptions equal to 15,000 units per annum, and over. Power: (1) same as Nos. 1 and 2 for lighting; (2) 2d. per unit where the use averages about five hours per day at two-thirds load. Electric radiators: (1) a flat rate of 2d. per unit; (2) 1½d. per unit where the use does not average less than three hours per day during any quarter. Cooking: 6d. per unit for the first hour and 2d. afterwards. Public lighting: (1) 2½d. per unit." As to the suggested reduction of tariff for private consumers Mr. Wilkinson says: "The present rate is 6d. per unit for the first hour, based on the reading of the maximum demand indicator, and 4d. afterwards, and suggests that the 4d. rate should be reduced to 3d. after the second hour. The effect of this reduction will be to give long-hour consumers, which are our most profitable customers, their supply at a lower average charge per unit. It is also expected that this reduction would encourage consumers to put lamps into dark places where they would be burning continuously, and it would discourage the unprofitable practice of putting lamps into shop windows only and not lighting the back premises. To enable you to decide if it is desirable to make any reduction in the general rate for electricity supply for Corporation purposes, I give the following figures: At present street-lighting is paid for at the rate of 2½d. per unit, and the following figures give the amount paid for the year at this price, and the amount which would have been paid if a 2d. rate had been in force—at 2½d. per unit, £983. 15s. 2d.; at 2d. per unit, £787. 0s. 2d.; difference, £196. 15s. For ordinary office and public building lighting, electric baths, etc., the charges have been 6d. and 4d., and the Corporation have paid at these rates the following for the year ending Dec. 31, 1901: 26,354½ units at 6d., £658. 17s. 3d.; 16,155 units at 4d., £269. 5d.—total, £928. 2s. 3d. And to reduce the Corporation rates to 6d. and 2d. would have modified the Corporation accounts accordingly as shown: 26,354½ units at 6d., £658. 17s. 3d.; 16,155 units at 2d., £134. 12s. 6d.—total, £793. 9s. 9d.; saving £134. 12s. 6d. Alterations are being made at present in the Royal Baths so that all the electricity used for the electric baths may be obtained at a flat rate of 2d. per unit. All the figures given in this report disregard the 5 per cent. allowed for prompt payments."

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Ashton.—The Hurst Urban District Council have consented to the laying a cable to the district infirmary through that portion of the Council's district situate at the junction of Mossley-road and Fountain-street. Tenders are to be obtained for the necessary cable in Katherine-street for an arc light at Albion Schools. A sub-committee has been formed to confer with the Electricity Committee and arrange the price of current for street-lighting during the present financial year.

A New Thames Canal.—The Canal Bill which has been promoted by cement manufacturers and others whose works abut on the Medway has passed the House of Lords, and is now before a Select Committee of the House of Commons. Power is sought for the construction of a canal from Rochester to a point on the River Thames about two miles below Gravesend, about five miles in from the start. It is intended that the haulage on the canal should be done by electrical power.

Bristol.—At every meeting of the Electrical Committee applications for extensions of the mains come up for consideration, and extensions were conceded last week for Silverthorne-lane, Wells-road, Portwall-lane, Hebron-place, Bedminster, Bath-street, Limerick-road, Prince-street, and on Clifton-down. The committee declined to make extensions in Wildway-street (St. Philips), Coronation-road, North-street (Bedminster), and Westbury-park; while reconsideration is to be given to applications from Hope Chapel (Clifton) and Chandos-road.

Bridgend.—An enquiry was held on Wednesday into an application of the Council to borrow £4,000 for electric lighting purposes. The Council have decided to charge consumers 6d. per unit at first, but they expect to be able to reduce this charge in a year or so. At this rate the Council will be in a position to put in connections free of cost. Mr. Hill, of the South Wales Electrical Power Company, and a representative of the Council are making a canvass of the town to ascertain how many private houses and business establishments will use the electric light.

Teddington.—The Electric Lighting Committee reported at the last meeting the receipt of a letter from Messrs. Edmundson's Electricity Corporation, Limited, stating that their electric light mains were laid up to the boundary of the Council's district, and they would be prepared to furnish a supply to Teddington and enter into negotiations for this purpose. The Council decided to invite tenders from companies stating the terms upon which they would be willing to take over the provisional order granted by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, to the Council.

Slough.—The Council in committee having duly considered the advisability of transferring the Slough electric lighting order to the Windsor Electrical Installation Company, or to some other company to be formed for the purpose of acquiring the order, last week resolved that the order for lighting Slough and Datchet by electricity be so transferred upon the terms set forth in the draft deed of transfer as settled by Mr. G. H. Charsley and the solicitor to the Windsor Company and upon condition that any new works will be erected within the urban district of Slough, and that the clerk be instructed to take the necessary proceedings to enable such transfer to be carrried out.

Walsall.—The last report of the Electric Lighting Committee shows that the total number of consumers supplied on May 31 last was 227. During the past month the total units generated at the station were 33,039. The total output from the main generators was 31,660 units. The total units from the transformers was 24,088 (estimated). The units registered on the meters amount to 21,640. The machinery was run for 484 hours. The wages paid amount to £90. The Town Council have decided to apply for sanction to borrow £1,325 for the installation of heat economisers and fan, with the requisite engine power, at the Wolverhampton-street generating station, including the brickwork and fittings.

Dewsbury.—In connection with the report of the electricity department for year ending March 31, 1902, we note that this is the first full year in which the reduced rate of charges has operated—*i.e.*, 6d. for the first hour instead of 1½ hours, as before, and this has made a difference of £270 in the year's revenue to the advantage of their consumers. There were used during the year 1,300 tons of fuel (rough slack)—151 tons at 12s., 68 at 11s., 22 at 10s. 6d., 140 at 10s., and 920 tons at 9s. 6d. per ton. The number of units sold is 258,576. Of their total units for lighting 49 per cent. is at 6d. per unit and 51 per cent. at 3½d., as against 60 and 40 per cent. respectively under the old scale of 1½ hours maximum. The committee have also supplied free 4,500 units to the public library.

Kingswinford.—At the last meeting of the Rural District Council, the clerk read correspondence from the solicitors to the Midland Electric Corporation for Power Distribution in respect to the delay in the provision for electrically lighting the district and the application of the Council to the Board of Trade to arbitrate. They stated that the company had met with difficulties and delays in completing the generating station at Ocker Hill, but this was now being completed, and they believed that the engines were being run this week. The work of laying the remaining cables would not take long, and there was no reason for the Council applying to the Board of Trade. The work would be done at an early date. It was decided to instruct the clerk to write the company that they must complete the whole of he work.

Tunbridge Wells.—It is the intention of the Electric Lighting Committee to charge half price, or 3d. per unit, for all current used in illumination during Coronation week. At the last meeting of the Lighting Committee the borough surveyor submitted a report upon chimney shafts erected and now in course of erection by the Alphons Chimney Construction Company. The matter was referred to the electrical engineer and borough surveyor to prepare a specification. The electrical engineer reported on the question of having the maximum demand indicators calibrated so as to enable consumers to obtain a rebate in respect of each quarter instead of half-yearly, and stating that the manufacturers would supply cards and recalibrate the instruments at their own expense. The consideration of the matter was deferred.

Woolwich.—The Borough Council intend to apply for a loan of £101,000 for the purchase of the Woolwich District Electric Lighting Company's undertaking. At the last meeting of the Council the Town Clerk reported that on May 23 he had completed the purchase by the Council of the Eltham portion of the Blackheath and Greenwich District Electric Light Company's undertaking, and had since notified all the Eltham consumers, numbering 19, that the Council are now the owners of the undertaking, and that all accounts due from them for current supplied during the present quarter should be paid to the Council. A circular has been addressed to the residents of Eltham, together with a pamphlet prepared by the electrical engineer, giving particulars of supply.

Stoke Newington.—The last report of the Electric Lighting and Sites Committee states (1) that the laying of the mains in the High-street and Stoke Newington is now completed; (2) that the Board of Trade have made the Stoke Newington electric lighting order, which empowers the Council to supply electricity within so much of the borough as is not within the area of supply to which the Hackney Electric Lighting Order, 1893, extends, and that the same has been included in a Confirmation Bill now before Parliament; and (3) that the Local Government Board have made an order, subject to confirmation by Parliament, for enabling the Council to put in force the compulsory clauses of the Lands Clauses Act with reference to the lands required by them for the purpose of providing a site for the erection of a refuse destructor.

Australian Contracts.—Messrs. Noyes Bros., of Sydney, N.S.W., the Australian representatives of the British Westinghouse Electric and Manufacturing Company, Limited, have recently secured two important electric power contracts. One is for a complete conversion of the horse tramway system of Adelaide, South Australia, to electric traction. In all, there are some 65 miles of track to be dealt with. The other contract is for a complete electric power installation to be put down in the new railway works of the Queensland Government railways. These works are at Ipswich, near Brisbane, and the plant put down will consist of 800 h.p. of generating plant, with numerous motors for machine driving. The system is to be of the two-phase type. The whole plant, steam, electric, and auxiliary apparatus, is covered by the one contract, the price of which amounts to over a quarter of a million pounds.

Stafford.—The Electric Lighting Committee's report, adopted at the last meeting of the Town Council, referred to Mr. J. Clothier's resignation as electrical engineer, and stated that during the time Mr. Clothier had been in charge of the electric lighting works large extensions of plant had taken place, the streets had all been recabled, and the doubling pressure of supply had been carried out under his supervision. He had performed his duties to the entire satisfaction of the committee, and his resignation was accepted with regret. A honorarium of £50 has been granted him. Steps are to be taken for applying to the Board of Trade for a provisional order to supply electricity outside the borough. The following amended scale of discounts will be allowed on accounts for current consumed per quarter—namely: up to 140 units, 2½ per cent.; between 140 and 700 units, 5 per cent.; between 700 and 1,400 units, 7½ per cent.; above 1,400, 10 per cent.

Coventry.—With regard to the enquiry noted in our last issue, we find that the sum of £22,483 to be borrowed includes £725 as the excess cost of the purchase of a 600-kw. alternator instead of a 400-kw. one previously sanctioned, and £6,725 for a new 600-kw. steam alternator, £640 for large boilers and forced draught, £850 for steam-pipes, £800 for injection and discharge pipes to new hot-well, £50 for second hot-well, £200 for grease filter, £60 for second grease filter, £125 for second evaporator and erection, £350 for switchboard extensions, £100 for larger foundations for alternator, £250 for foundations for new plant, £1,850 for coal bunkers and conveying plant, £2,250 for meters and house connections for 130 consumers, £5,000 for mains, £500 for transformers, and £2,000 for purchase of motors. The Electric Light Committee have been empowered to dispose of the No. 1 plant at the electric light works, which has become too small and useless, and its place is to be taken by more up-to-date plant.

Arc Works Sports.—The Arc Works Club, which is an athletic club composed entirely of the employés of Messrs. Crompton and Co., Chelmsford, held their annual meeting at the club ground, Chelmsford, on Saturday last. For the comfort and convenience of those travelling from London saloon carriages were attached to the 10.55 train from Liverpool-street. Upon arrival at Chelmsford conveyances were in attendance, and the party driven to the Arc Works, where by Colonel Crompton the visitors were conducted through the various manufacturing departments, the Mayor of Chelmsford, J.P., V.D., and Major Rasch, M.P., honouring the company by their presence. After luncheon another drive brought the visitors to the club ground. Despite the unsettled state of the weather, it did not damp the spirits of the true sportsmen, and the large number present had the satisfaction of witnessing a well-arranged athletic programme, some of the items being very closely contested. The valuable prizes were distributed by Mrs. Crompton.

King's Lynn.—The engineer's last report states that since the last meeting applications had been received for 178 8-c.p. lamps, including two small motors, making a total of 12,392 lamps from private consumers. Two Nernst lamps had been fixed for trial in the streets, one at the corner of New Conduit-street and one at the East gates. It is stated that these lamps give 66 c.p., or double the light, at about one-fifth less current than the ordinary lamps. Up to the present they are working satisfactorily, and have required no attention. Another 12 are to be obtained. The working expenses for the month of April, as compared with the same month last year, are stated as follows: units generated 21,909, last year 19,618; units sold to private consumers 6,645, last year 3,080; units sold at power rates 902, last

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year 14; fuel, stores, repairs, and wages at station (cost of) £120. 6s. 1d., last year £159. 4s. 7d.; cost per unit generated 1·31d., last year 1·94d.; wages of lamplighters and outside staff £15. 9s. 11d., last year £14. 15s. 4d.

Electric and General Investment Co.—We are informed that the directors have decided to recommend the payment of the following dividends, etc., for the year ended May 31, 1902: Ordinary shares—a dividend of 5s. per share, of which 2s. per share was paid on account in December last, leaving 3s. per share to be distributed, and a bonus of 2s. per share; the trustees for the ordinary shares reserve fund propose to distribute out of the proceeds of investments sold and dividends received 1s. per share, making a total present distribution of 6s. per share, or 30 per cent., or a total distribution of 8s. per share, or 40 per cent. for the year. Founders' shares—a dividend for the year ended May 31, 1902, of £50 per share; the trustees for the founders' shares reserve fund propose to distribute out of the proceeds of investments sold and dividends received, £10 per share; making a total present distribution of £60. The above-mentioned payments will be subject to the deduction of income tax. The dividends, if sanctioned by the shareholders, will be paid on July 3, 1902.

Brighton.—On Saturday the Mayor (Alderman Stafford) switched on the current for an electric motor, which has just been installed at Brill's Baths to supersede the steam-pump hitherto in use for supplying the baths with sea-water. The electric installation enables the pumping to be done in one-third of the time occupied by steam and at about one-fourth of the cost. The motor is provided by the Corporation. Alderman Stafford, congratulating the directors of Brill's Baths on availing themselves of the Corporation current, mentioned that a large establishment, by using the municipal supply instead of paying for a separate installation, was saving £700 a year. Mr. H. P. Parshall has been engaged by the Corporation to investigate the difficulties which have arisen with regard to the charges for current by the Lighting to the Tramways Committee. The Tramways Committee, who get their current in bulk from the Lighting Committee, complain that they are charged 1½d. per unit for their supply, and, on this basis, they last quarter paid to the Lighting Committee £1,485. 18s. 7d.

Presentation. — To celebrate the completion of the British Insulated Wire Company's contract for the installation of the Glasgow Corporation telephone department's underground work, the company's resident superintendent, Mr. A. C. Devey, has been presented with a handsome silver cigarette case by the chief members of the telephone department, the presentation being made at the central exchange by Mr. John Macfee, deputy manager. On the same occasion, Mr. J. C. Jones, assistant superintendent, on behalf of the company's local staff and workmen, presented Mr. Devey with a pair of statuettes and a silver cruet as a souvenir of the cordial relations existing between them. The work just completed comprises 100 miles of underground 3in. cast-iron pipes, and about 150 miles of cable equivalent to approximately 30,000 miles of single wire. This is the second largest underground telephone system in the world, the Post Office system in London taking the first place. Glasgow can, however, claim to have installed the largest telephone cable ever made. This cable being too large to go into the 3in. pipes, is accommodated in a 6in. pipe.

Post Office Telephones.—Some time ago representations were made to the Post Office by Mr. W. F. D. Smith as to the delay in connecting subscribers to the new telephone service of the Department, some of whom in the Strand district have been waiting for six months to be place on the Post Office lines. Mr. Austen Chamberlain has replied that about 1,650 telephones are working in connection with the central exchange in Queen Victoria-street. In Fleet-street and the Strand the main cables for subscribers' lines were laid and completed some time ago, but in order to avoid unnecessary opening the footways in the busiest thoroughfares, arrangements have had to be made to transfer the telegraph wires in the existing pipes under the pavement to other routes, so as to make these pipes available for the distribution of telephone wires. The work is of a difficult and complicated nature, but it is hoped that it will be completed along Fleet-street and the Strand in the course of three weeks or a month. As soon as this has been done the work of connecting the premises of subscribers in the Strand district with the main lines of telephone wires will proceed very rapidly.

Swansea.—We note that applications for power from private consumers are coming in very quickly. One firm alone is applying for 230 h.p. Up to the present an effort has been made to keep consumers from coming on owing to shortness of plant, but now the work of installing 2,600-kw. sets is well advanced applications are coming in quicker than they can be dealt with. The amount obtained for private lighting is 3·54d. From Mr. Prusmann's first year's report the works' cost and total costs appear very satisfactory. A deficit of £349, even when excluding sinking fund for the present year, and making no allowance for depreciation, is not a bad result to obtain at the end of the first year, with an average price of only 3·54d., with no tramway load, and practically no day load whatever. It is expected that the second year's working will bring the undertaking very near turning the corner, if it will not actually show a profit. A report by the electrical engineer on the police telephones has been approved recommending that the whole service should be renewed—instruments and connections—and that a central exchange be established, at a cost of £130 to £150, to connect the 15 stations.

Croydon.—The appointment of Mr. A. C. Cramb, of West Hampstead, as chief assistant electrical engineer has been confirmed. Application is to be made to the Board of Trade that the Board should appoint an electrical inspector under the Croydon Corporation Electric Lighting Order, 1890; at the same time suggesting that Mr. Hugh Erat Harrison, of the Electrical Standardising Institute, Faraday House, be nominated by the Council for the appointment upon the following terms of renumeration: Examination of meters in London—single meters, 10s. 6d. each; from two to 12 meters, 8s. 6d. each; each meter beyond 12, 7s.; experimenting upon and reporting on sample meters, £1. 1s. each. Certifying of meters—inspecting and testing at Croydon, £2. 2s. per day, in addition to expenses. Retaining fee as electric inspector—£25; the retaining fee, however, merges into the above stated fee, so that until the sum due for tests, etc., exceeds £25 no charge is made to the Corporation beyond this fee. Mr. D. Cowan, station superintendent at the electricity works, is to receive a bonus of £20, as an equivalent for loss of house accommodation for about 18 months, and when the house now being built is occupied by Mr. Cowan a rent of 5s. a week will be charged, Mr. Cowan to receive electric light free of charge.

Belfast.—The accounts of the electric lighting department for the year ending March 31, 1902, show that the output has increased from 908,067 in 1900-1901 to 1,206,699 in 1901-1902, or about 33 per cent., and the lamp connections have increased in the same period from 79,000 to 98,000 8-c.p.'s, which included 900 h.p. in motors. The average price obtained has been reduced from 3¾d. to just under 3½d., over 20 per cent. of the current sold being at motor prices. The cost figures have all been reduced, with the exception of maintenance, which is higher than the previous year, this being due to heavy expenditure to repairs to buildings due to the storm last winter and reconstruction of a portion of the main flue. The committee consider it good policy to keep everything in good repair out of revenue. The gross profit on the year amounted to £9,053. 19s. 1d., the interest and sinking fund, etc., absorbing this, and leaving as net result a deficit of £347. 7s. 7d., which is being brought forward to next year. The interest and sinking fund are heavy in comparison with the revenue, owing to the fact that very large extensions of plant and mains have been carried out which will not be remunerative for some time to come. Further extensions for the supply of power to some of the large shipbuilding yards are in hand, and it is expected that the motor connections and output will be doubled during the present year.

Jarrow.—The County of Durham Electric Power Distribution Company are erecting temporary works in connection with which Mr. W. E. Tooth is the resident electrical engineer. The plant will consist of Fraser dry-back marine type boilers of 140lb. pressure and two 75-h.p. Brush Universal engines of 380 revolutions, direct coupled to two Brush direct-current bipolar dynamos with a total capacity of 100 kw. E.P.S. accumulators, with a normal output of 194 kilowatt-hours and a maximum discharge rate of 280 amperes, will be installed. Triple-concentric feeders are to be used, laid solid, also three-wire direct-current three-core distributors laid solid. It is proposed to charge for lighting 7d. per unit per first 100 hours per quarter and 1d. afterwards, and for power 4d. and 1½d., with discounts rising from 6½ per cent. for a consumer with 16 per cent. load factor to 41 per cent. with 52 per cent. load factor. The main buildings have been erected with sufficient accommodation for five 500-kw. motor-generators. Power will be supplied in bulk by the Newcastle Electric Supply Company at 10,000 volts. A cable laid in a disused coal mine will convey the current across the River Tyne from the north to the south side. The price charged by the Newcastle Company will be £3. 10s. per annum per kilowatt of maximum demand, and ·35d. per unit for all energy supplied. This is equivalent to 2·65d. per unit for first hour's maximum demand, and ·35d. for succeeding units.

London County Council.—The Council on Tuesday agreed to lend the Bermondsey Borough Council £13,925 for electric lighting and dust destructor works. Notice of intention to lay mains, etc., were approved as follows: Blackheath and Greenwich District Electric Light Company (two transformer boxes and mains in connection therewith in Tranquil-vale, and low-tension mains along a portion of Coleraine-road, St. John's-park, along Lee-road, across High-road, and along portion of Eltham-road); Kensington and Knightsbridge Electric Lighting Company (mains along Glendower-place and Pelham-street); Notting Hill Electric Lighting Company (mains along Clarendon-road); Brompton and Kensington Electricity Supply Company (low-tension mains along Cromwell-crescent and Westgate-terrace); Charing Cross and Strand Electricity Supply Corporation (mains along Crown-court, Martlett-court, and portion of Strand and Strand-lane); County of London and Brush Provincial Electric Lighting Company (low-tension mains along Martin's-road, Lamb's Conduit-passage, Oxford-road, Putney Bridge-road, High-street Putney, and Upper Richmond-road); Metropolitan Electric Supply Company (low-tension mains along Gloucester-place, Dorset-street, Manchester-street, South-street, North-street, Montagu place and square, Bryanston-square, and high-tension mains along Loudoun-road); St. Pancras Borough Council (mains along St. Mark's-square, Cromer-street, and a portion of Windmill-street); London and Brush Provincial Electric Lighting Company (transformer box in Lambeth-road and low-tension mains along Burbage-road); London Electric Supply Corporation (mains of high and low tension along Tooley-street, Tower Bridge-approach, Horselydown-lane, Gainsford-street, and Queen Elizabeth-street); Westminster Electric Supply Corporation (mains across Bridge-street and along a small portion of the Victoria-embankment); and from St. Pancras Borough Council (mains along Gower-street and London-mews). Notices to lay mains, served under orders granted to local authorities, were received as follows: Battersea Borough Council (New-road); Hampstead Borough Council (Redington-road, East Heath-road, Albion-road, Cressy-road, Holford-road, Minster-road, King Henry's-road, Priory-road, and Sarre-road); Islington Borough Council (portion of Cloudesley-square, City-road, Colebrooke-row, Grosvenor-road, Wallace-road, and Petherton-road); Stepney Borough Council (Vallance-road, New-road, Well-street, Goulston-road, and Brick-lane); Woolwich Borough Council (portion of Villas-road).

Coronation.—From the explanation accompanying a handy map recently published in the *Daily Telegraph* we extract the principal electrical features. There will be a number of banks, insurance, and other offices in Threadneedle-street (where there is a celluloid display),

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Cornhill, Lombard-street (old bankers' signs reproduced), Gracechurch-street, and Bishopsgate-street (fine shows by banks). Foreign bankers in the City make exceptional efforts. There is also the Peace design in King William-street, the Monument with its searchlights (by Pain), effective river reflections from the buildings at London Bridge, and the festooning of the bridge itself in lamps. Broad-street Terminus is also to be worth seeing, and in Cheapside (Peel's Statue) and Cannon-street illuminations are in hand. The Guildhall should be seen. In the City the crowd will "keep to the right." Proceeding westwards by the direct route, Ludgate-hill, Fleet-street, and the Strand have numerous displays by banks, assurance offices, and newspaper offices. The Westminster Town Hall will offer a new departure in electric illumination. On the northernly route the illuminations begin at Holborn-circus, and there is a celluloid show near Holborn Bars. From Blackfriars Bridge along the Thames-embankment there should be noted the electric crown over the statue of Queen Victoria at Blackfriars Bridge, the display of the City of London School, and the Embankment and Gardens as far as Westminster Bridge, in which 20,000 lamps will be employed. Waterloo Bridge will have 2,500 electric lamps. There is a special display in Parliament-street (London and North-Western Railway Company's offices), giving the equivalent of over 4,000 8-c.p. lamps; the series of Agent-Generals' offices in Victoria-street; the Government Offices (mostly Royal emblems) in Whitehall; the London County Council decorations in Spring-gardens; the Cockspur-street shipping offices' transparencies; the clubs in Pall-mall (largely gas flambeaux); and the Royal Palaces and residences: Marlborough House, York House, St. James's Palace, Clarence House, with Stafford House and Bridgewater House, facing the Green Park. St. James's-street will be controlled by the new Metropolitan Police system of circulating crowds. In the vicinity are the St. James's-square decorations. Albemarle-street (Defries) will give a uniform decorative effect at night. Special features will be found in Grosvenor-square, Berkeley-square (Lansdowne House), Piccadilly (particularly Devonshire House), Regent-street (Royal tradesmen's crystal devices), and at Oxford-circus, besides displays in New Bond-street, Conduit-street, and connecting thoroughfares. Lying westwards of Buckingham Palace this area includes a number of displays in Belgrave, Lowndes, Eaton, and Chester squares, with Grosvenor-place and Hyde Park-corner, near to which is Lord Rothschild's residence. The squares are sure to be worth visiting. Chester-square will have fairy lamps. The West-end is to have a unique illumination of the new Westminster Cathedral with electric lights on the evenings of the 26th and 27th inst. Among the devices employed will be a powerful searchlight to be worked from a scaffolding 282ft. from the ground. There will also be two enormous crowns, containing some hundreds of electric lights. The work has been entrusted to Messrs. Donnison, Berlyn, Sillem, and Co. by the Duke of Norfolk on behalf of the Catholic Union of Great Britain. In addition to the illuminations mentioned, a number of others are in preparation.

PROVISIONAL PATENTS, 1902.

JUNE 5.

12817. Improvements in or relating to electric switches. Maunsell Mercier and William Osborne Andrews, 57, Barton-arcade, Manchester.

12823. Improvements in electrical measuring instruments. Arthur Cecil Heap and William Oliver Smith, Century Works, Lewisham, London.

12846. An improved controller and switch for electric motors. John Bush and Matthew Thomas Medway, 90, Lausanne-road, Nunhead, London.

12857. Improvements in and relating to storage batteries. Walter Edward Winship, 60, Queen Victoria-street, London. (Complete specification.)

12870. Improvements in or connected with apparatus for charging electric accumulators. Société Lespagnol et Mériguet, 23, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents Act, 1901, Nov. 14, 1901, being date of application in France.) (Complete specification.)

12881. Improvements in electric resistances and safety fuses. George Henry Faweus, 53, Chancery-lane, London.

JUNE 6.

12951. Improvements relating to electromagnetic switches. Oscar Schwimmer, Ignatz Schön, and Max B. Schwimmer, 45, Southampton-buildings, Chancery-lane, London.

12956. Improvements in transmitting apparatus for electric telegraphs. Philip Middleton Justice, 55, Chancery-lane, London. (The Rowland Telegraphic Company, United States.) (Complete specification.)

12958. Improvements in switches for electric motors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

12959. Improvements in machines for winding insulating tape on the coils of electrical apparatus. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

12960. Improvements in electrical conductors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.)

JUNE 7.

13037. An improved coin-freed machine or apparatus for administering electricity. John Jofeh, 8, Quality-court, Chancery-lane, London.

JUNE 9.

13064. An improved electrical fire-alarm. Robert Wailes Cooke and John Scott, Akenside-hill, Newcastle-upon-Tyne.

13074. A patent automatic electric heating apparatus for governing incubators. Frederick Tomlin, 124, Chancery-lane, London.

13082. An improved combined electrical switch and cut-out for street poles and the like. Max Railing and John Hillery Collings, 71, Queen Victoria-street, London.

13088. Improvements in electric arc lamps. Robert Hopfelt, 53, Chancery-lane, London.

13115. Improvements in wireless telegraphy. Jocelyn Home Thomson, 323, High Holborn, London.

13119. Improvements relating to electrical testing apparatus. David Perret, 45, Southampton-buildings, Chancery-lane, London.

JUNE 10.

13154. Improvements in and connected with electromagnetic annunciators for telephonic or similar purposes. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actiengesellschaft Mix und Genest, Germany.)

13164. Improvements in regulating electric light circuits, specially applicable to the lighting of trains. Henry Leitner and Richard Norman Lucas, 44, St. Martin's-lane, London.

13170. Trolley wire support. Ebenezer Hill and Ebenezer Hill, jun., 52, Chancery-lane, London. (Complete specification.)

13171. Trolley wire support. Ebenezer Hill and Ebenezer Hill, jun., 52, Chancery-lane, London. (Complete specification.)

13175. Improvements in equalising appliances for interconnected polyphase-current systems. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

13181. Improvement in the current collectors or trolleys of electric railway and tramcars. Jasper Wetter, 37, Essex-street, Strand, London. (Paul Pfeiffer, Germany.)

13205. Improvements in or relating to electric clocks or time-pieces. Josef Bühler, 111, Hatton-garden, London. (Complete specification.)

15207. Improvements in or relating to electric telephotographic or reproducing apparatus. Alfred Julius Boult, 111, Hatton-garden, London. (Laurent Semat, Egypt.)

JUNE 11.

13255. Improvements in electrical measuring instruments. Arthur Cecil Heap, Century Works Lewisham, London.

13267. Improvements in and in connection with fusible electric cut-outs. William P. Burke, 17, Bromley-street, Commercial-road, London.

13275. Improved safety device for electric railways. Edward Parry and Frederick William Bidder, 6, Bream's-buildings, Chancery-lane, London.

13291. Electrical apparatus for indicating time at various places from a principal timekeeper. Léon Kusnick, 47, Lincoln's-inn-fields, London.

JUNE 12.

13297. An improved trolley head, arm, and posts for overhead electric wires, and a safety appliance for rendering broken electric wires harmless. Jasper James Carter, 4, Vergemont Hall, Clonskeagh, co. Dublin.

13308. Improvements in or appertaining to lifeguards for electric tramcars or the like. Dionysius Newton, 9, Tempest Hey, Liverpool.

13328. An intensive electric and solar furnace. Adeline Paget, 41, Devonshire-street, Portland-place, London. (Newton W. Emmens, United States.)

13357. Improvements in connection with trolleys for electric tramways or railways. The British Thomson-Houston Company, Limited, and Frederick Samuelson, 83, Cannon-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published July 3.

1901.

4863. Combined electromagnetic and carbon microphone. Rossetter.

9959. Incandescent electric lamp globes. Bohm.

11552. Automatic self-locking lifeguards for electrically-propelled cars or other vehicles. Hudson.

12089. Automatic electrical signalling apparatus for railways. Spagnoletti.

12094. Electric cables. Tremain.

12121. Fluid pressure machinery for pressing together the copper segments and insulating strips of electric commutators and for compressing the discs of armatures. Petch.

1902.

947. Apparatus to give alarm by mean of an electric bell in the event of a locomotive running past a signal at danger. Chubb.

1136. Electrodes for arc lamps. Gebr. Siemens und Co. and Viertel.

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TRAFFIC RETURNS.

Line.	Returns for week Ending	1902.	1901.	Increase or decrease.	Total receipts for half-year. 1902	1901.
		£	£	£	£	£
Aberdeen Corporation	May 31	754	717	+ 36	36,875	34,648
Birmingham Tramways	June 14	4,649	4,640	+ 9	113,148	103,664
Blackburn Corporation	,, 15	710	715	- 5	16,484	14,297
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 14	470	553	- 83	7,844	8,424
Bolton Corporation	,, 15	1,470	1,337	+ 133	34,158	33,431
Bradford Corporation	,, 1	2,937	1,431	+ 1,506	51,258	18,628
Bristol Tramways Company	,, 13	4,235	4,504	- 269	—	—
Carlisle Tramways Company	—	—	—	—	—	—
Central London Railway	,, 14	7,000	6,240	+ 760	161,819	148,775
City and South London Railway	,, 15	2,953	1,869	+ 1,084	71,449	47,232
Cork E. T. and L. Company	,, 12	585	536	+ 49	10,198	9,881
Darwen Corporation	—	—	—	—	—	—
Darwen-Hoddlesden	—	—	—	—	—	—
Dover Corporation	,, 14	206	217	- 11	4,532	4,388
Dublin & Lucan Electric Railway	,, 15	110	115	- 5	2,320	2,258
Dublin U. T., electric cars	,, 13	3,690	3,778	- 88	—	—
Dublin S. District, Electric	,, 13	853	913	- 60	—	—
Dundee Tramways Company	May 14	647	678	- 31	—	—
Glasgow Corporation	June 14	11,648	11,419	+ 229	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 14	1,716	1,661	+ 55	18,429	18,216
Liverpool Corporation	,, 7	10,492	9,590	+ 902	209,534	193,714
Liverpool Overhead Railway	,, 15	1,407	1,607	- 200	34,281	37,713
Newcastle-on-Tyne Corporation	,, 7	2,665	—	—	—	—
Portsmouth Corporation	,, 14	1,450	652	+ 798	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 15	3,984	—	—	—	—
Southampton Corporation	—	—	—	—	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £237 decrease.
Barcelona Ensanche y Gracia, £120 decrease. Barcelona £149 increase.
Brisbane, £293 increase (month of May, £10,832; decrease, £573).
Buenos Ayres and Belgrano Electric (month of May, receipts £12,464; increase £322), £113 decrease.
Calcutta, £246 increase.
Cape Town (month of May), receipts, £16,330; expenditure, £7,205.
Isle of Thanet Electric, £134 decrease
Mexico Electric (month of May), receipts, £20,380; expenditure, £11,400.
Perth Electric, £28 increase.
Port Elizabeth (month of May), receipts, £3,796; expenditure, £1,872.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Last price.
Commercial and Industrial.—	£	£
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1 ..	¾-⅞
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¼-½
—— Ordinary, 1-125,000	1 ..	⅜-½
British Insulated Wire, Ord., 1-70,000	5 ..	7¼-8½
—— 6 per cent. Cum. Pref., 1-40,000	6 ..	5¼-6
—— 5 per cent. Mortgage Debentures	100 ..	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	5¾-6
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2 ..	1¼-1⅝
—— Non. Cum., 6 per cent. Pref.	2 ..	1¾-2¼
—— 4½ per cent. 1st Debenture Stock	100 ..	101-104
—— 4½ per cent. 2nd Debenture Stock	100 ..	95-100
Callender's Cable, Debentures	100 ..	111-115
—— Ordinary	5 ..	16¼-17¼ xd
—— 5 per cent. Pref.	5 ..	5¾-6¼
Crompton and Co.	3 ..	3-3¼
—— 5 per cent. Debentures	100 ..	103-106 p.c
Edison and Swan United, Ordinary	3 ..	⅛-⅜
—— 5 per cent. Debentures	5 ..	1¼-2¼
—— 4 per cent. Deb. Stock, Red.	100 ..	75-80
Electric Construction, Limited, Nos. 1 to 112,100	2 ..	1¼-1⅜
—— 7 per cent. Cumulative Pref.	2 ..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	99-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10 ..	10-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100 ..	98-101
W. T. Henley's Telegraph Works, Ordinary	5 ..	16¼-17½
—— 4½ per cent. Preference	5 ..	5¼-6
—— 4½ per cent. Debentures	100 ..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	99-102
Parker, Thos., Limited, Ordinary	10 ..	15½-16½
Telegraph Construction and Maintenance	12 ..	34-37
—— 5 per cent. Bonds	100 ..	103-106
Telegraph Manufacturing, Ordinary	5 ..	—
—— 5 per cent. Cum. Pref.	5 ..	—
Willans and Robinson, Ordinary, 1-30,000	5 ..	8¼-9½
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	6¼-6¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107
Electric Railways.—		
Central London, Ordinary	100 ..	104-107
—— 4 per cent. Pref.	100 ..	103-106
—— ,, ,, deferred	100 ..	100-103
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100 ..	117-120
City and South London, Consolidated Ordinary	100 ..	71-74
—— 4 per cent. Debenture Stock	100 ..	115-118
—— 5 per cent. Pref. Stock '91	100 ..	128-133
—— ,, ,, ,, '96	100 ..	125-129
—— ,, ,, ,, '01	100 ..	121-125
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13¼
—— Ordinary, 1-50,000	— ..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	— ..	102-104
Waterloo and City, Ordinary	100 ..	93-96

Name.	Amount paid.	Last price.
Electric Lighting and Supply.—	£	£
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	¼-⅜
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100 ..	100-104
Bournemouth and Poole, Ordinary	10 ..	11-12
—— 4½ per cent. Cum. Pref.	10 ..	9¼-10¼
—— Debenture Stock, Red.	100 ..	103-106
Brompton and Kensington, Ordinary	5 ..	9-9½
—— 7 per cent. Preference	5 ..	9-9¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	8¼-8½
—— Nos. 20,001-30,000	5 ..	8¼-8½
Cambridge Electric Supply Company, Ltd., £10 Ord.	8 ..	14½
—— ,, ,, £10 Ord.	6 ..	10¾
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100 ..	105-107
Charing Cross and Strand	5 ..	9-10
—— Nos. 50,001-70,000	5 ..	8-9
—— 4½ per cent. Cum. Pref.	5 ..	5¼-5¾
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100 ..	105-107
Chelsea Electricity Supply	5 ..	5-5¼ xd
—— 4½ per cent. Debentures	100 ..	108-111 xd
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	11¼-12¼
—— 5 per cent. Debenture Stock	100 ..	125-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100 ..	103-106
County of London and Brush Provincial, Ordinary	10 ..	7¼-8¼
—— 6 per cent. Cum. Pref.	10 ..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100 ..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	6¼-6¾
—— 6 per cent. Cum. Pref.	5 ..	5¾-6¼
—— 4½ per cent. First Mort. Deb.	100 ..	108-111
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5 ..	4¼-4¾
—— 5 per cent. Debenture Stock, Red.	100 ..	101-104
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5 ..	5¾-6¼
—— 4½ per cent. First Deb. Stock, Red.	100 ..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5 ..	10-11
—— 4 per cent. Debenture Stock, Red.	100 ..	101-104
Kensington and Knightsbridge and Notting Hill	100 ..	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9¾-10¼
London Electric, Ordinary	3 ..	1¼-1⅜
—— 6 per cent. Pref.	5 ..	4-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	94-99 xd
Metropolitan, Ordinary	10 ..	16¼-17¼
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100 ..	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary	5 ..	9-9¼
—— Preference	4 ..	6¼-6½
Notting Hill Electric Lighting	10 ..	14-15
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7-7¼
—— £4½ Shares, New	4½ ..	6-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5-6
—— 4 per cent. Debenture Stock	100 ..	99-102
River Plate Electric Light and Traction, Deb.	100 ..	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100 ..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	1¾-2¼
—— 4 per cent. Debenture Stock	100 ..	80-90
South London, Ordinary	5 ..	2¾-3¼
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14¼-15¼
—— 7 per cent. Pref.	5 ..	8¼-8¾
—— 3½ per cent. Deb.	100 ..	98-101
Westminster, Ordinary	5 ..	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	2½ ..	3¼-4 xd
Electric Tramways.—		
Anglo-Argentine, 1-260,007	5 ..	4¼-4½
—— Permanent 6 per cent. Debenture Stock, 1888	100 ..	127-132
Blackpool and Fleetwood Tramroad	10 ..	13¼-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5 ..	3¾-4¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5 ..	4¾-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100 ..	104-107
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10 ..	7-7½
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10 ..	9¾-10¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40 ..	102-104 p.c
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10 ..	13¼-14½
—— 6 per cent. Cm. Pf., 30,001-60,000	10 ..	12¾-13
—— 5 per cent. Perpetual Debenture Stock	100 ..	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5 ..	1⅝-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	5-5¼
—— 5 per cent. Deb. Stock, Red.	100 ..	104-107
—— Prov. Cert., all paid	100 ..	97-100
Cape Electric Tramways, Nos. 1-400,000	1 ..	2⅜-2⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10 ..	4¾-5¼
—— 4 per cent. 1st Mortgage Debentures	100 ..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10 ..	13-14
—— 5 per cent. Cum. Pref.	10 ..	11-12
—— Debentures	100 ..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10 ..	11¼-12¼
—— 6 per cent. Pref., Nos. within 1-60,000	10 ..	14¼-15¼
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100 ..	96-99
Imperial Tramways, Ordinary	all ..	22-22¼
—— 6 per cent. Cum. Pref.	all ..	14¼-15¼
—— 4½ per cent. Deb. Stock	100 ..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5 ..	4¼-5
Kidderminster and District Lighting and Traction, Pref.	5 ..	3¾-4
London United Trys. (1901), 5 per cent. Cum. Pref. Within 1-82,500	10 ..	10¾-11¼
—— ,, ,, ,, ,,	5 ..	5¼-6
—— 4 per cent. 1st Mt. Db. Stock, Red.	100 ..	106-108
—— ,, ,, Prov. Crts.	50 ..	55-57
New General Traction, Ordinary	5 ..	2-3
—— 6 per cent. Cum. Pref.	10 ..	3-4
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100 ..	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	10½-10¾
—— 5 per cent. Cum. Pref.	10 ..	11¼-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100 ..	101-104
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	9-10
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
—— 4½ per cent. Debenture Stock	100 ..	107-110
South Lancashire Electric Traction and Power Company—		
—— £250,000 Ordinary	1 ..	1
—— £51,132 6 per cent. Preference	12s. ..	¼
—— £50,000 ,, ,,	1 ..	1
—— £500,000 4½ per cent. Debenture Stock	60 p.c. ..	60 p.c.
Telephones.—		
National Telephone, Preferred	100 ..	95-99
—— Preferred, 590,001-790,000	3½ ..	3⅛-3⅜
—— Deferred Stock	100 ..	53-57
—— 6 per cent. Cum. First Pref.	10 ..	12-14
—— 6 per cent. Cum. Second Pref.	10 ..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 ..	4¼-5¼
—— 3½ per cent. Deb. Stock, Red.	100 ..	94-97
—— 4 per cent. Deb. Stock, Red.	100 ..	103-107
Oriental Telephone and Electric Company	1 ..	15/16-1 1/16

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NOTES.

Wireless Telegraphy in Alaska.—We learn that the Marconi Wireless Telegraph Company have entered into a contract with the United States Government to instal their system in Alaska, to connect Fort Davis with St. Michael's, an uninterrupted distance of 108 miles. The installation is estimated to cost about £2,000.

An Electric Combine.—It is announced that an offer has been made by the General Electric Company of America to acquire control of the Sprague Electric Company. According to the information received, the first-named company propose to obtain the controlling interest in the Sprague concern principally by the exchange of securities. The capital of the Sprague Electric Company is given at £1,000,000, and that of the General Electric Company, which recently increased its capital stock, at £9,000,000, so that the combined capital of the amalgamated houses will be 10 millions sterling.

American Association.—We have received a preliminary announcement of the fifty-first annual meeting of the American Association for the Advancement of Science, which opens to-morrow at Pittsburg, in the United States. The conference will be continued the best part of next week, and the several affiliated scientific societies will hold their sessions in Pittsburg at the same time. Elaborate arrangements have been made for the reception of the members and their friends attending the convention, and some very important papers are expected to be contributed by prominent scientists of the day.

Cable Rates.—It is only a natural consequence that as time goes on the rates enforced by the telegraph companies should be steadily decreased to within reasonable limits, but it is especially noticeable in the past six months that reductions in tariffs to all parts of the world have come upon each other with remarkable rapidity. The latest company to follow this lead is the Western Telegraph Company, who have announced a reduction of the cable rates to British and German West Africa. From the 1st prox. the following reductions to these places will apply: Lagos, from 6s. 5d. to 6s. 3d. per word; Brass, 6s. 7d. to 6s. 3d.; Bonny, 6s. 10d. to 6s. 3d.; Lagos Government stations, 6s. 7d. to 6s. 5d.; Cameroons, 7s. to 6s. 5d.

Rontgen Society.—The following is the list of officers and council for the ensuing year, who will be balloted for at the annual meeting of the society on July 3: President—Mr. Herbert Jackson, F.C.S.; vice-presidents—the Right Hon. Lord Blythswood, the Right Hon. the Earl of Crawford, K.T., Messrs. J. Mackenzie Davidson, M.B., D. Ferrier, M.D., F.R.S., J. H. Gladstone, D.Sc., F.R.S., and Dawson Turner, M.D.; council—Messrs. G. B. Batten, M.D., Barry Blacker, M.D., Wm. Chattaway, J. H. Gardiner, F.C.S., A. W. Isenthal, F.R.P.S., the Rev. P. Mulholland, B.A., Messrs. E. Payne, M.A., C. E. S. Phillips, G. H. Rodman, M.D., E. W. H. Shenton, L.R.C.P., H. Snowden Ward, F.R.P.S., and J. Wimshurst, F.R.S.; hon. treasurer—Mr. J. J. Vezey, F.R.M.S.; and hon. secretary—Mr. F. Harrison Low, M.B.

Machinery Users' Association. — The annual general meeting of the above association was held on Thursday, the 19th inst., at the Westminster Palace Hotel. Sir W. H. Houldsworth, Bart., M.P., presided, and in moving the adoption of the report and accounts referred to the improved position in which the association stood owing to the report of the Royal Commission on Local Taxation and of the recent judgment of the Lord Chief Justice in the case of Crockett and Jones and the Northampton Union Assessment Committee. A recent decision in Scotland, adverse to the manufacturers, had brought a great amount of Scotch support to the association. Mr. Lewis Evans referred to the question of water supplies as being a most important one for manufacturers, while Mr. W. H. Holland, M.P., spoke with approval of the formation of the Commercial Committee in Parliament.

Auto-Decoherers.—The question of self-decohering coherers is discussed by Mr. M. A. Rochefort in a note to the French Academy. It has been stated that the difficulty of regulating auto-coherers is due to the fact that the limits between the imperfect contact, not quite at the cohering stage, and the imperfect contact which will cohere but requires tapping, are too close to allow a self-righting coherer to be made with imperfect contacts. The author shows that every self-righting coherer may be transformed into one of the ordinary kind by diminishing the pressure on the filings. He is not, however, yet prepared to state whether the converse holds true. Great practical improvement is believed to attach to coherers which automatically decohere. By slight modifications of the soft-iron coherer, the author has succeeded in using it in wireless telephony experiments. These coherers may be regulated by an external magnetic field with great advantage and certainty.

Galileo Ferraris Award.—The Committee for the "Galileo Ferraris Award," which was instituted in 1898, have determined to open an international competition for the award of the above prize on the occasion of the unveiling of the monument to that illustrious scientist in Turin in the month of September next. The award is of 15,000 Italian lires (£600) together with the compound interest thereon accumulated since the year 1899 up to the day of the award, and will be granted to the inventor of some practical application of electricity from which some noteworthy progress may arise. Competitors may produce either pamphlets, schemes, and drawings, or machines, apparatus, and contrivances concerning their invention. The jury, composed of the committee, shall have full power to cause practical experiments to be made upon the inventions entered for competition, and upon the relative apparatus, contrivances and machines. Competitors are to file their application and deliver their works, machines, apparatus and whatever appertains to their invention not later than 6 o'clock p.m. on Sept. 15, 1902, at the office of the Secretary of the Committee, care of the Administrative Committee of the First International Exhibition of Modern Decorative Art in the buildings of the Chamber of Commerce and Art, 28, Via Ospedale, Turin, Italy.

Manufacture of Atmospheric Products.—We understand from the *Western Electrician* that a process is being exploited at Niagara Falls for the fixation of nitrogen, investigation, it is said, having determined that a high-voltage direct current, made to arc in a particular manner in a closed chamber, will convert air into nitrogen trioxide, giving a large yield. The result is the formation of a powerful company to make atmospheric products at Niagara on a commercial scale. It is given out that in the process a chamber about 10ft. high is used, into which is led cool, dried air. This air is made to pass through a region where electric arcs are continually discharging, the arcs being of light current and heavy voltage. It is about these arcs that the chemical transformation takes place, the air becoming a brownish-red, gaseous substance—trioxide of nitrogen. From the enclosed chamber the gas is led to an absorption tower, where it is brought into contact with whatever substance of which a nitrate is desired. Thus, it is said that by leading the gas through pure water pure nitric acid results therefrom. If brought into contact with caustic potash, the product becomes salt-

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petre, and in contact with caustic soda, the product formed is Chili saltpetre. Lord Kelvin, when he was in the States a short time ago, is reported to have spent a few hours in the experimental plant at Niagara, and is accredited with having given his verdict in favour of the success of the process.

Electrical Engineer Volunteers.—We note that the possible formation of a corps of Electrical Engineer Volunteers is being widely discussed in the States just now. The immense value of such a body of men, trained in the art of electrical science, as an auxiliary force to an army on active service was amply proven by the excellent work done by our Electrical Engineers in the field during the late war. The scheme was discussed at a recent meeting of the American Institute of Electrical Engineers, and not only met with the approval of the members generally, but was also welcomed by General A. W. Greeley on behalf of the United States army. In his remarks before the institute, this officer truly said that in military affairs electricity could probably play to-day even a more important part than it does in civil affairs. The increasing complexity and scope of electricity make it impossible for the soldier or the sailor to have a proper working knowledge of the subject, and this alone renders the services of a technical corps invaluable, especially in time of war. It is believed that an Electrical Engineer corps in the States would be very popular, and that the military authorities would do all in their power to encourage its formation and admit it, possibly, to field manœuvres, as is done in this country. By the way, we note that our corps of Electrical Engineer Volunteers are to undergo their annual training this year, by detachments, at Deal, Bexhill, Harwich, Gravesend, Portsmouth, Isle of Wight, Sheerness, Milford Haven, Plymouth, and Falmouth.

A Motor Compensator.—Mr. C. P. Steinmetz was last month granted a patent in respect of an alternating-current motor compensator, the object of which is to reduce the starting torque of a synchronous or induction motor only in proportion to the reduction of current taken from the mains, the torque per ampere of the main current remaining unchanged. After the motor is started the regulator can be adjusted so as to raise the voltage at the motor terminals until full voltage is reached. The regulator comprises a magnetic structure consisting of a fixed and a movable part, provided with compensator coils, one for each phase when used on a polyphase circuit. The compensator coils are connected across the mains, and the motor or other regulated circuit is connected to corresponding intermediate points in these coils. The coils have a series branch or portion in series with the load, and a shunt branch or portion in parallel with the load. One form illustrated for use in connection with a three-phase motor consists of a six-pole ring, every alternate pole having coils. Within the ring is a movable magnetic iron shuttle with three poles. By changing the relative positions of the poles of the shuttle the magnetic circuit can be varied so as to include both the series and the shunt branches of the compensator coils in a closed magnetic circuit, and therefore in a position to transfer energy from one branch to the other; or to withdraw the series shunt branches from inductive relation by opening the circuit of the series branches and leaving the magnetic circuit with the shunt branches closed.

Powerful Electric Discharges.—The issue of the *Electrical Review* of New York for the 31st ult. prints a short communication from Prof. John Trowbridge relative to an observation made by him upon the spectrum of an exceedingly powerful electrical discharge through the ordinary vacuum tube used in the study of the spectra of gases. In the employment of a battery of 20,000 cells to charge glass condensers he found that glass plates less than $\frac{1}{8}$in. in thickness could not be used, for the sudden rush of a powerful charging current was sufficient to break down an insulation which would resist several hundred thousand volts accompanied by a weak charging current. Moreover, it was not safe to build up the condensers made of glass plates, even of $\frac{1}{8}$in. in thickness, in a compact form, for the plates, under the tension of 20,000 volts, broke down, possibly from the effect of gliding discharges over the glass surfaces from the edge of one coating to that of another, although the distance was made far greater than one would suspect should be traversed by such anomalous discharges. Under the conditions of the experiments the discharges rose to values of 10,000 amperes for about one millionth of a second. In these circumstances the ordinary Plucker tubes used were destroyed after a few discharges, and immediately became coated inside with a white deposit of sodium salts coming from the glass. The interesting point, however, is that the resulting spectrum contained dark as well as bright lines—an evidence of selective reversibility of the silver salt, which is of great importance in conclusions drawn from the study of astronomical photographs. Concluding his communication, Prof. Trowbridge states that a tube filled presumably with dry hydrogen gives after a few powerful discharges, when subjected to feebler alternating currents, the spectra of argon. These arise probably from the dissociation of a trace of residual air in the process, of the dissociation also of water vapour always present in glass tubes, together with the presence of an alkali like sodium.

Electric Block Signalling.—At the recent Moscow convention of the electrical engineers of Russia several propositions were put forward for the solution of certain problems in the electric blocking of trains, and of the many systems submitted there was one which met with more favour than any of the others. The action of this particular system is similar to that of most of other proposals brought forward, being based on the ductility of the rail, but it uses to better advantage the characteristics of the rail on the approach of a train. From an illustrated description of the favoured system in the *Electrotechnic* of St. Petersburg, we gather that the method employed is as follows: On two adjacent sleepers a beam of charcoal iron is fastened. In the middle of the space between the sleepers a box is fastened vertically to the beam. This box contains an arrangement of levers required for the transmission of the motion and for the formation of a contact. It has also an opening for the introduction of an insulated cable for transmitting the current, and another opening, containing a pin, for the transmission of the bending motion of the rail to the apparatus. The beam, as well as the box with the mechanism, has an immovable, fixed position, independent of the position of the rail. In the middle of the space between the sleepers is fastened tightly to the base of the rail a brace which has a spring that reaches below the pin. Under the normal inactive position of the device, the rail brace and pin have the position of rest with a percussion screw resting on the pin. As soon as a train approaches, the rail and the pin commence to move, and the whole system, finding no resistance, will permit the arm of a lever, with its weight, to drop slowly downward till a connection with the lower contact is established. The current is thus allowed to pass from the cable into the lever and the earth. While the pressure on the rail is continued the established contact remains. When the rail returns to its normal condition, which naturally takes place when the

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train has passed, the whole system at once comes to its position of rest. In case the train should remain standing on the rail, the ductility of the rail comes into evidence and brings the device into action.

Train-Lighting by Electricity.—Further progress in the adoption of electrical apparatus for train-lighting in Germany is noted in a consular report from Berlin. For the past 15 months the German railway engineers have been making experiments with various forms of electric lighting, the net result of which was recently reported to the Association of German Mechanical Engineers by Mr. Wichert, the chief of construction. In his communication Mr. Wichert traversed descriptively the experience of the Prussian Administration with the several methods of car-lighting, from candle to electricity. From the standpoint of the technical engineer, the axle-driven dynamo, located in each car and making each an independent unit, is the ideal system. In addition to the dynamo, the method requires only a small auxiliary storage battery to feed the lights while the train is at rest, and a regulator to equalise the current during the different rates of speed attained when running. But one of the principal objections to this system, without considering the space occupied, is that it is inseparable from the jarring, grinding noise of the dynamo, which has not yet been reduced to a point where it ceases to annoy the passenger. The second method tested in Prussia is that with large storage batteries located in each car and fed from electric plant at terminal or other stations. This system has the advantage that it does not consume any power from the locomotives, and makes no noise or vibration; but its most obvious disadvantage is that storage batteries of sufficient capacity to carry a current supply for a long run are heavy and costly, and the process of charging them involves delay and special apparatus. For these reasons, therefore, the Prussian State Railway Administration have settled upon a compromise between the two foregoing methods—viz, a system by which a steam-driven dynamo is placed on the locomotive, which supplies current to a small regulating storage battery in each car of the train. According to the report above referred to, this system meets more perfectly than either of the others all the requirements of the passenger train. It is now being installed on many of the State railways in Prussia. In the distribution of lights each compartment in a first or second class car has a ceiling lamp, controlled by the attendants, and four reading lights at the sides of the carriages, which can be turned on or shut off at will by the passengers.

Tramways Congress in London. — Preliminary details of the arrangements for the holding of the Tramways and Light Railways Congress at the Agricultural Hall, Islington, next week have already appeared in this journal, and we would only remind our readers that the convention will be opened by Mr. Gerald Balfour at 12 noon on Monday, the 30th inst. Immediately after the ceremony the Tramway and Light Railway Exhibition will be formally inaugurated in the main building of the Agricultural Hall. We have, however, received a list of the papers which will probably be read and discussed at the business meetings of the congress on Tuesday, Wednesday, Thursday, and Friday, these proceedings being timed to commence at 9.30 in the morning. The titles of the papers, the majority of which are contributed by the foreign delegates from the Union Internationale Permanente de Tramways, are as follows: "Transfer Tickets" (correspondence), by Mr. Lavallard, manager, Paris Omnibus Company; "Narrow *v.* Ordinary Gauge," by Mr. C. de Barlet, general director of the Belgian Light Railway Company; "Brakes," by Mr. Poetz, engineer-in-chief of the Hamburg Tramways Company; "Proposed Basis for Estimating Powers of Motors," by Dr. G. Rasch, of the Polytechnic School, Aix-la-Chapelle; "Conditions under which Tramways may be laid on Roads," by Mr. A. Janssen, general secretary of the Brussels Tramways; "Laws Regarding Tramways and Light Railways," by Mr. R. H. Scotter; "Car-Sheds," by Mr. Trantweiler, engineer-in-chief of the Strassburg Tramways Company; "Traction Systems," by Mr. Ziffer, director of several Austrian light railway companies; "Profitable Employment of Rolling-Stock," by Mr. J. H. Heiszen, manager of the Amsterdam Corporation Tramways; "Central Stations," by Mr. Ch. Thonet, director of the General Contract Company of Liège; "Cost of Electric Energy," by Mr. Ch. Thonet; "Underground (Tube) Railways," by Mr. P. W. McMahon, chief engineer of the City and South London Railway; "Carriage of Luggage, Goods, and Mails," by Mr. G. Marshall, manager of the Brella Light Railways; "Heating of Cars," by Mr. Peiser, chief engineer Great Berlin Tramways Company; and "Report by Messrs. L. Janssen and Geron on a Uniform System of Accounts." There will also be various other communications presented for discussion. The banquet to be given by the Tramways and Light Railways Association to the foreign members of the International Tramways Union will take place at De Keyser's Royal Hotel, Victoria-embankment, on the night of Friday, the 4th prox.

The Light Railways Act.—The report of the Ligh Railway Commissioners for last year, which has just been issued, affords ample food for reflection. Perhaps the most striking feature about the document is the fact that the number of applications for orders under the Light Railways Act is still on the decrease. The actual figures are interesting. Thus, in 1896, the first year of operation of the Act, there were 56 applications for orders; in the next year, 1897 98, there were 65; in 1898-99 the number was 94. The year 1899-1900 brought this figure down to 67, and in 1900-01 this was further reduced to 53—less, even, than in the first year. These figures speak for themselves, and the reason why promoters of electric traction systems in this country are now fighting shy of procedure under the Light Railways Act is not very difficult to see. As is generally known, the condition precedent to the granting of an application for powers under the Tramways Act, either by Bill or provisional order, is the sanction of the local authority or authorities concerned to the scheme, and if this be not obtained, promoters may just as well keep their money in their pockets as to attempt to get their powers granted. In the Light Railways Act this absolute veto on the part of the local authority to defeat any scheme of which it is minded not to approve is not given, and when the Act first came into operation promoters of these schemes saw, or thought they saw, an opening out of the difficulty of getting the consent of the local authority, and having their proposals considered on their merits. This, no doubt, will account to some extent for the increase in the number of applications to the Light Railway Commissioners in the three years from 1896 to 1900, when the figure stood at 94. This number, as shown above, fell in 1900-01 to almost half, and the natural conclusion is that the Light Railways Act is disappointing in its operation. The important particular in which it has failed to meet with the approval of promoters is obviously that with regard to local veto. Only last week it was admitted by Mr. Gerald Balfour that not only the Board of Trade, but the Light Railway Commissioners, had felt themselves bound by the Tramways Act on this question of local veto, and that the Light Railway Act no longer offered a way of

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escape out of the difficulty. The result, then, is that whichever procedure be adopted, either under the Tramways Act, by Bill or provisional order, or under the Light Railways Act, the proposals of promoters of private enterprise are subjected to the whims and fancies and often the quite unreasonable obstruction of the local authority. To this, therefore, more than to any other reason, must be attributed the great falling-off in the number of applications to the Commissioners in the past year. What the present year will bring forth it is impossible to say. As a comparison, it may be mentioned that last November 44 new applications were put forward. Those for May, 1902, number 16. The total for 1901-02 is thus 60—only four in excess of the first year's application.

Three-Phase Currents for Traction Purposes.—For a remarkably lucid and concise account of European practice in electric traction with three-phase alternating currents, we would refer our readers to an article by Mr. Carl L. De Neuralt, which he contributes to the *Electrical Review* of New York for the 31st ult. The author there describes in considerable detail the main features of some of the more important railways on the Continent using alternating currents for traction purposes at the present time. Probably the best example of an alternating-current railway installation is that of the Burgdorf-Thun Railway, and the results of some tests made on this line are given, with a few general conclusions as to the applicability of polyphase alternating currents to traction systems. These tests, carried out by Messrs. Siemens and Halske, showed clearly that an alternating-current railway was absolutely feasible, and proved that no serious difficulty would be encountered in regard to the trolley line construction. The total length of the Burgdorf-Thun Railway is 25 miles. The energy is furnished by the power station on the Kander, the primary line voltage being 16,000 and the number of cycles 40 per second. Fourteen transformer stations—the transformers being of the oil-cooled type—reduce this voltage to the voltage in the trolley lines—*i.e.*, 750—this being the limit set by the authorities at the time. Most of the sub-stations are equipped with a small 2-kw. lighting transformer, furnishing current for lighting the neighbouring railway station. The height of the trolley wires above the rails is about 16ft., the contact devices on the cars consisting of four steel frames per car, two on each side of the car roof. The distance of about 30ft. between the two sets of contact devices is just long enough to allow three of the four bars making contact under any condition. The motor-car carries a 64-h.p. three-phase motor geared to each axle. The gear ratio is 1 : 3, and the speed of the motor 600 revolutions per minute, equivalent to a train speed of nearly 25 miles an hour The author also gives an excellent example of the application of three phase currents to tramways in the case of the Lugano system. The total length of the line is about three miles, with maximum grades on long stretches of 3 per cent. and on short stretches of 6 per cent. The transmission voltage is 5,000 volts at 40 cycles, and transformers reduce this to 400 volts in the trolley line. Two trolley wires are used, and the rails serve as third conductor. There is one 20-h.p. motor per car, completely enclosed. The author states that tests have demonstrated that it is possible to start with ease with these motors even on 6 per cent. grades and under more than full load. He also describes the Gornergrat Railway, the Jungfrau Railway, and the Stansstad-Engelberg Railway, in each of which practically the same practice has been followed. The author's conclusion is that there are cases where alternating currents are particularly well adapted to solve the problems under consideration, and where continuous currents could not be advantageously employed. Each special case should therefore be studied for itself, and the decision as to what system should be adopted ought to be dependent on the different conditions which might apply to the particular case, principally profile of the road, speed required, number of stops, and character of the traffic.

Electric Traction on Steam Railways.—The current number of the *Electrical World* abstracts a paper by Huber, in which the problem of electric traction under steam railway conditions is first discussed. At the outset he states his opinion that the electric locomotive must be used on these lines, and the reason which he gives for this conclusion is that, while single cars running at short intervals are suitable for passenger service, electric traction on normal railways has to take care also of the freight traffic, and handle the transfer of heavy freight trains between different main or branch lines. To ensure economy of operation, a high voltage must be used. This tends to make the use of three-phase currents prohibitive, as two overhead contact wires would be required, and they would not be insulated sufficiently to fulfil all requirements of safety. Only a single overhead contact wire can be considered reliable. The author therefore recommends single-phase alternating current for transmission. This alternating current is converted into direct current by a motor-generator placed on the locomotive, and this direct current is supplied to the motors. The direct-current side of the motor-generator is separately excited, which, in the opinion of the author, gives an excellent method of speed regulation, starting and braking, and returning power to the line on descending grades; and he refers to the systems proposed before by Ward Leonard, and recently by Mordey. The Oerlikon Company have worked out the practical details of the system, and have recently made an offer to the Swiss Railway Department to instal the system on a road of its network. A locomotive is being built with four axles, for receiving alternating current at 15,000 volts, for a capacity of 700 h.p. at the drawbar, the total weight being 44 tons. This shows that such a locomotive is not too heavy. To drag a train of 250 tons weight, with a speed of 25 miles, on a grade of 1 per cent., about 505 kw. are required, which for 14,000 volts and a phase difference of 10 per cent. means that 45 amperes are to be taken off from the contact wire. This current is not excessive. The only serious objection of the use of alternating current for traction with rail return is the reactance of the rails, which causes too high a voltage loss, if the frequency is, say, 42 periods (Burgdorf-Thun). The author believes that although the weight and the cost is thereby increased, it will be necessary to use a lower frequency, say 16 periods, and gives numerical calculations which show that the losses are small on a long line which is equipped with this system and on which several trains are running at the same time. The feeding points are proposed to be placed at distances of 120 km. He thinks that a lower voltage than 15,000 is insufficient and a higher voltage undesirable, as 15,000 volts is said to be the highest E.M.F. which can be produced directly in machines with safety and without special difficulties. The Oerlikon Company have worked out a new system of suspending the contact wire, which gives a very great freedom in its alignment; it runs at the side of the road, and the trolley poles slide along it, being movable around an axle in the direction of the car and being pressed upwards by a spring. He claims that the arrangement of the switches becomes very simple. In conclusion, the author expresses the opinion that for traction in general, with the exception of high-speed roads and track and pinion mountain roads, the use of any other but direct current for feeding the motors is wrong.

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FORMERS AND FORMER-WINDING.

BY F. W. DAVIES.

(Concluded from page 837.)

VII.—NOTES ON THE DESIGN OF WINDINGS AND FORMERS.

The calculations necessary for the design of the former-windings may now be considered. The principal points involved in their design are the amount of insulation to be used, and, in the case of armature winding, the space required for the ends of the windings. It is well to remember that it is always better to err by allowing too much room for insulation, rather than too little; as tightly-fitting coils are a frequent cause of breakdowns, both in field-magnet and armature coils. With field-magnet coils, a little clearance between the inside of the finished coil and the magnet core should always be allowed, as the core castings cannot be relied upon to come out exactly to the required size. There being plenty of room, there is no valid objection to the very slight enlargement of the coils necessitated by allowing this clearance. The clearance should be not less than $\frac{1}{16}$in. all round the core, and in the larger sizes may be as much as $\frac{1}{8}$in., or even more. Except in very rare instances, the total thickness of insulation on the inside of field-magnet coils need not be more than $\frac{1}{16}$in. This insulation may consist of a layer of flexible micanite, vulcanised fibre, presspahn, or other suitable insulating material, about 25 mils in thickness, which is placed next to the wire round the inside of the coil, and bent over at the ends to insulate the ends of the coil. The whole is then bound over with strong cotton tape in the manner shown in Fig. 3. This brings the thickness of the insulation on the inside of the coil up to about 50 mils. A coil insulated in the manner just described, and afterwards "served" with some good insulating varnish, and then baked, presents a very neat appearance, and is perfectly safe—both electrically and mechanically.

Having determined the clearance between the field-magnet core and the coil, and the insulation on the inside of the latter, it is an easy matter to determine the dimensions of the former for winding it on. The former should be made of the same cross-section as the magnet core, plus the amount allowed for clearance and insulation. Thus, assuming that $\frac{1}{16}$in. is allowed all round for clearance, and another $\frac{1}{16}$in. for insulation, the former must be $\frac{1}{4}$in. larger than the magnet core each way if it is of rectangular section, or $\frac{1}{4}$in. larger in diameter if of circular section.

It is not such a simple matter to determine the amount of insulation necessary, and to calculate the room required, for the coils of an armature. The thickness of insulation to be used must be calculated with more exactitude, as the space is usually very limited; and the armature core, unlike the cast core of a field magnet, may be relied upon for being of the exact size. Armature coils may be insulated from the core either by the plan adopted for the insulation of field-magnet coils—of placing all the insulation upon the coils themselves, and then binding them over with tape, leaving the core bare; or by the older plan of insulating the armature core in the usual manner, and also lightly insulating the coils with tape, this latter usually being done at the ends only. The former plan often proves to be the cheaper as regards labour. It is used by several firms at the present time, and is a plan that has much to recommend it. It is necessary to bind the ends of the coils with tape, whichever method of insulation is adopted, as the tape not only insulates the coils, but serves to bind the component turns of each coil together. Especially is this necessary when there are a large number of turns per coil. When the armature is insulated independently of the coils, the total thickness of insulation on it should be about 40 mils per side for ordinary voltages, such as up to, say, 500 volts. This may be made up of 25 mils of presspahn or flexible micanite (which of these is used will depend upon the voltage), and 12 mils of "Empire" cloth, or varnished calico. The total thickness of insulation will then be about 40 mils *actually*, owing to the fact that the two thicknesses of insulation will not lie perfectly close together. For higher voltages the insulation should, of course, be proportioned to suit. The thickness of the taping at the ends of the coils should be about 12 mils per side. When a plain armature core is used, a strip of insulation, about 25 mils in thickness, should be placed between every coil on the periphery of the core. When the core is uninsulated and all the insulation put on the coils, the first layer of insulation may be in the form of troughs. These troughs, which should be about 25 mils in thickness for armatures up to 500 volts, are placed one on each active limb of the coil. The coil is then carefully taped all over with either strong cotton tape or prepared tape, until the insulation is brought up to the required thickness. The armature end plates should be insulated as usual; also a layer of insulation may be inserted between the two layers of the end windings if the armature is barrel-wound.

The expedient of placing two or more coils in one slot in a slotted armature is one that is occasionally resorted to. When this is done, the insulation between the coils which are thus placed together, need not be very thick. It is convenient to wind such a group of coils as one large coil, placing the necessary insulation between them during the process of winding. The advantage of placing several coils in one slot is that not only is space economised thereby, but the punching of the armature stamping is considerably simplified, owing to the number of slots being reduced. It is not advisable to place more than two coils in the same slot, as the grouping of them together in this fashion tends to complicate both the winding and the connections.

In order to satisfactorily design the former for the armature coils, it is necessary to know four things: the dimensions of the armature core, the pitch of the armature winding, the distance to which the coils will project at each end, and the particulars for the winding of the coils. The dimensions of the core, the pitch of the winding, and the winding particulars (such as the number of coils, turns per coil, and size of wire), are matters that are decided by the ordinary calculations. An explanation of these calculations does not come within the scope of these articles at all, but must be sought in books and articles dealing with designing. The space required for the ends of the winding, although such an important point, has received from writers on electrical subjects but the same scanty consideration that has been accorded to formers and former-winding generally.

With the evolute winding, the distance to which the end windings will project depends upon the permissible thickness of each spiral. When the permissible thickness of the spirals has been determined, it will then be possible—if the armature is wire-wound—to ascertain the best arrangement of the wires in the end spirals, and to decide whether or not the armature will require to be wound in sets in order to get the coils on. From this we can find out the width of each spiral. If the armature is bar-wound the width of the end connectors can very easily be determined, for it is obtained by dividing the required cross-sectional area of the end connectors by their thickness. The maximum *possible* thickness of the spirals for an evolute winding may be obtained approximately by means of the following formula:

$$t = \frac{\pi\, d\, r}{\sqrt{c^2\, r^2 + 10\, d^2\, z^2}}.$$

In this formula, t = the maximum possible thickness of end connector, or spiral, in inches; d = the virtual diameter of the armature core, in inches—the virtual diameter being the over-all diameter of the core in the case of a plain armature, the diameter as measured at the bottom of the slots in a toothed core, and the diameter measured at the bottom of the perforations in an iron-clad core; r = the radial depth of the actual spiral part of the end winding, in inches; c = the number of coils on the armature, or the number of coils in one set, if the armature is wound in sets: $z = \frac{\text{the pitch of winding}}{4} + 2$, the pitch being here taken as one-half of its actual value, if the armature is wound in two sets or one-third if wound in three sets.

It will be noticed that the thickness of the end spirals obtainable from the above formula is the maximum *possible* thickness. It is well, in order to allow for ventilation between the spirals, and also to allow for any irregularities that may occur in the forming of them, that their thick-

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ness (over the insulation) should be rather less than this The *maximum permissible* thickness (over the insulation) may be taken as ·75 of the *maximum possible* thickness.

The space required for the ends of a bastard winding is not such a definite quantity as that for an evolute or barrel winding, as the form given to the coils is not a clearly defined one. As, however, it is used mainly on small armatures, where the end space is not relatively of such importance, this does not much matter. Roughly speaking, the space required for the end windings is approximately proportional to the virtual diameter of the armature core. For all practical purposes the formula, $e = \cdot 4\, d$ (where e = the distance, in inches, to which the winding will project at each end, and d = the virtual diameter of the armature core, in inches) will suffice for the calculation of the space required.

The end space required for the barrel winding, like that for the evolute winding, can be calculated with a fair amount of accuracy. The following formula shows the method of obtaining the length to which the ends of a barrel winding will project beyond the core:

$$e = \frac{a\left(\frac{t\,y}{4}\right)}{\sqrt{a^2 - \left(\frac{t\,y}{4}\right)^2}} + 3\,r.$$

Here e = the distance to which the winding will project beyond the core at each end, in inches; a = one-half of the length of arc between the two limbs of a coil, in inches; t = the thickness or width of a coil, in inches—measured over the insulation; y = the pitch of the armature winding; r = the radial depth of one limb of a coil, in inches.

The ends of an armature winding of the barrel type are usually supported by means of end plates, which are tapered on the periphery. They are tapered for two reasons: in the first place, the end windings are not so liable to get damaged when the armature is laid down on a bench or on the ground, as it would be if the end windings were flush with the periphery of the armature—specially when a toothed core is used; and in the second place, the whole armature presents a smarter appearance when the end plates are thus tapered. A suitable taper for end plates is 1 in 12. When an armature is wound with a heavy bar winding of the barrel type, the barrel end plates may be dispensed with entirely; as the winding is strong enough to support itself—it being under no strain at the ends, save that due to centrifugal force. It is necessary in such cases to provide a templet at each end of the armature whilst it is being wound, to build up the winding on. Not only is there a slight saving in the cost of manufacture by thus dispensing with the end plates; but the winding keeps cooler, owing to the increase in the area of the effective radiating surface.

Formers of all kinds require to be fixed in some way whilst in use. Formers for the coils of field magnets, wire-wound ring armatures, and wire-wound drum armatures with bastard winding, are held between centres during the process of winding. Block formers for drum armature coils of both the evolute and the barrel types are usually placed on the bench for winding. Formers of the frame type are preferably fixed permanently to the winding bench. Some kinds of frame formers for barrel-type wire-wound drum armatures, instead of being used on the winding bench, are mounted on shafts which are held between centres whilst the coils are being wound, this kind of former being considered by some to offer greater facilities for winding.

The application of a little "French chalk" to a former, especially when it is made up of several separate blocks or pieces, is a great improvement; as it renders it easier to take to pieces, and facilitates the removal of the coils. A little chalk may be rubbed on the adjoining surfaces of those formers which are made up in sections, such as the formers for field-magnet and ring armature coils; the former for bastard-wound drum armature coils. Also a little should be sprinkled occasionally on formers of all kinds, at those places where the wires rub on them when the coils are being removed. By giving these points a little attention most of the trouble and annoyance caused by abraided insulation on former-wound coils may be avoided.

EDMONDSON'S AUTOMATIC LOCKING SIGNALS.

There is no doubt that some efficient system of controlling the running of tramcars and light railways by means of signals on the block principle, without increasing the wages account, is likely to meet the wants of a considerable number of our tramway and consulting engineers, especially where, through force of circumstances, it has been, or is, necessary to lay single track. To put the passing places so close together that the driver can see the next one ahead is, after all, an expensive compromise between single and double track, and useless in foggy weather. What is wanted to meet all requirements must be automatic, simple, and not likely to get out of order, and as such the system we propose describing in this article merits attention. The signal consists of an oblong box or case containing the mechanism, and having a shaft or spindle projecting through one side, to which the semaphore

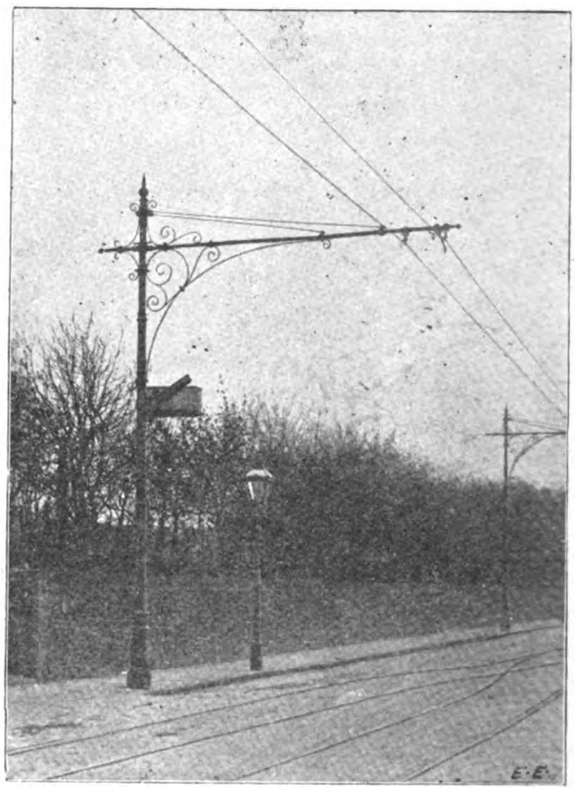

FIG. 1.—The Edmondson Automatic Tramway Signal.

arm is fixed on the same shaft, but inside the box is keyed a crossbar, on each end of which are suspended two iron cores. These iron cores hang within solenoids fixed to the base of a cast-iron frame, to which all the mechanism is attached, and are used to pull over the crossbar and semaphore arm to "Danger" or "Line clear," according to which solenoids are energised. Whichever position the semaphore arm is in it is effectually locked. If at "Danger" it cannot be put to "Line clear" except by the action of the solenoids, which first unlock, then pull the semaphore arm over, and automatically lock it in that position; the reverse, of course, holds good. The contacts for working these signals are fixed alongside the trolley wires, either by means of a special ear or a bracket clamped to the bracket arm. They consist of a short length of flat brass bar, which is insulated from the ear or bracket, and is so adjusted with respect to the trolley wire that the trolley head must rub along it when passing, and so make contact between the two. The brass bar is held in position by means of springs, so that the act of making contact does not put any appreciable strain on the trolley head or wire. As the contacts are made of short length for convenience and the sake of appearances, it was considered advisable to provide some means for ensuring the signals

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being pulled home and locked irrespective of the speed of the cars. This is accomplished by means of relay switches, which are closed by the action of a trolley head touching a contact, and which maintain the circuit between the solenoids and trolley wire after the trolley head has left the contact. These switches can only be opened by the semaphore arm being pulled home and locked, either to "Danger" or to "Line clear," so that the full movement must be completed with equal certainty whatever the speed of the car.

Fig. 1 shows the signal fitted to a side pole, and is taken from a photo of one which has been in use for some 12 months past. Fig. 2 is a diagram showing a section of single track and passing places fitted with a pair of signals and six contacts, which allow the following results—viz.: Suppose a car running from left to right on the diagram. As soon as the trolley head touches contact No. 1, signal B will go to "Danger" or "Line blocked." At contact No. 2 signal A will go to "Danger," thus giving the car a free run through the signal section by first blocking both ends; at contact No. 3 both signals will go to "Line clear," which opens the section for the next car or for a car going in the opposite direction. By means of contacts Nos. 4, 5, and 6 cars running from right to left carry out the same combination. As it is just within the bounds of possibility that two cars coming from opposite directions may touch contacts No. 1 and 4 at the same instant, each driver would then see his home signal go to "Danger" before he reached the home danger contact, and would thus know that there was a car at the other end of the section, in which case one car must be given the preference and allowed to go through the single track. Assume this to be the car running from right to left in the diagram, then the car running from left to right would have to back past contact No. 1, so that on entering the signal section after it was cleared, it would again set signal B to "Danger," then signal A to "Danger," and would clear both signals in the usual manner at contact No. 3. The above could also be met by fixing a second distant danger contact for signal B alongside contact No. 2. In this case the car running from left to right would not need to back past contact No. 1, but would reset signal B to "Danger" when passing this extra contact, and so block the far end of the single section. These signals are fitted with red and green bullseye lights, which make them equally efficient at night or in foggy weather. The bullseyes are so arranged that when the semaphore arm is at "Danger" it covers up the green light and exposes the red light, and *vice versâ*. The lamps for these lights are, as is the whole of the mechanism, run direct at the trolley wire voltage, and so the use of batteries, either primary or secondary is obviated. The signal lamps are, of course, fitted with a switch for extinguishing them in the daytime, the same being in a watertight cast-iron box with lock and key. This system, as far as we can see, is a simple, efficient, and thoroughly practical solution of the difficulties met with in single-track tramways and light railways. It is absolutely automatic, and permits of the track being used to its fullest extent. The possible combinations of signals and contacts are numerous, and permit of their being used with equal success for right-angle crossings, sharp curves, etc., on double or single tracks.

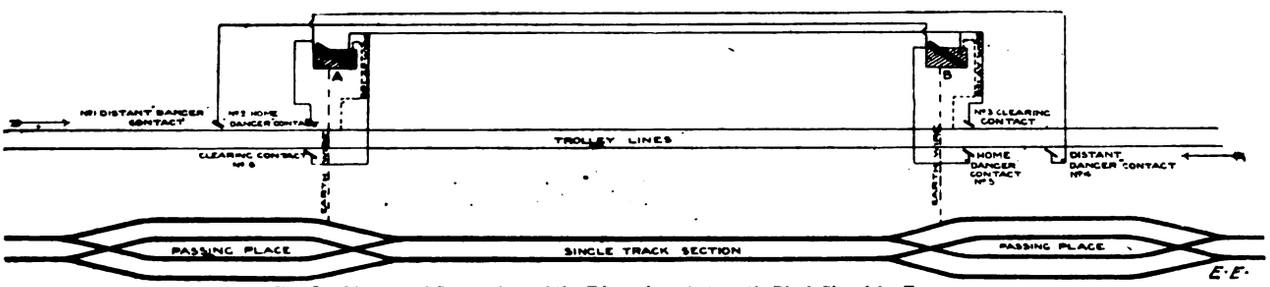

FIG. 2.—Diagram of Connections of the Edmondson Automatic Block Signal for Tramways.

SOCIETY OF ARTS.—With the approval of H.R.H. the Prince of Wales, president of the above society, the Albert medal for the year has been awarded to Prof. Alexander Graham Bell "for his invention of the telephone."

THE ELECTROLYSIS OF GAS-MAINS.*

BY JAMES SWINBURNE, M.I.C.E.

(Concluded from page 849.)

We may now consider the electrical connections of a tramway system. In its simplest form a tramway system consists of an electrical generator driven by power at the station. This is connected with an overhead wire, which is thus kept at an electrical pressure of 500 volts. Each car has a sort of fishing rod with a little trolley wheel, which makes contact with the overhead wire and connects to the motors. From the motors the circuit is led to the wheels, and thence to the rail. It is carried back to the station by the rails.

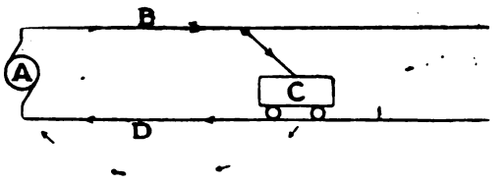

FIG. 1.

The current that goes back to the generator is necessarily equal to the current that goes out. Electricity is not like gas; there is the return circuit which must carry the whole current. Any current that leaks away from the rails must either find its way back into the rails or otherwise get back to the generator.

Whether the current will all go back by the rails, or will partly go by the earth, depends upon the resistance of the paths. Iron as a substance has very little resistance compared with damp earth; but, on the other hand, the damp earth forms a very broad path—in other words, the cross-section is very large. Again, the rails are not continuous, and the joints have more resistance than the rails. The result is that there is considerable straying from the rails. This is shown diagrammatically in Fig. 1. Here A is the generator; B is the overhead system at 500 volts; C is a car; and D is the return circuit. Some electricity leaves the rails, and returns towards the generator by the earth, and when it gets near the station it enters the rails again. The earth acts as a by-pass. Electricians talk of leakage; but the analogy is the by-pass. In Fig. 2 is another elementary system with gas-pipes shown close to the rails. The gas-pipes are generally good conductors. Sometimes the joints do not make good electrical contact, and the resistance of the joints is high. In Fig. 2 the gas-pipe is shown as E. There is a current into the pipes at F, and out again at G. As has already been explained, the earth acts as a sort of by-pass to D, and takes a share of the return current. The gas-pipe acts as a sort of second by-pass—that is to say, a by-pass to a by-pass; and there is thus a small current in the pipe. If the system is examined it is seen that the rails have a fairly large current leaving them. The rails must be proportionately corroded at these regions. Then a portion of the leakage goes into the gas-pipe at F. This does no harm, as the pipes are

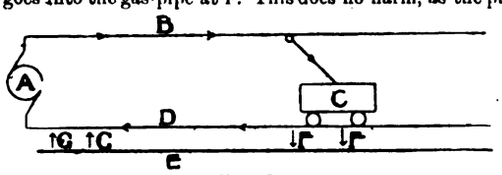

FIG. 2.

cathode there. That is to say, the current into the metallic conductor does not corrode it. At G, however, the current leaves the pipe; so there is corrosion there. The electricity that leaves the pipe at G crosses through the earth to the rail, and thus to the generator. If, therefore, the pipe is connected by means of a wire to the return or negative end of the generator circuit, the electricity leaves the pipe by a metallic conductor, so that there is no corrosion. As will be seen presently, making metallic connection to the pipes in the neighbourhood of the station is one of the methods of minimising the electrolytic corrosion.

We have mentioned electrical current and electrical pressure, and referred to resistance and conductors. It would be no use to try and give a clear explanation of what controls electric currents here, for time is too short. Many, probably most, of my readers also understand the matter already. But it may be advisable to give those who have not studied electricity at least some idea of the relations of the electrical quantities we have to deal with most. The electrical current

* Lecture delivered before the Incorporated Gas Institute.

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(amperes) is analogous to a current of water, a conductor corresponding roughly to a pipe. The resistance of the conductor (ohms) then corresponds with the friction of the pipe, due to its smallness of bore or internal roughness, and the electrical pressure (volts) to the pressure or head of water. But there is this difference: the relation between the flow of water and the pressure causing the flow in a pipe is complicated; but in electricity it is very simple. The current (in amperes) is proportional to the pressure (in volts) divided by the resistance (in ohms). In the case of electrolysis there is often a back pressure; for instance, when water is electrolysed into oxygen and hydrogen. But in the sort of electrolysis which we are discussing, there is generally no appreciable back pressure. This is mentioned because it is sometimes said that electrolysis cannot take place unless there is over a volt of pressure available.

If we consider a track where the rails form the only return, if the current to be returned is large and the distance long, so that the resistance is considerable, we might have considerable pressure between the far end of the rails and the station. In America, especially in the early days, they had very high pressures on the rails—sometimes 30 volts and upwards. Taking the earth itself generally as being at zero pressure, or, to use the water analogy, at zero level or head, we may consider that one end of the rails would in the extreme case mentioned be 15 volts above the zero, and the other 15 volts below.

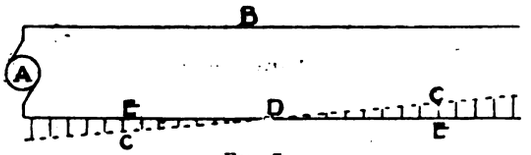

FIG. 3.

With such a pressure as this there would be considerable leakage, or by-passage of current through the earth. Any pipes lying along the route would then pick up a portion of the stray current, and suffer corrosion where the electricity left it. The variation of potential along the earthed return, supposing it to be uniform, is shown in Fig. 3. Here E E is the return, and its potential with regard to the earth is given by the vertical distance between E E and the inclined line, C C. At the far end the rails are positive (this being shown by C being above E), and no corrosion of pipes will take place; but at the near end they are negative. Between these two areas there is a spot, D, where the rails are at earth potential; and there is no tendency for electricity to pass to or from the pipes.

We may now consider the precautions and measures taken to minimise corrosion of pipes. The first thing is to keep the resistance of the return rails as low as possible. The resistance is chiefly at the joints, and it is difficult to make good contact by means of the fish-plates. The rails are, therefore, "bonded," or electrically joined by bonds of flexible copper. Sometimes to make better joints the rails are electrically welded, or welded and cast by Goldschmidt's process, or joined by pouring fused iron round them from a portable cupola. In a long line, or where the traffic, and, therefore, the return current, is large, no amount of bonding will do. The Board of Trade here come in with a regulation that a tramway must not spend more than seven volts on its return rails. What are called "suckers" are, therefore, introduced. Fig. 4 shows the system with suckers. The suckers are insulated conductors which draw off from various points of the system. They generally have what are called "negative boosters" in their circuits. A "booster" is a machine for adding a little pressure to a circuit; a negative booster subtracts pressure or sucks. It is an electric motor, driving a generator, the generator being so arranged that it sucks in proportion to the current, so that the far end of the sucker, where it joins the rails, is kept at nearly zero pressure, or not

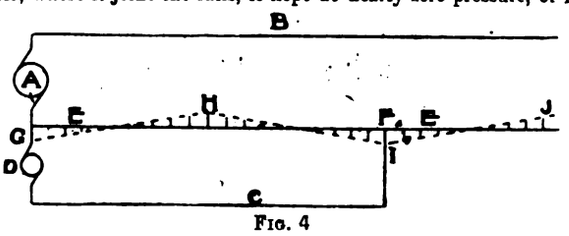

FIG. 4

more than 3½ volts below it. Thus, in Fig. 4, an insulated conductor, C, is taken from the point, F, of the rails through a negative booster, D, to the generating station. The potential of the rails is represented by the line, G H I J, which shows that some sections of the track are positive and some negative. The rails are insulated to some extent incidentally by being embedded in concrete, which is a very bad conductor when dry, but according to many measurements conducts well when wet. It might be worth while to saturate it with some waxy, tarry, or greasy material when dry. Tarring the rails, or coating them, does not insulate them permanently. A layer of asphalt keeps the ground under it dry and increases the resistance.

The Board of Trade regulations do more than limit the difference between different parts of the earthed system. They provide that, with earth-plates at the station at least 20 yards apart, with not more than an ohm resistance to earth in parallel, these plates shall only collect two amperes per mile of tramway, or 5 per cent. of the total current. Any rails must not be more than 4½ volts above any neighbouring pipes or 1½ below them. These pressures are determined with Leclanché cells. They make various other minor regulations. Sometimes, instead of using suckers, the flow of electricity is helped along the rails, as it were, by what we may call "helpers" or "helpers home." These are "boosters" arranged in the rail circuits so as to help the flow, as it were. Thus, suppose the engineer decided to keep within a limit of four volts maximum difference of pressure in his rails. At maximum load a length of rails might have four volts drop of pressure, from + 2 to − 2 volts, the middle being at the zero or earth pressure. At the − 2 point, the rail would be severed and the electric circuit led through a conductor to a booster, which would add four volts and return it to the next section at + 2 volts. The system is shown in Fig. 5, in which C and D are the boosters inserted in the rail circuit, E. The potential of each of the sections varies from positive to negative, as shown by the inclined lines, F G, I J, and K L. Helpers are not used, as far as I know; but the idea, though old, has been recently revived. Little or nothing more can be done to protect the pipes by dealing with the return-rail track. Something can, however, be done to the pipes. As has been explained, it is not the entry of the electricity into the pipes that does the harm; it is where the electricity leaves the metal and goes into the damp earth—that is to say, where the pipe is acting as anode. If all the parts of the pipe that might act as anode are connected by wires to the rails, or to the station, so that the electricity can be carried off without passing into an electrolyte, there is no electrolysis, and the pipes are safe. The region round the station is clearly that where the pipes may be anodes. This region is, therefore, often known as the "danger area," and if metallic connection is made from the negative terminal of the station to the pipes in the danger area the pipes are safe. This increases the current in the pipes, but that does not matter to the pipes unless there are joints which cause the electricity to pass round by the earth. The increase of current means increase of corrosion of the tramrails, but that is the tramway people's look out. When suckers are used they are arranged so that they reduce the pressure of the rails where they join below the earth, so that the rails are then negative to the earth. They therefore make local danger areas. The pipes should thus where possible be connected to the rails there.

We have now mentioned practically all the methods known of keeping down the chances of electrolysis by designing the tramway to produce as little effect as possible. We have, of course, only dealt with the overhead single trolley system, which is universally used in this country. One cure is to depart from the system altogether. For instance, we might have both conductors overhead. This would get rid of electrolysis altogether; but the method is so inconvenient, so costly, and so unsightly, that it is almost out of the question. Unless there were much stronger evidences of real damage from electrolysis than any we have so far, Parliament would never put such a thing on

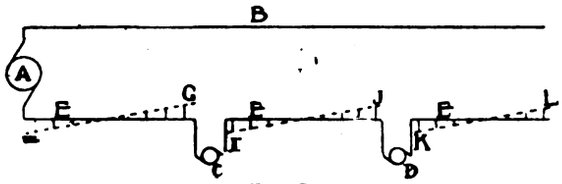

FIG. 5.

tramway companies. The double trolley has been used in one or two places, but the results are not encouraging. Some of the conduit or culvert systems, in which the electric conductors are in a sort of long nearly closed conduit, with a narrow slit along the top, have both conductors insulated; but this give rise to difficulties at crossings and turn-outs. Surface-contact systems can also be designed to have no earthed conductors, but in their case also it is very much more difficult to insulate both conductors. The precautions in design and working which can be taken by the tramway engineers are thus: (*a*) good bonding of rails, and rails of large section; (*b*) suckers to the rails from the power-houses; (*c*) insulation of rails by concrete, and so on; (*d*) inserting "helpers" in the rail circuits.

There is still another system which has not received the attention at the hands of electrical engineers that I would suggest it deserves—that is, the "three-wire" system. Along one line the overhead wire is at a pressure of 500 volts; along the other it is negative, at − 500 volts. The circuit is then not from the rails to the power-house, but merely across to the other rails and home by the next tramcar and the − 500-volt overhead wires. The system is more complicated, and there are 1,000 volts between neighbouring overhead wires, as well as the usual 500 between one and the earth. There is also difficulty in balancing, so that there is approximately the same current on each side. Connections from the rails to the power-house are still necessary, but they are smaller and much less numerous for a given area.

We may now consider what the gas and water companies can do to protect their pipes. Throughout the danger area they should be metallically connected with the power-house or the suckers. Coating with Angus Smith's composition, or asphalt, tar, and the like, prove to give little or no protection. It is found that wrought-iron pipes are corroded more quickly than cast, especially close-grained cast iron. In this country wrought iron is only used for service pipes, as far as I know. It would be an advantage to destroy the electrical continuity of pipes by occasionally packing joints with sulphur, sulphide of iron, or something other than lead. Lead does not make a good electrical joint. Pouring lead round does not remove the bituminous coating of the pipes. Lead also soon coats itself with insulating compounds, such as hydrated oxide, which prevents its making good electrical contact. This should be done, especially in places where the ground happens to be dry and well drained. It has been proposed to adopt earthenware or stoneware pipes. Such schemes are of little value. The pipes are already down, and, generally speaking, will remain down unless something serious happens to them. The insulation of occasional joints in water-pipes would also be of advantage. It might be supposed that this would do little, because the water conducts, and would therefore make a passage round the insulated joint. The water supplied to houses is, however, such a

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very poor conductor that the current carried by it may be neglected. Insulating the joints in this way may, however, sometimes do harm. For instance, suppose a line of pipe is carrying a current which is taken to the power-house by a metallic wire connected to it for that purpose, the pipe might have no current leaving it and therefore no corrosion. If the pipe is insulated at a joint it will introduce a local resistance, and the electricity will leave the pipe and go into the earth close to the joint, entering the pipe again a little further on. One side of the joint thus become anode with corrosion, while the other becomes cathode, which does not matter. Insulating joints does not, therefore, necessarily help. It reduces the current, but at the expense of local corrosion, unless the joint is in very dry ground. If joints are insulated at very frequent intervals, the pipe will be so discontinuous as a conductor that it will pick up no appreciable current. Insulation of joints is, therefore, a good measure when taken judiciously, but it is not always possible, as a company cannot well open up the roads on purpose to break the joints and recaulk the mains. In America it has been proposed to make gas and water pipes of stoneware Such pipes could, of course, be made, and in some ways it might be easier to render them gastight. They might also be made strong enough to stand a steam-roller without being buried very deep. But any change of that sort cannot be considered seriously in this country, except for new mains. Practically the only thing the pipe-owning companies can do to safeguard themselves, or to lessen the effects of stray currents, is to insert insulating joints at intervals where possible, and to connect the pipes metallically with the power-house, or the rails in danger areas—that is to say, in areas where the pipes are apt to be anodes. Cast-iron pipes are sometimes joined up with wrought-iron or lead service pipes, often with brass couplings. Such metals in damp soil set up local currents of their own, which eat the lead or wrought iron apart altogether from any tramways.

The next, and perhaps the most important, question is: How much damage are electrical tramway systems doing now, and how much will they do in the future? We hear a great deal about the damage done in the United States, and there is no doubt that there has been a great deal of trouble there. The statements in the technical Press are exceedingly difficult to deal with. There is strong partisanship and great exaggeration. In addition, many of those dealing with the matter have very inaccurate notions about electrolysis. The conditions in America are different, but especially they have been different. Damage by electrolysis is essentially a matter of time, and the corrosions that are now making themselves evident in America are the results of past working. Electrical tramways have been in extensive use there for some 12 years: and it might appear that the present state of the pipes show us what to expect here in 10 years or so. This, however, is not so. In America, especially in the early days of tramways, the rails were of small section; and they were very badly bonded. They were largely laid in mud which forms the bed of many American roads. But, more than all this, they frequently allowed 30 volts in the rails, or three times our permissible maximum.

We have developed electrical tramways slowly in this country. One result of our British way of doing things is that we now put our tramways down well. The Board of Trade also limit the pressure allowed between points in the rails; and the tramway engineers generally keep very much within this limit for their own sakes. It must be remembered that the tramway people do not want to eat pipes. They may be made liable for damages some day or other if they do. But there is another point. Any stray electricity that gets into pipes must have left the rails, and must have corroded them proportionately. But the current in the pipes is only a fraction, generally a very small fraction, of the whole stray current; so that if there is corrosion of pipes, there is a very much greater corresponding corrosion of the tramway rails. In their own interests, therefore, electrical engineers keep the stray currents down as low as they possibly can. Of course, if a considerable part of the stray current goes along a pipe, and frequently leaves it to go round an insulated joint, returning to it after the joint, there is corrosion wherever it leaves the metal. If there are many such joints, the total corrosion of the pipes may be comparable with that of the rails, or even greater, though the current from the rails is greater than that in the pipes. But the frequency of such insulated joints in practice sends the resistance up, so that there is then comparatively little current in the pipe circuit.

The most remarkable fact about electrolytic corrosion is that it is clearly not so great as might be expected. It has even been said that earth conducts like metals, non-electrolytically, so that electricity can leave rails or pipes and go into the earth without the corresponding corrosion. This theory is far too good to be true. The components of the soil are mostly insulators in themselves. Such substances as silica (sand), and the various silicates of which clays are composed, and chalk, are all insulators; and the conduction is due, not to them, but to the salts dissolved in the water that moistens them. No transparent body can conduct otherwise than electrolytically. This theory appears to me, for one, quite untenable. It is much more probable that, in estimating the corrosion of pipes, people are apt to overestimate the difference of electrical pressure between points in the earth. Take a simple case of a long straight single rail on the surface of comparatively badly conducting earth. Suppose it is at two volts above the ground in pressure. The ground just in contact with the rail will be raised to two volts. The earth a long way from it, on the other hand, will be at zero pressure, if not disturbed by some other source of electrical pressure. There is thus a gradual fall of from two volts to zero as the distance from the rail increases. But the rate of decrease of pressure is much greater close to the rail than far off it—in fact, the rate at which the pressure decreases is approximately inversely proportional to the distance. The result of this is that the pressure falls quickly as the distance from the rail increases. Another way of putting it is that the earth itself in the immediate neighbourhood of the rail acts as a sort of coating, the two volts being nearly all spent on it. The pressure of the earth a short distance from the rail will thus be very little above zero. If a good conductor, such as a pipe with electrically conducting joints, were laid in earth which was two volts above zero pressure, and if the pipe were kept at zero pressure by being connected to a power-house, or by going into a region where the earth was at, say, two volts, it would, if of equivalent size and shape, pick up a current equal to that leaked by the rail already discussed; but if it is laid in a region at a minute fraction of a volt above the normal, it will only pick up a corresponding current. One of the few papers which gives definite information in a useful form is by Larsen and Faber. These observers measured the currents in pipes following the tracks, and found values which are serious. These observations go to show that pipes close to lines with large pressure drops will, if not protected by metallic connections, be seriously corroded in course of time. It is probable, in spite of this special case, that pipes pick up much more minute currents than is generally believed. Another reason for supposing that the pipes do not take up very large currents is that there are earth currents due to natural causes. Now, earth currents would cause electrolysis just as much as stray tramway currents; but pipes have been in the ground for not very far off a century, and pipes 50 years old are often found to be as good as new. Yet the earth currents have been going on all the time. Unfortunately, we have few useful data about earth currents. What we want to know is the differences of electrical pressure between one region and another. The observations are made by the telegraph authorities, and they have nearly always given their results in terms of the current in their wires. They have given these without stating their resistances, so that their figures are useless. A book by an eminent German professor has recently been published furnishing figures involving an enormous amount of work. They deal with Germany, but convey no information, because the data which would make them valuable have been inadvertently dropped out.

Fortunately a few telegraphists, instead of reading the deflections of a galvanometer, have tried how many telegraph battery cells had to be put in to reverse the current, and from this we can get a rough idea of the differences of pressure between different regions. I may mention that Varley once found between London and Ipswich a difference of pressure of about 140 volts, or 2½ volts fall of pressure per mile. Such pressures are variable, but they are comporable with the disturbances due to electrical tramways. I have measured the currents in pipes where there are no tramways within many miles, and found them comparable with those found near working tramways. Yet they do not seem to do so very much harm. It is possible that all corrosion of pipes, apart altogether from tramways, is produced by or accompanied by electrolysis. Dissolved oxygen, or oxidising solutions in the earth, would attack iron without electrolysis; but it is doubtful if the moisture in the earth contains such matters. The decaying vegetable matter and humus, and in towns decaying animal matter, would all be reducing agents, and prevent any direct oxidation of iron. Though what I have been saying may tend to allay fears as to the ravages of electrolysis, I certainly do not mean to say tramways will do pipes no harm. They certainly will do them no good. The question is: How much harm will they do? Electrolysis involves damage of the most insidious kind. It means a gradual corrosion of pipes until they either break or develop leaks in all sorts of unexpected places. Whether it will really damage the property of gas companies to a serious extent I for one cannot say. It is a matter of time. The best thing gas and water companies can do is to watch their pipes carefully, inspecting them whenever they are open for other purposes. When the road is opened and a pipe uncovered, it would be as well to measure the electrical current in it. It is quite easy to measure the current in a pipe. The fall of pressure over a given length, excluding any joints, can be taken with a sensitive galvanometer. The resistance can be calculated or got by measuring a similar pipe. From these data the current is got. By including a joint the resistance of the joint can be found. The measurements of current should be taken day and night, to see if the current is due to tramways. Another measurement that is important is the relative pressure of the pipe and neighbouring earth. If the pipe is positive to the neighbouring earth, it is acting as an anode, and is therefore being corroded, and ought to be metallically connected with the power-house. If the pipe companies cannot get legal protection, the best thing they can do is to make friends with the tramway people. Where the electrical tramways and the gas and water are owned by a local authority, there ought to be no difficulty, but even otherwise the electrical company and the pipeowners would do well to work together. To make these electrical tests involves some electrical knowledge, and gas and water companies do not want to employ electricians on their staffs. The tramway people could generally make these tests for them without any great difficulty, and arrange experiments with them.

As to what the right course for Parliament to take may be, there is much to say on both sides. On one side it would not do to veto earthed returns, because this would throttle an industry. It is quite certain it would injure the tramway industry enormously to forbid earth returns. This means depriving the public of means of locomotion; and depriving the tramway shareholders of profits. The tramway shareholders are part of the public, and have a right to be considered. So are the gas and water companies, and their shareholders. In addition, they were there first. But the evil of vetoing earthed returns is serious and certain, while the evils of electrolysis are comparatively remote, and uncertain; so taking industry broadly, Parliament has so far decided to allow earthed returns.

The next question is as to whether pipe companies should have damages if their pipes are eaten. This seems obviously fair. But there is very serious difficulty in carrying such protection clauses into effect. A gas company find their pipes eaten in one district. The first thing is to prove the corrosion is electrolytic, and not due to natural causes. This is in itself not necessarily easy. Suppose it is clear that the failure is due to electrolysis, the electrolysis may be

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due to natural earth currents. If not, and it is due to an electrical system, who is to say which system? In small towns where there is only one tramway system the chance of appreciable electrolysis is small. In large towns there are, or soon will be, several tramway systems, and probably some electrical railways. It would be very difficult for a London company to decide who ate their pipes, and still more difficult to bring the crime home by the clumsy and expensive method of arbitration. To make the tramway people liable for any damages is obviously fair; the real difficulty is to carry the matter out. Such a liability is for that reason very serious to the tramway. A small tramway—which we will for this example suppose really innocent—is liable to be mulcted in damages that might ruin it by a mistake of judgment of an arbitrator, or of experts called before him. This is a very serious liability.

To sum up there is electrolysis, and your pipes are being eaten, but whether the corrosion is really serious or not can hardly be settled yet. Tramways are increasing in all directions, but they are also being more and more carefully designed. The large systems use lead-covered cables themselves, which are infinitely more easily damaged by electrolysis than gas-pipes, because the lead is easily corroded, the conductors are continuous, and the cables are generally near the tramlines. The electrical tramways are thus more likely to damage themselves than their neighbours by any bad design or careless working. It behoves gas and water companies, however, to watch carefully. The question of electrolysis is not really settled. In the course of years we may have more information, and we may then find either that the stray currents are practically harmless, or that new laws have to be made.

QUESTIONS AND ANSWERS.

If thou hast knowledge, let others light their candle at it.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ should be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter must be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

493. Since the speed of an induction motor depends upon the periodicity and the number of poles, what advantage is obtained by increasing the field flux?—M.

N.B.—Will "M." kindly send his name and address?

494. What are the benefits of carbon breaks on switchgear? Is the resistance of the carbon of any practical value? What principles should guide one in designing such "breaks," and how would you determine the necessary size of carbons for breaking a given load?—L. W. G.

ANSWERS.

Question No. 487.—Give details of the best method of regulating the direct-current E.M.F. of a rotary converter.

Best Answer to No. 487 (*awarded* 10*s.*).—All the methods of regulating the continuous-current E.M.F. in common use involve the regulation of the alternating E.M.F. supplied to the slip rings, and only differ in regard to the way in which this is done. If the load on the machine is fairly steady, as in lighting work, hand adjustment of the alternating voltage is sufficient and is generally preferred, whilst if the load is subject to large and sudden variations, as in the case of traction work, hand regulation is not effective, and automatic regulation must be resorted to.

Hand regulation can be carried on in any of the following ways: (1) By inserting resistance in each phase as the load is reduced. This, though perhaps the simplest, is very uneconomical, and is practically never used. (2) By inserting an adjustable choking coil in each phase and increasing the volts choked as the load is reduced. This method is simple and cheap, and the only objection to it is the lowering of the power factor of the supply system. (3) The number of turns in the primary or secondary of the transformers supplying the converter can be altered by means of a special switch, and the ratio of transformation thus altered. The objection to this is principally one of price, as well as the somewhat special winding of the transformers. (4) Another plan, sometimes employed by the Allgemeine Elektricitäts-Gesellschaft, consists in mounting a small alternator on the same spindle as the rotary converter and connecting its armature windings in series with those of the converter. The alternator then acts as a booster, and, by adjusting and reversing its field excitation, the number of volts which it adds to or subtracts from the supply mains can be varied at will. The same result can, of course, be obtained by a booster on the continuous-current side. There is no special advantage in this method except, perhaps, when dealing with heavy currents, and it is expensive. (5) Probably the best method of hand regulation, and that most commonly employed, consists in inserting a small static boosting transformer with adjustable voltage in each phase. Such transformers are made in various forms, one of the best known of which is shown in Fig. 1. The central moving core, A, carries a primary winding connected across one phase of the supply mains. The external stationary core, B, is wound with two secondary coils connected in series with the same phase. The central core can be turned through an angle of 180deg. When it is vertical, the secondary voltage is a maximum. As it is turned round, the secondary voltage gradually falls and become zero when A is horizontal, the fluxes through the different parts of the secondary neutralising one another. If A is turned still further, the secondary voltage rises again, but is now in the opposite direction relatively to the supply voltage.

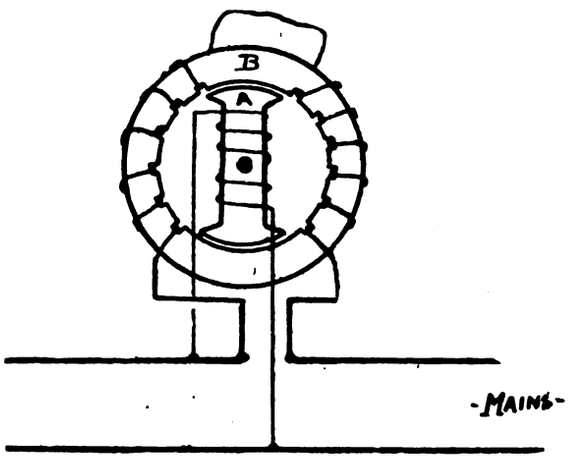

FIG. 1.

The maximum booster secondary voltage, stated as a percentage of the supply voltage per phase, need, therefore, only be half as much as the percentage change in continuous-current voltage required. The alternating supply voltage is given such a value that the correct continuous-current voltage is obtained at about half-load with the booster giving no volts. Then, as the load increases or falls off, the core A is turned one way or the other so as either to add or subtract volts. In the case of polyphase rotary converters, as many boosters as phases are required, and their handles should be interlocked so that all the phases are adjusted at the same time and equally.

Turning next to the question of automatic adjustment of the voltage, this has been largely employed in traction work, and is always attained in the same way—viz., by compound winding the field of the rotary converter and inserting a certain amount of self-induction in the alternate-current supply mains. The action depends on the fact that the phase relation of the alternating current flowing into a rotary converter to the voltage at its terminals depends on the excitation of the machine. For every load there is a particular value of the exciting current which makes the power factor unity—the current being in phase with the voltage—and if the excitation is less than this value, the supply current lags behind the voltage, and the power factor is less than unity; whilst if the excitation is greater, the supply current will be ahead of the voltage in phase, as in the case of a condenser, and the power factor will again be less than unity. The effect of this on any self-induction in the circuit is to cause

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the voltage across the self-induction (which always lags nearly 90deg. behind the current) to vary in phase relatively to the supply voltage, and consequently to vary the actual voltage supplied to the slip rings of the converter. This is shown in Figs. 2, 3, and 4. Fig. 2 represents the case when the current, A C, is in phase with the slip-ring voltage, A E, and the choking-coil voltage, E S, is practically at right angles to both. In this case the external supply voltage, A S, is greater than the slip-ring voltage, A E. When the current, A C, lags behind the voltage A E, as in Fig. 3, the difference between A S and A E becomes still greater; whilst if the current is ahead of the voltage (Fig. 4) the slip ring voltage, A E, is seen to be actually greater than the external voltage, A S—the choking coil adding some volts on, in fact. By so proportioning the shunt and series windings of the converter that at light loads the input current lags, whilst at full load it leads, and by adjusting the choking coils inserted in the mains by experiment, it is possible to produce either a continuous-current voltage which is constant at all loads, or one which actually rises 5 or 10 per cent.

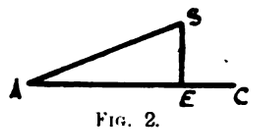

Fig. 2.

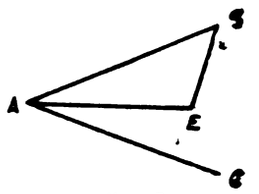

Fig. 3.

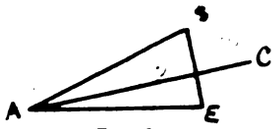

Fig. 4.

from no load to full load as desired. Instead of employing separate choking coils, it is sometimes preferable to arrange the supply transformers to have considerable magnetic leakage, and so act like choking coils.—Q.

Answer to No. 487 (*awarded* 7*s.* 6*d.*).—There are two good methods of regulating the direct-current pressure of rotary converters. For lighting work, where fine regulation is required, the best results are obtained by using an inductor regulator or some modification of the inductor regulator. For traction the best regulation is obtained by compounding. The resulting pressure on the direct-current side of a rotary converter varies as the alternating pressure on the slip rings. This is the principle upon which both the above methods of regulating depend.

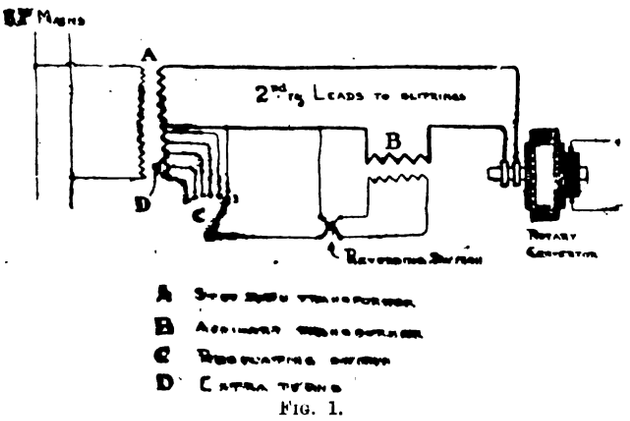

Fig. 1.

1. *Inductor Regulator.*—The inductor regulator consists of an iron core which can move inside both a shunt coil and a series coil wound on each phase of the alternating circuit. (If step-down transformers are used, of course these coils are on the secondary side.) When the iron core is moved, it alters the mutual induction between the shunt and series winding, and therefore alters the pressure on the slip rings. If the core is pulled out of the coils the mutual induction between them is reduced, the pressure on the slip rings becomes greater, and therefore the pressure on the direct-current side rises. On the other hand, if the core is moved further into the coils, the mutual induction is increased, the pressure on the slip rings becomes less, and consequently the direct-current pressure less.

2. *Modification of the Inductor Regulator.*—This is shown in Fig. 1. A few extra turns, D, are added to the secondary of the step-down transformer, A. These extra turns (which can carry about one-fourth of the full secondary current) are connected, as shown, through a regulating switch, C, to the primary of the small auxiliary transformer, B, the secondary of which is in series with the low-pressure alternating circuit. As the regulating switch, C, is turned from left to right the pressure in the primary of B is increased, and a proportional E.M.F. is induced in the secondary. This induced E.M.F. is added or subtracted to the pressure on the slip rings, according to the position of reversing switch. The method of working this regulator is quite simple. With the reversing switch in one position, as the regulating switch, C, is turned from left to right, the direct-current pressure will drop. With the reversing switch changed over, when C is turned as before, the direct-current pressure will rise. Of course, the reversing switch must only be thrown over when all the extra turns of D are cut out—*i.e.*, when the arm, C, is on contact.

3. *Compounding.*—As a rotary converter is a synchronous machine, the power factor it runs at depends upon the strength of the field. At a certain excitation (as shown by its V curve) the power factor is a maximum. If the excitation rises above this point, a leading alternating current is obtained, and the pressure on the slip ring is increased. On the other hand, if the excitation falls below this point a lagging current is obtained, and the pressure on the slip rings is decreased. By arranging the shunt field winding, and, if required, putting choking coils in the alternating circuit, the compounded rotary converter when running at no load takes a lagging current. As the load increases, the compound winding increases the field, diminishes the lag of the current, and thus increases the pressure on the slip rings, producing a proportional rise in the direct-current pressure. When the machine is fully loaded the alternating current will be leading, and the direct-current pressure will have increased in proportion to the increased pressure on the slippings. By suitably adjusting the compound winding and the choking coils, a very good automatic regulation of the direct-current pressure is obtained. The compound winding may be used as well as the inductor regulator on the same machine. This is a great advantage when the machine supplies both a lighting and a motor load.—R. W. Gregory.

Answer to No. 487 (*awarded* 5*s.*).—The difficulty in regulating the direct-current E.M.F. of a rotary converter arises from the fact that the ratio of the direct to the alternating applied E.M.F. is constant, and cannot be altered by varying the excitation of the machine. Hence the only way of regulating the direct-current E.M.F. is to vary the applied alternating potential difference. The best method of doing this is to wind the field-magnet circuit of the rotary as a compound machine, and to place three choking coils in series with the three slip rings on the three-phase side. When no load is taken from the direct-current side the rotary is under-excited, and the current in each phase lags considerably behind the E.M.F. in that phase. Suppose E is the total applied E.M.F. in each phase, then if e_1 be the potential difference across the choking coil, and e the potential difference between the slip ring and the neutral point, then at no load E is approximately equal to $e_1 + e$, because e_1 and e are nearly in phase. As the load on the direct-current side increases, the excitation increases owing to the series windings of the field magnets, hence e gets more and more into phase with the current, and at full load is generally in advance of the phase of the current. When e is in phase with the current,

$$e = \sqrt{E^2 - e_1^2},$$

and it is easy to show by geometry that this is always greater than $E - e$, and ultimately, if e were 90deg. in advance of the phase of the current,

$$e = E + e_1.$$

It will be seen that e continually increases as the excitation of the machine increases, and hence a considerable amount of regulation can be obtained

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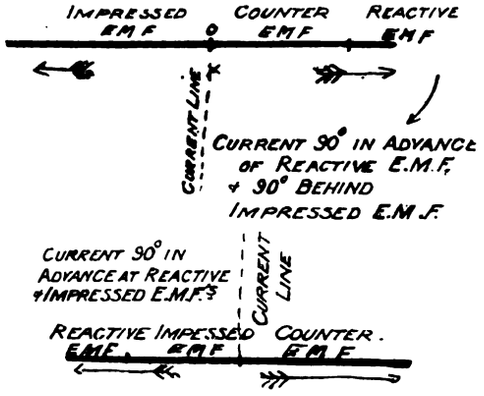
Mr. Eborall, in the *Journal* of the Institution of Electrical Engineers, vol. xxx., p. 718, states that it is perfectly easy to arrange for the direct-current pressure to be over-compounded 10 to 15 per cent., the actual regulation being nearly as good as with an ordinary over-compounded direct-current machine. To obtain this amount of regulation, the drop across the choking coils at no load must be 10 per cent. of the applied alternating potential difference, and the over-compounding of the field magnets of the rotary must be about 10 per cent. greater than what it would have been on the equivalent direct-current machine, for the direct-current pressure is not proportional to the field flux, but to the impressed alternating-current pressure on the slip rings.—J. C. R.

Answer to No. 487 (*awarded* 5*s.*).—The commercial methods of regulating the continuous-current voltage of a rotary converter depends upon whether the machine is being used for traction or lighting. We will consider the traction regulation first. We must remember (*a*) that a rotary converter simply consists of an ordinary dynamo or motor, with an ordinary distributed continuous-current armature winding, with a commutator at one end of the shaft and slip rings at the other, connected, in three-phase working, to points 120deg. apart on armature winding, alternating current being led into the machine at the slip rings and taken out at the commutator end as continuous current, consequently it can easily be seen that the continuous-current voltage depends upon the voltage impressed upon the slip rings; (*b*) also that the converter runs in synchronism with the main generator, and, in fact, behaves very much like any ordinary synchronous motor. In any converter we have to consider three separate E.M.F.'s set up: (1) impressed E.M.F, depending upon generator volts; (2) counter E.M.F., depending upon excitation and field of machine; (3) reactive E.M.F., due to current passing through reactance and resistance of armature, and which is proportional to that current.



The algebraic sum of these three E.M.F.'s is zero. Suppose the converter, running synchronously, is under-excited, then the counter E.M.F. is less than the impressed E.M.F. (to which it is always in phase and opposite). Consequently to fulfil the aforementioned condition, the reactive E.M.F. becomes in phase with and adds to the counter E.M.F., so that the algebraic sum is zero. But according the principles of alternating currents, the current in a system is 90deg. ahead of the E.M.F. of self-induction, and consequently it must be 90deg. behind the impressed E.M.F., or in a shorter expression it is "lagging." Similarly, if the machine is over-excited, so that the counter E.M.F. is greater than the impressed E.M.F., then the reactive E.M.F. becomes in phase with the impressed E.M.F., and as current is 90deg. in advance of reactive E.M.F., it is also 90deg. in advance of impressed E.M.F.; consequently the current of the system is said to be leading. It is thus seen that by suitably altering the excitation of the converter, leading or lagging currents can be induced in the system.

In tramway practice the converters are excited by a shunt winding across the continuous-current 'bus bars, and also an additional compound winding in series with the armature. It is so arranged that at no load the converter is under-excited, and the current in the transmission system is lagging. This increases the E.M.F. of self-induction of the line, and drops the voltage at the receiving end, and consequently the impressed E.M.F. on the slip rings and the continuous-current voltage usually to 500 volts. As the load increases the excitation also increases, due to the compound winding, and with it the counter F.M.F., thus bringing the impressed E.M.F. and current into phase, then the line drop is proportional to resistance only; therefore voltage at receiving end rises and also continuous-current volts. At full load the counter E.M.F. is greater than the impressed E.M.F., and consequently current leads, and voltage rises up to the usual maximum of 550.

For lighting work, converters shunt wound, the power factor of the system is usually kept at unity, to reduce distribution losses, by adjusting the field with the rheostat, and by using some form of power factor indicator. Then to vary the continuous volts, the impressed E.M.F. on the converter slip rings is reduced or increased by means of a rheostat which cuts in or out some of the windings of the transformers supplying the converter. In the first case, for traction work, the control is automatic, but in the second case, for lighting, the control has to be done by hand.—F. H.

Question No. 488.—Give a full description of the proper tests which should be applied to girder section steel tramway rails, say 100lb. per yard; also what results would be considered satisfactory from such tests.

Best Answer to No. 488 (*awarded* 10*s.*).—In the first place, the rails should correspond exactly to size as regards depth, width, and depth of groove, width of tread, etc., these being fixed beforehand in accordance with their suitability for the work in hand, and a template made for the approval of the engineer responsible before they are put in hand. For this comparatively heavy section (100lb.) they should be in lengths of 40ft or 45ft. as to at least 90 per cent., but a proportion of shorts equal to not more than 10 per cent. may be allowed, varying from 30ft. to 37ft., these shorts being cut from longer rails having faulty ends, and being used at curves, stops, etc. Each rail should be rolled from a single ingot of Bessemer steel, having the chemical proportions approximately as follows: carbon from ·45 to, say, ·55 per cent., silicon not more than ·06 per cent., sulphur not more than ·06 per cent., and phosphorus not more than ·06 per cent. The remainder to be iron and manganese, with a trace of copper. Samples should be tested from time to time by a chemist to see that these proportions are not exceeded. The ingots should be cast of such a size as to leave an over-plus at the end of each rail of about 18in. for cutting off, and all ingots should be reheated before cogging. Rails should be free from cracks, excrescences, burrs, or other defects, and of uniform section for the whole length. They should be perfectly straight and true, and their ends sawn off square. Some engineers specify that they should be machined where the fishplates go, but this is hardly necessary, although undoubtedly an advantage in getting perfect alignment when laid.

With regard to actual strength tests, as specified below, some of these appear rather severe, and any well-established English firm of railmakers may be relied upon to supply an article quite capable of meeting the demands made on the rails in practice. Test pieces should be taken from each day's make, and tested in the usual testing machines at the maker's works. The rails should show a tensile strength of from 40 to 47 tons (averaging about 45 tons) per square inch with an elongation of 15 per cent. with a contraction of area of, say, 25 per cent. and an elastic limit of 30 tons per square inch. Any rail should support a dead load of 31 tons suspended from its centre, when held on solid bearings 3ft. 6in. apart in the clear, and should not show a greater deflection than $\frac{1}{4}$in. after half-an-hour's time, or any permanent set on removal of the weight. Any rail should stand being bent cold to a radius of 30ft. It is usual to specify that if 10 per cent. of the rails fail under any of these tests, the lot taken from that blowing shall be condemned, and the rails are sometimes marked so that this can be distinguished.

The holes for the fishplates and tie-bars should be clean and free from burrs, those for the fishplates being preferably drilled, and those for the tie-bars punched at the right distances apart; a deviation of, say, $\frac{1}{16}$in. to $\frac{1}{8}$in. in position, and $\frac{1}{32}$in. to $\frac{1}{16}$in. in size being allowed.

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The fishplates should be made from the same quality of steel as the rails, and the tie-bars of wrought iron, or preferably of steel with a tensile strength of 25 tons per square inch.—J. A. MORTON.

Answer to No. 488 (*awarded* 7*s.* 6*d.*).—As the track is one of the most expensive items in a tramway system, costing from £6,000 to £8,000 per mile, or from 35 to 50 per cent. of the total cost of the installation, it is well to make sure that the materials and workmanship are both as good as can be procured. If the track is bad, it at once reacts on the rolling-stock, causing the car trucks, motors, etc., to wear much faster than they otherwise would do The general adoption in this country of a "standard" rail section is much to be desired. With the present multitude of sections, which are constantly being added to, it becomes impossible for railmakers to stock rails, hence the time of delivery and also the cost of the rails is much increased. The conditions to be complied with in designing a "standard" rail section are so limited that there should be little difficulty in arriving at the best way of meeting them. The Board of Trade have recently made an announcement that the minimum weight of a rail shall be 90lb. per yard—*i.e.*, a sectional area of about nine square inches for a hard-steel rail having a conductivity of one-twelfth to one-fourteenth that of copper. The rails laid on electric tramways in this country have a life of from six to twelve years, depending on the curves, the gradients, and the traffic, etc.

During the last 20 years there has been a considerable change in the chemical composition, physical qualities, etc., of tramway rails. Ten years ago the common percentage of carbon was ·35, which was a very soft steel indeed. These were fairly successful with horse traffic with cars weighing three or four tons, but failed completely with the 10 or 12 tons cars used with electric traction. The following rail composition was stipulated for Glasgow, and represents the latest practice: carbon, ·55 to ·65 per cent.; manganese, ·8 to 1·0 per cent.; phosphorus, ·06 per cent. (but not more); sulphur, ·05 per cent. (but not more); silicon, ·15 to ·2 per cent.

As regards *tests* no definite understanding exists, though a drop test seems very general. A piece of rail 4½ft. to 5ft. in length is taken, and is rigidly supported with a clear space of 3ft. between the points of support. A weight of about 2,000lb. is then dropped vertically some 15ft. or 18ft. on to the centre of the rail, the stress being transmitted vertically through the web. The rail must not break or show signs of fracture, or unduly bend. A test of tensile stress is also very common. Mr. W. Howard Smith suggests the following in a very interesting paper published in the *Electrical Engineer*, July 19, 1901. The breaking stress per square inch in tension should be from 42 to 48 tons. The elongation over a length of 8in. should be 15 per cent. I have found from tests that the elastic limit in tension varies from 28 to 32 tons per square inch, and the breaking stress from 40 to 48. The contraction of area at the point of fracture varies from 30 to 60 per cent. A 100lb. rail would have a cross-sectional area of about 10 square inches, hence the elastic limit should be from 280 to 320 tons and the breaking load 400 to 480. The usual lengths of rails now supplied are 45ft. and 60ft. The 60ft. lengths are somewhat inconvenient, however, requiring extra long trucks on railways, and are also cumbrous to handle on the road, but they save bonds and joints, and are better than the short lengths when once they are laid.—T. SQUARE.

Answer to No. 488 (*awarded* 5*s.*).—The usual tests which girder steel tramrails are subjected to are: tensile tests, falling weight tests, and chemical tests.

The tensile test pieces are cut from the rail and prepared and broken in the usual manner which is familiar to all readers. The usual figures for such tests are: breaking stress 37 to 43 tons per square inch; elongation in length of 8in., at least 15 per cent.; contraction of sectional area, at least 30 per cent. For rails used on the Huddersfield system the figures were as follows for 98lb. rails: breaking stress, 43·81 tons per square inch; elongation, 18·1 per cent.; contraction, 47·8 per cent.

Falling Weight Tests.—A piece of rail 5ft. long on supports 3ft. apart to resist a blow from a weight of one ton, falling on the centre from a given height, without causing more than 1in. deflection; a second blow from given height without showing sign of fracture. For rails 90lb. to 100lb. weight per yard the drops would be 9ft. and 22½ft. respectively.

Chemical Tests.—The following tables give the percentage limits of foreign matter in steel allowed in usual specifications, but the maximum figures are in no case to be exceeded:

English practice.

Carbon.	Manganese.	Silicon.	Phosphorus.	Sulphur.
0·4-0·5	0·85-0·95	0·06	0·10	0·08

American practice.

0·4-0·6	0·76-0·10	0·66-0·20	0·06-0·11	0·047-0·07

Of course, the chemical composition varies slightly according to design and manufacture, but above figures are limiting proportions.

The Illinois Steel Company give the following figures and test in their standard specifications for steel rails 70lb. to 100lb. per yard: carbon, 0·45 to 0·55; sulphur, not to exceed 0·05; phosphorus, not to exceed 0·10; silicon, 0·1 to 0 2; manganese, 0·8 to 1·0. Also test during manufacture: from each heat one ingot shall be cast 2½in. by 2½in. by 6in. long, to be drawn down at one heat by hammering to a test piece ¾in. square and 18in. to 20in. long. The same when cold to be bent to a right angle without breaking; bar to be bent by blows from a hammer.—F. H.

Answer to No. 488 (*awarded* 5*s.*).—The first test to be mentioned is probably the usual and well-known tensile test. A piece of metal of the same material as the rail is obtained, either of rectangular or circular section (Fig. 1). The size of this section will, of course, depend on the capabilities of the machine which will be used for the test.

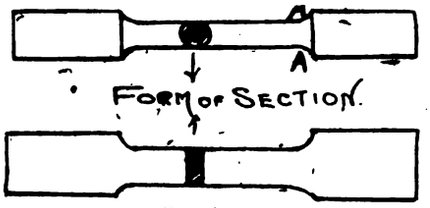

FIG. 1.

It might be mentioned that care must be taken not to make the radii at A A small. Two centre punch marks are made on the axis of this specimen 2in. apart. This is done very exactly. The specimen is now put in the machine and is loaded *gradually* until it breaks. The commercial method of measuring the extension is to press the two broken pieces together, and measure the distance apart of the centre punch marks by means of a steel rule, having on it one-hundredths of an inch, and a pair of finely pointed dividers. The extension in one-hundredths of an inch × 200 gives the elongation per cent. in 2in. According to Unwin's "Testing of Materials of Construction," 35·4 tons per square inch was an average of a certain class of rails and 29·5 per cent. was the elongation in 2in.

The next test is that for toughness. The test usually employed for this is a bending one. A 3ft. length of rail is used if required for breaking, and anything up to about 6ft. is used if a test for deflection and permanent set is required. The deflection is a measure of the toughness. Figures can hardly be given for a test of this description, as the moment of inertia of the section of the rail is one of the principal features of the test, and this differs in different sections. Unwin describes a test in the above-mentioned work which has been made with rails. He says: "To control the bending test, a falling weight test has been used. A monkey or ball, weighing 300lb., 600lb., or 1,000lb, and falling 6ft., 12ft, or more on the rail bends it more or less; the number of blows the rail will stand before twisting or breaking or deflection with one blow is taken as an index of toughness. For some usual figures of tests I would recommend "G. W." to Unwin's book, or to the *Proceedings* of the various institutions of engineers.—T. T.

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THE EMBANKMENT TRAMWAYS.

The House of Lords on Monday last struck out of the Tramway Bill of the London County Council all those clauses which dealt with the construction of tramways south of the Strand. This leaves the shallow tunnel line down the new street now under construction, but it will have no outlet on the Embankment nor any connection with another tramway line at its southern end. The reasons given in the debate for the rejection of the proposal to construct tramways on the Embankment were many, but we believe that the consideration of supreme importance in the ballot was the knowledge that the Bill under consideration was only part of a larger scheme. That this is true is common knowledge, and the final object of the Tramway Committee of the London County Council is to get tramways on the bridges over the Thames, so that the northern and southern tramway systems might be joined up. The shallow tunnel under the new street was to be the first such link through the heart of London, but the Embankment tramways and those over the bridges would be surface lines. The fear was expressed accordingly that if the present Bill was passed, the lines on the Embankment would be used in the future as a reason for granting parliamentary powers for the lines over the bridges. That tramways would have hampered the traffic on the London bridges is sure, and Parliament has yet to be convinced that the business and general traffic should give place to tramway passengers. The action of the House of Lords will commend itself to many who have expert knowledge of the increased possibility of narrow and crowded roads with automobiles. In any case the London County Council would have done better to have shown their full scheme, and to have stood or fallen by that.

NEXT WEEK.

This week we hardly expect our editorial efforts to be carefully perused, but we hope that the above heading will remind a large section of electrical engineers that they can have a good time in London next week under the guise of attending business meetings. In the first place, the Incorporated Municipal Electrical Association is holding its annual convention in London, which will last over from Wednesday, July 2, until Saturday, July 5, both days inclusive. Mr. J. H. Rider, the electrical engineer to the London County Council tramways, is president this year, and, as is only right, the chairman of the London County Council will welcome the members of the association at the first general meeting on Wednesday, which will be held at the Institution of Mechanical Engineers. The item in the programme of this association which involves the greatest change from that of previous years is the abandonment of the annual dinner in favour of a smoking concert. The advantage is that, instead of half a dozen gentlemen speaking for the company when they would rather be smoking, the whole of the members can talk at the same time. The programme of papers to be read and of visits to be paid is an exceptionally good one, so that if municipal engineers are forced by the holding of the meeting in London to join in the Coronation festivities, they can explain to their town councillors that they required a quiet time in the Metropolis in order to put together what they wish to say in the important discussions which are sure to follow the reading of these papers. The other meeting which is of great interest to all electrical engineers, is that of the congress of the Union Internationale Permanente de Tramways. The congress of this union opens on Monday, June 30, at noon. The President of the Board of Trade has under-

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taken the opening ceremony, which will take place in Berners Hall at noon. Full programmes of both these congresses will be found in this week's issue.

ANTICIPATIONS.

Now Mother Shipton's numbered with the dead;
Her all-prophetic cloak is on my head;
And thus I prophecy how things will hap,
And Time will verify what I have said.

When Coronation fever's in the air
O ye who 'wait delivered goods, beware!
This chief excuse will cover all delays—
"The Holidays": and so for this prepare.

The while the great procession passes by:
I know that Edward Rex will surely sigh
To change his chariot for a motorcar,
And haste the crawl into a wingless fly.

When at the end of that all-glorious day:
A boist'rous wind doth on the gas-jets play
OD AVE E NG is all that will be seen,
Save where the "juice" the words complete display.

Where such illuminations glow the skies,
Put up in haste by those who money prize
More than good name—I see a sad surprise
For him who on pre-figured amps relies.

Then when the aftermath comes, sweet and sour,
And men return to work with smile or glower,
The cheerful face will show the weekly wage,
The sad: gets paid, *when* working, by the hour.

B. C. H. J.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

We beg to remind our readers that the seventh annual convention of the above association opens in London at the Institution of Mechanical Engineers, Storey's-gate, Westminster, on Wednesday, the 2nd prox. At 10 a.m. on that day Mr. J. H. Rider will deliver his presidential address. The full text of the official programme of the meeting was given in our last issue. The convention closes on Saturday, July 5.

A CONTRIBUTION TO THE KNOWLEDGE OF ROTATING HYSTERESIS.*

BY M. SCHENKEL, DRESDEN.

The tests here described were principally undertaken for the purpose of discovering whether the value of the rotating hysteresis loss decreased to zero again at very high inductions after having risen from zero to a maximum value. The experiment has only been attempted three times up to the present—by Bailey, the discoverer of the effect, by Messrs. Beatty and Clinker in England, and, finally, by Messrs. Graw and Hieke in Vienna. Two of these experimenters used a thin disc of iron suspended between the poles of an electromagnet, so as to obtain high saturations.

The present writer, on the other hand, determined to employ as great an amount of iron as possible. In order to obtain the high inductions, it seemed best to employ a magnet with conical pole-tips, and as this magnet had to be of considerable size, it became necessary to rotate the iron sample rather than the magnet. The magnet was of dynamo steel, and could stand 25,000 ampere-turns continuously, or 40,000 for a short time. The bore of the poles was 37mm. diameter and 40mm. long, and the rotating iron cylinder was 35mm. diameter and 17·5mm. high. It consisted of dynamo stampings, supplied by Messrs. Siemens and Halske, ·35mm. thick, insulated with thin paper. Obviously no uniform distribution of the flux could be expected in the sample, and no attempt was made to determine the distribution; the average value of the induction, B, alone was measured by means of a ballistic galvanometer. Wherever mention is made, in the following, of induction, the average induction is to be understood. The highest value attained in the experiment was 28,000 = B with 26,000 ampere-turns.

As a free suspension in the magnetic field was not permissible owing to the enormous magnetic forces, it was necessary to employ self-centering bearings. It was, therefore, impossible to measure the turning moment required for hysteresis alone. A certain torque due to friction was, perforce, included in the measurements. The following method of test was selected in order to allow for this: The iron sample, E (Fig. 1), rests on a bush, B, kept as small as possible, which is free to rotate on the truly cylindrical axle, A, and carries a pulley, R. The sample, E, can be rotated by means of a cord passed round the pulley, R. This cord passes through a sort of belt dynamometer, which is made very light, and enables the torque transmitted to R to be measured. The internal friction of this dynamometer was separately investigated, and found to be very small. The axle, A, rests in the upper and lower self-centering bearings, L L, and is held from above by a bifilar suspension, which rotates with it

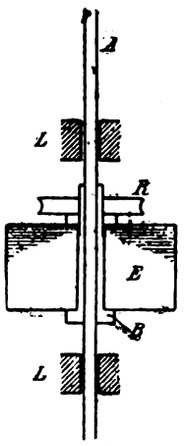

Fig. 1.

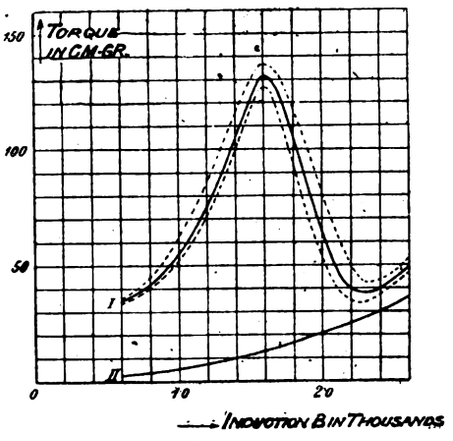

Fig. 2.

On account of the rotation the torque on this bifilar suspension had to be measured by the height through which the object is raised, and not by the angle of deflection. It is unnecessary to provide the sample, E, with any support against sliding along the spindle, as the magnetism itself keeps it suspended between the poles.

The principle of the measurement of the torque due to hysteresis for any induction B was as follows: (1) Axle A and sample E rotate in the same direction and equally fast. The latter point was very exactly ensured by means of small stroboscopic discs fixed to A and E. Both measuring instruments—the dynamometer and the bifilar suspension—give a reading of torque. The sum of these readings, D_1, is equal to the torque, D_H, for hysteresis + the torque for friction in the self-centering bearings, L. (2) Axle A and sample E rotate in opposite directions, but at the same speed as above (determined by means of stroboscopic discs). Then the bifilar suspension measures the sum, D_2, of the torques $D_L + D_B$, where D_L is the torque of the axle, A, in the bearings, L, and D_B is the friction of the axle, A, in the bush, B. The dynamometer measures the sum, D_3, of the torques $D_B + D_H$.

Three independent equations are therefore obtained:

$$D_1 = D_H + D_L;\ D_2 = D_L + D_B;\ D_3 = D_B + D_H;$$

from which D_B can be determined. The friction losses are entirely eliminated without making any further assumption than the quite justifiable one that these losses remain constant during the time of each single test.

Curve 1 (Fig. 2), connecting the torque required for hysteresis and eddy currents in centimetre-grammes with the induction, B, at 10 periods per second, was obtained in this way. By making similar tests with various periodicities up to 30, but constant induction, B, it could be shown that

* Translation in abstract from the *Electrotechnische Zeitschrift* for May 15, 1902.

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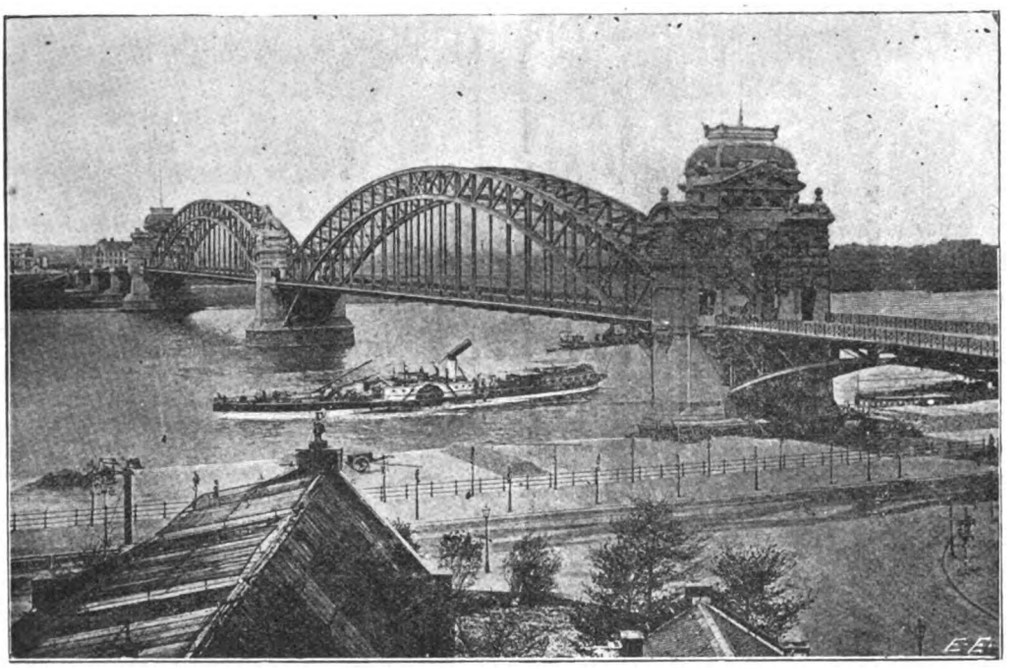
the torque increased proportionately to the periodicity; this points to the fact that the eddy-current torque increases in proportion to the periodicity whilst the hysteresis torque remains constant. The amount of the eddy-current torque could also be obtained from these tests at various inductions, and this is shown in Curve II. (Fig. 2). It should be mentioned that Curve I. is drawn through 49 points, and the dotted parallel curves indicate the limits of accuracy—*i.e.*, none of the points employed lay without these boundaries. The difference between I. and II. shows the torque for hysteresis alone.

The tests tend to confirm the results of the above-mentioned experimenters. Increasing first slowly, then more quickly, and then again more slowly, the hysteresis reaches a maximum value at a B of 16,000. After this it falls off remarkably quickly, and appears to approach the zero line asymtotically. At a B = 23,000, however, it is already reduced to only about 8 per cent. of its maximum value. As the volume of the iron sample, E, was 15 cubic centimetres, the curve shows that the watts lost at 10 periods were $(131 - 13)\frac{2\pi \times 10}{15} = 495$ C.G.S. = ·485 watt per cubic centimetre for an induction B = 16,000, whilst they were only ·04 watt for B = 23,000.

It may be pointed out, in conclusion, that the comparatively large proportion of the total loss formed by the eddy-current loss is due to the arrangements of the experiment by which the production of eddy currents was rather favoured.



The New Rhine Bridge, Dusseldorf.

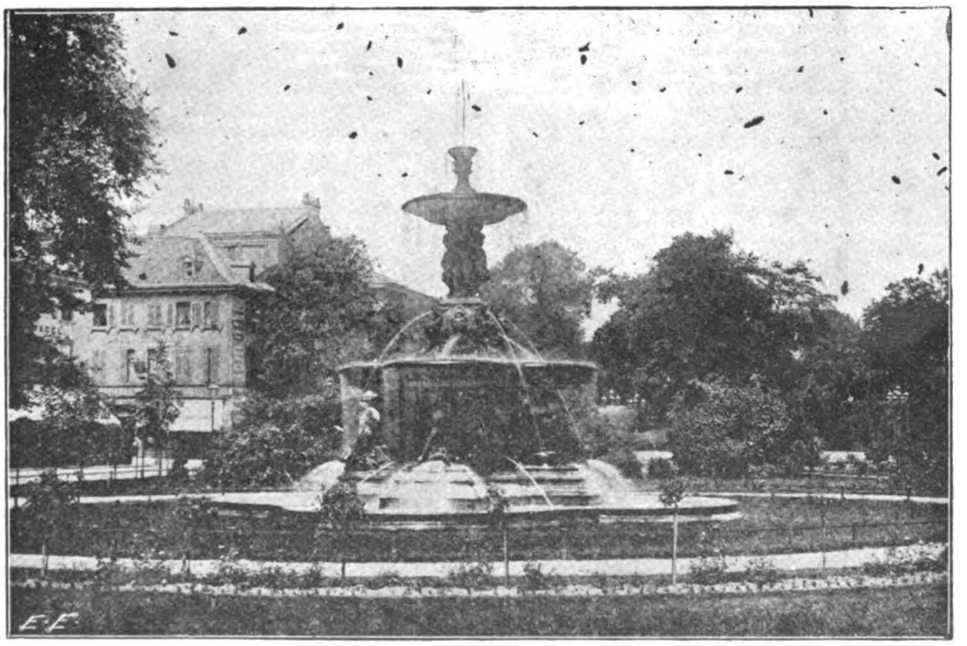
THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

TENTH ANNUAL MEETING, DUSSELDORF.

[BY OUR OWN CORRESPONDENT.]

(Continued from page 880.)

The annual report having been read by Mr.. Kapp, a proposed standard construction for flexible wire used in connection with hanging lamps was submitted to the meeting. The following is a translation: "The copper contained in the flexible wire has a sectional area of 0·75 square millimetres. The copper core consists of tinned wires having a maximum diameter of 0·3mm., and made into a cable. The core is first covered with cotton, and then encased in vulcanised rubber having a thickness of 0·6mm. Two cores thus insulated are to be combined with a strengthening cord or strand made of suitable



A Park Scene, Dusseldorf.

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material, the whole being then enclosed in a braiding of cotton, hemp, silk, or similar material. The strengthening cord or strand may also be arranged double on both sides of the cores. If the strengthening strand is of metal, it must be taped or braided. The common braiding of the wire can be dispensed with, but the rubber-covered cores must in that case be separately braided. The twin flexible so constructed must be capable of withstanding an alternating pressure of 1,000 volts when in a dry condition." After some discussion, these recommendations—formulated, it should be mentioned, by the committee of the Verband entrusted with the consideration of questions relating to wires and cables—were adopted.

Badge worn by Members of the Verband, Dusseldorf Meeting.

It will be seen that the object of the standard is to obtain a flexible wire, the mechanical strength of which shall be independent of the copper core and its insulation. Whether a special form of lampholder and separate connection of the carrying strands to such lampholder would be entailed by the innovation did not transpire. But it seems to us that unless such special provision be made, the object of the improvement will be defeated.

LEGAL INTELLIGENCE.

CABLE RIGHTS.

On Monday in the House of Lords, Lord Macnaghten (presiding) and Lords Brampton, Robertson, and Lindley, heard arguments in the case of the West India and Panama Telegraph Company, Limited *v.* the Cuba Submarine Telegraph Company, Limited, which came up on appeal from an order of the Court of Appeal, affirming, with some variations, a judgment of Mr. Justice Farwell.

The action was commenced in the Chancery Division by the respondents for the purpose of asserting and enforcing certain alleged rights of theirs under agreements made in 1870 and 1877. The substantial question was the meaning of the words "telegraph communication" in the agreement of 1870, the point at issue being whether the appellants and respondents were, as the appellants contended, in telegraph communication only with such places as they respectively serve by their own lines, and lines which are or may be leased to them respectively, or over which they respectively have or may obtain control. The main contention of the respondent company, on the other hand, was that the appellants were bound to account to them for payments received in respect of messages which did not pass over the respondents' system, but which were destined for any place with which the respondents in their capacity as members of the public could communicate by telegraph in the ordinary course of business. Mr. Justice Farwell decided in favour of the respondents, and with certain variations his judgment was affirmed by the Court of Appeal. Hence the present appeal.

At the conclusion of the arguments, their Lordships now held that the decision of the Court of Appeal was right, and they accordingly dismissed the present appeal with costs.

THE HIRAM MAXIM LAMP COMPANY.

Before Mr. Justice Farwell in the Chancery Division on Friday, **Mr. C. E. Jenkins, K.C.,** mentioned the case of the Hiram Maxim Lamp Company, Limited, *v.* Henry Wardlow and others. He had a motion to make, but proposed to postpone it till Tuesday.

Mr. Upjohn, K.C., for the defendants, dissented, and **His Lordship** asked what were the facts of the case.

Mr. Jenkins said the action was brought by the Hiram Maxim Lamp Company against certain gentlemen, who were directors of that company. Though the action was brought in the name of the company it was really brought upon the authority of the Hiram Maxim Electrical Engineering Company, which controlled the shares in the lamp company; and it asked for an injunction to restrain the defendants from making a certain call and other relief of that kind.

His Lordship, reading from the writ, said it was sought to restrain calls, and an order to prevent the directors from summoning an ordinary general meeting.

Mr. Jenkins said the plaintiffs had a good cause of action against the directors, who refused to give them a list of shareholders in order to call a meeting. The result was that they were afraid the affairs of the company were not being properly conducted.

His Lordship reviewed the whole course of the litigation, and said there was a limit to the delays which had already ensued, and he dismissed the application for a stay accordingly. He also refused Mr. Jenkins's application for leave to appeal.

A TELEPHONE CASE.

At Darlington County Court on Wednesday last week, the Rev. Mr. Eckersley, the owner of property on the High-row, Darlington, sought to recover damages and an injunction against Messrs. Cox, Walker, and Co., electrical engineers, for fixing a telephone wire to the chimney of the plaintiff's property, occupied by Messrs. Lipton and Co. It was stated that a similar thing had been done eight years before, and action had to be taken to get its removal. Now the offence had been repeated, and though it had been taken away on demand, a wire had, later, been placed in front of the plaintiff's property.

The defence was that the wire had been fixed by mistake on plaintiff's instead of another chimney which joined it, where the company had leave to fix the wire, and evidence was given to this effect.

His Honour refused an injunction, but gave judgment for the plaintiff for £1 damages and costs.

COMPANIES' MEETINGS AND REPORTS

W. T. HENLEY'S TELEGRAPH.

On Friday the ordinary general meeting of the shareholders in this Company was held at the Cannon-street Hotel, Mr. Sydney Gedge presiding.

The **Chairman,** in moving the adoption of the report, stated that the ordinary and preference share capital remained unaltered. There was power to issue £200,000 of each, and there had actually been issued £175,000 of each. Before long, however, it might be necessary to increase the capital to the larger amount. The mortgage debenture stock remained at £50,000 in the balance-sheet, because it was kept alive for special reasons, but the amount was being annually reduced. The net profit for 1901 was £57,449, which was rather more than that of the previous year, and they brought forward £24,000. The result was that the directors were able to ask the shareholders to confirm their declaration of a dividend for the whole year of 20 per cent., of which 15 per cent. had already been paid. Referring to the breakdown in the negotiations for joining hands with the Callender's Cable and Construction Company, Mr. Gedge expressed regret that certain difficulties had arisen as to the terms of the proposed amalgamation, which, in the view of both Boards, rendered such a step for the present impracticable. Although the amalgamation had failed for the present, there was no reason why it should not take place at a future date.

Mr. George Sutton, in seconding the resolution, stated that the industrial crisis in Germany had played havoc with part of their business, but, nevertheless, profits had been rather larger. The American competition had also affected them to some extent, but not as regarded prices. As regarded the business this year, he was perfectly satisfied with the returns up to May, and he had no doubt that for the remainder of the year the business would be as good.

The resolution was unanimously adopted, and the dividend recommended declared.

MOTOR MANUFACTURING COMPANY.

An extraordinary meeting of this Company, held last month, having approved an agreement for the sale of the undertaking to a new company to be incorporated under the same name, part of the consideration being the allotment to shareholders of 252,966 shares in the new company of 5s. each, with 3s. per share credited as paid up, Mr. Alfred Burgess, the liquidator, has now issued a circular announcing that these shares are ready for distribution. In this document he gives a rough estimate of the financial position upon which the new Company will commence business. In addition to the share capital—£63,241—there are debentures for £20,000, while creditors of the old company to be paid by the new company (including a considerable sum for deposits on cars ordered by customers) figure for £16,000. On the other side of the account the following amounts are shown: estimated amount to be received from debtors of old company, £3,000; work in progress, complete cars, and stock, £36,445; machinery, £23,000; tools, £3,000; patterns and drawings, £500; cash to come in in respect of the 2s. per share liability on the 252,966 shares, £25,296; and buildings leases, etc. (cost £20,500), £8,000. The liquidator adds that there are orders in hand at the present time to the extent of £23,264, provided they are executed quickly. It has been ascertained beyond doubt that the principal cause of the loss sustained in the past is the fact that the company constructed too many different types of motor vehicles. He understands that it is proposed to reduce the number of standard types to three—that is: (1) a single-cylinder car; (2) a two-cylinder car; and (3) a four-cylinder car—and that the cylinders and many portions of the engines of each of these

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three types will be absolutely interchangeable, also that the saving thus effected in the cost thereof will be considerable.

LISBON ELECTRIC TRAMWAYS.

The report of the directors for the year ended Dec. 31 last states that the conversion of the system was continued, with the result that by the end of the year more than one-half of the lines were in operation electrically, and there was every prospect of the rapid completion of the whole system as originally provided for. The working of the tramways by animal traction showed a loss, even under the best conditions, and the numerous interruptions, due to the construction, added to it considerably. The first line was opened to the public by electric service on Aug. 31, and the earnings, which up to the introduction of electric traction had been steadily falling off, immediately increased, and the results of each new service, opened to the public from time to time, have been equally satisfactory. Although the four months under review cannot be taken as an indication of the earning power of the Company, the directors feel confidence in stating that in their judgment the Company can safely look forward to a prosperous career. The accounts show a profit on working of £1,677, and a net debit balance to profit and loss after payment of debenture interest of £28,025.

WEST AFRICAN TELEGRAPH.

The report of the directors for 1901 states that the revenue for that period amounted to £75,554, against which £20,674 is charged for ordinary expenses and £17,720 for expenditure relating to repairs of cables, etc. After providing £95 for income tax, there remains a balance of £37,065, to which is added £322 brought forward, making a total available balance of £37,387. From this balance there has been deducted £7,508 for interest on debentures and £16,566 for sinking fund, leaving £13,312, out of which the directors propose to place £13,000 to the general reserve fund, and carry £312 forward. The revenue for the year under review includes a further sum of £12,000 in respect of subsidy due from the French Government, but which has not been paid. This arrear, together with the sums withheld in previous years, now amounts to £80,415. The negotiations, however, with the French Government, referred to in the last report, have been successfully concluded since the date of these accounts, and the first instalment of £112,000, due from the French Government on account of the cables purchased by them, has been received.

THOMAS PARKER, LIMITED.

The directors' report for the year ended April 30, 1902, states that, after writing off the various depreciations, the balance standing to the credit of profit and loss account is £9,049. 9s. 9d. Out of this the directors propose to pay a dividend at the rate of 10 per cent. per annum, less income tax, amounting to £7,060. 7s. 2d., and to carry the balance—£1,987. 2s. 7d.—forward to next year's account. The director who retires by rotation is Mr. R. Armistead, who is eligible, and offers himself for re-election. The auditors, Messrs. Allen Edwards and Smith, also retire, are eligible, and offer themselves for re-election.

Dr. BALANCE-SHEET.		£	s.	d.
Capital—viz., 7,500 ordinary £10 shares, fully paid..		75,000	0	0
Debentures authorised.....	£75,000			
Debentures issued.....	58,400			
Deposited with bankers	25,000			
		33,400	0	0
Sundry creditors (less reserve for discounts)		16,168	17	0
Amount due to bankers		14,972	19	10
Reserve fund.....		17,000	0	0
Profit and loss account		9,049	9	9
		£166,091	6	7

Cr.	£	s.	d.
Sundry debtors (less reserve for discounts)	44,420	3	10
Freehold land, buildings, plant, etc., less depreciation	81,794	19	6
Stocks on hand and work in progress	38,709	0	5
Investments at cost	1,167	2	10
	£166,091	6	7

UNITED RIVER PLATE TELEPHONE.

The directors of the above Company report that the gross receipts in sterling for the year ended March 31 last in the River Plate were £114.841, as against £109,540 for the year before; and the working expenses in London and the River Plate £60,345. After deducting debenture interest and interim dividends on preference and ordinary shares, and adding transfer fees and interest on investments, there remains a profit of £33,405, to which must be added £6,058 brought forward from the previous year, leaving an available balance of £39,464. After transferring the sum of £20,000 to reserve fund, which will then amount to £75,000, the directors recommend that a final dividend of 4½ per cent. be paid upon the ordinary share capital of the Company, making, with the interim dividend paid Dec. 31 last, a return of 7 per cent. for the year, and that the balance of £6.414 be carried forward.

ANGUS ELECTRIC LIGHT AND POWER.

The report of the directors for the half-year states that the works at Montrose and Brechin were completed in July, since which time a satisfactory supply has been maintained in both towns. At the end of the year the equivalent of 2,066 8-c.p. lamps were connected in Montrose and 2,790 in Brechin, and up to the present time 2,672 additional lamps have been applied for in Montrose and 1,502 in Brechin, making a total of 9,030 in the two towns. The directors consider this a very satisfactory start for towns of this size. The result of the six months' working, after paying all expenses, has been a net profit of £42. 4s. 5½d., which it is proposed to carry forward to next account. The statement of electricity generated, sold, etc., shows that 12.513 units were generated in Montrose and 18,233 in Brechin. Public lamps used 3,407 units in Montrose and 5,605 in Brechin, and private consumers 5,895 in Montrose and 5,348 in Brechin.

ELECTRIC AND GENERAL INVESTMENT.

The report of the directors for the year ended May 31 last states that the profit and loss account shows a gross profit on the transactions of the year of £32,247. After deducting all general charges and the interim dividends already paid on the preference and ordinary shares, and providing for the proportion of the final dividend accrued on the preference shares to May 31, there remains a net balance of £20,470. Of this sum the directors propose to carry £10,470 to the contingencies account in order to strengthen the funds available for dealing with further business. This will leave an available balance of £10,000 for the payment of dividends, as noted in our last issue.

APPOINTMENTS VACANT.

Assistant Superintendents (5), Indian Telegraph Department, commencing salary 4,200 rupees, June 30. See advertisement.

Distribution Engineer, London County Council Tramways Department, £350 per annum, July 14. For particulars see advertisement.

Charge Engineer, Southwark Electric Station, Penrose-street, Walworth-road, S.E., £2. 10s. per week, July 2. See advertisement.

Assistant Superintendent of Mains, Edinburgh Corporation, £150 per annum, July 7. See advertisement.

Foremen Linesmen (3), Manchester Corporation Tramways, £2. 10s. per week, July 5. See advertisement.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Chester.—The Corporation invite tenders for accumulators and booster. Tenders by July 7.

Shanghai.—The last day for receiving tenders for the proposed municipal tramway and motor 'bus service is June 30.

Madrid.—The Department of Agriculture require a number of meters and instruments valued at £1,000. Tenders by June 30.

Sunderland.—The Corporation invite tenders for the supply of permanent way, overhead equipment, and cables. Tenders by July 9. See advertisement.

West Ham.—The Council invite tenders for 50 double-deck electric tramcars, complete with electrical equipment. Tenders by July 8. See advertisement.

Romford.—The Urban District Council invite tenders for the construction and maintenance of electricity supply works in the district. Tenders by June 30. See advertisement.

Valparaiso.—The Municipality are inviting tenders for electric lighting and tramways. We understand that particulars may be obtained from the Chilian Consul. Tenders by Sept. 1.

Leskovatz (Servia).—The Société d'électricité de Leskovatz require two turbines of 200 h.p. and two dynamos for three-phase current; also accessories for a power installation with a radius of 11 miles. Tenders by July 1 (14).

Bexley.—The Urban District Council invite tenders for points and crossings and boilers. Specifications, etc., may be obtained from the engineers, Messrs. Mordey and Dawbarn, 82, Victoria-street, Westminster, S.W. Tenders by July 7.

Lowestoft.—The Corporation invite tenders for the construction of tramways, rails, fishplates, and bolts, and permanent-way construction. Specification, etc., may be obtained from Mr. R. Beattie Nicholson, town clerk, Lowestoft. Tenders by July 12.

Launceston (Tasmania).—The Corporation invite tenders for polyphase generating, transmitting, and distributing plant and apparatus, transforming apparatus, reconstruction of existing plant, and enclosed arc lamps and accessories. Tenders by Sept. 15. See advertisement.

Willington Quay.—The Willington Quay and Howdon Industrial Society, Limited, invite tenders for supplying and fixing electrical apparatus as required for power and light at their Bewick-road premises. Specification, etc., can be had on application. Tenders by noon on July 4.

Falkirk.—The Corporation invite tenders for storage batteries, generators, transformers, switchboard, cable work, crane, lamps, and fittings. Specifications can be inspected at Messrs. Burstall and Monkhouse, 14, Old Queen-street, Westminster. Tenders by July 14. See advertisement.

Gillingham.—The Urban District Council invite tenders for the supply and erection of two water-tube boilers, steam and exhaust piping, condenser, cooling tower, high-speed engines, three triphase

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alternators (250 kw. each), switchboard, underground cables, arc lamps, crane, and well. Tenders by July 17. See advertisement.

Ipswich.—The Corporation invite tenders for the supply, delivery, and erection at the generating station, Constantine-road, Ipswich, of engines and dynamos, storage battery, overhead hand travelling crane, feeders, mains, and road work, permanent-way construction of tramways, and arc lamps. Tenders by July 5. See advertisement.

London, S.W.—The London County Council invite tenders for the supply, delivery, and erection at the Council's temporary generating station at Loughborough Junction of steam, exhaust, feed, and other piping, valves, etc. Specifications and other particulars may be obtained from the County Hall, Spring-gardens, S.W. Tenders by July 8.

Epsom.—The Urban District Council invite tenders for the supply and erection of semi-marine dry-back boiler, with fittings, etc.; ejector condensers, circulating pumps, and pipework; spray cooling pond; steam, feed, and drain pipes, etc.; and one 150-kw. steam dynamo (vertical enclosed high-speed engine) and switchgear, etc. Tenders by July 18. See advertisement.

Nuneaton and Chilvers Coton.—The Electricity Committee invite tenders for the supply and delivery of private lighting cables (paper), public lighting cables (rubber), joint-boxes and compounds and 20 arc lamp columns, with incandescent brackets, complete with arc and incandescent lamps, cut-outs, switches, resistances, and all other accessories. Tenders by June 30.

Stalybridge.—The Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board invite tenders for the supply, delivery, erection, and construction of three 500-kw. steam-driven, direct-coupled three-phase alternators, etc.; three 50-kw. steam-driven, direct-coupled continuous-current exciters, etc.; and permanent way, including copper bonding and conduits for cables. Tenders by July 7. See advertisement.

Teddington.—The Urban District Council having obtained a provisional order enabling them to supply electricity within the urban district of Teddington, invite tenders from persons and companies able to carry out electrical undertakings, stating terms upon which they would be willing to take over such provisional order, and to submit a scheme of electric lighting for the district, with particulars of cost. Tenders by July 12. See advertisement.

Chester.—The Corporation invite tenders for construction and reconstruction and electrical equipment of tramways, alteration, adaptation, and equipment of shed, tramway cars, and general equipment (preferably for the whole, or in sections)—viz.: permanent-way construction (length of route about 4,678 yards) and car-shed; bonds; overhead equipment; and cars. Specifications, etc., may be obtained from Mr. I. M. Jones, city surveyor, Town Hall, or Mr. F. Thursfield, city electrical engineer, New Crane-street. Tenders by July 7.

Norway.—The Board of Trade notify that tenders will be received at the Norwegian State Telegraph Department, not later than noon on July 7, for the supply of 25b-pair and 204-pair telephone cable, and for Leclanché battery glass. Specifications and conditions can be seen in the Technical Department of the Board of Telegraphs, Christiania. Apart from the usual customs duties, a preference of from 10 to 15 per cent. is given to native manufactures. The Board also notifies that tenders will be received up to 11 on July 1 for the supply to the Italian navy of American pitch pine to the value of £2,573, to be delivered at the Royal Arsenals. Particulars may be obtained at the Board of Trade Offices (Commercial Intelligence Branch), 50, Parliament-street, any day between the hours of 10 and 5.

RESULTS OF TENDERS.

Swansea.—The Town Council have accepted the tender of the Mannesman Tube Company, Limited, for steam pipes, valves, etc., at £1,065.

London County Council.—The tender of Jackson Bros. to execute the wiring and supply the fittings for an electric light installation at the Euston-road station, for £352. 3s. 6d., has been accepted.

Slot Meters.—The Rochdale Electric Company, Limited, have just received what is probably the largest order for an electric prepayment meter ever placed—viz., 1,000 slot meters for the Northern Counties Electric Supply Company, Limited, Newcastle. Last year's contract between the same parties was 500 meters.

Hackney.—The Borough Council have accepted the following tenders for the extensions of their municipal electricity works: (Section R)—boiler-house plant, Babcock and Wilcox, Limited, three water-tube boilers, feed pump, steam and water pipes, etc., £6,910. 5s.; (S)—water-softening plant (capable of softening 10,000 gallons of water per hour), Babcock and Wilcox, Limited, £1,120.

Paisley.—The Corporation have accepted the following tenders for the supply of plant to the electric lighting works: D. Adamson and Co., Dukinfield, near Manchester; Davey, Paxman, and Co., Limited, 78, Queen Victoria-street, London, E.C.; British Schuckert Electric Company, Limited, Clun House, Surrey-street, Strand, London, W.C.; Korting Bros., 53, Victoria-street, London, S.W.

London County Council.—The following quotations have been received for the electric lighting of the Camberwell and Battersea fire stations and the Battersea Park-road sub-station:

Battersea station.

Cramer and Co. (accepted)	£107	10	0
D. Assersohn	122	10	0
Jackson Bros.	133	18	0
Mossop and Co.	146	5	0
Lawrence and Co.	156	15	0
C. O. Clark and Co.	175	0	0
Baily, Grundy, and Barrett, Limited	225	0	0
Barron and Woodward	225	0	0

Camberwell station.

Cramer and Co. (accepted)	94	10	0
D. Assersohn	109	10	0
Jackson Bros.	121	8	0
C. O. Clark and Co.	125	0	0
W. Mossop and Co.	129	11	0
Lawrence and Co.	142	0	0
Barron and Woodward	195	0	0

Battersea river station.

Cramer and Co. (accepted)	85	10	0
D. Assersohn	104	0	0
Jackson Bros.	111	17	0
W. Mossop and Co.	120	0	0
Lawrence and Co.	130	0	0
C. O. Clark and Co.	135	5	0
Baily, Grundy, and Barrett, Limited	165	0	0
Barron and Woodward	198	0	0

Battersea Park-road sub-station.

Cramer and Co (accepted)	35	19	0
D. Assersohn	48	0	0
W. Mossop and Co.	58	11	0
Baily, Grundy, and Barrett	60	0	0
C. O. Clark and Co.	60	0	0
Jackson Bros.	60	19	0
Lawrence and Co.	67	10	0
Barron and Woodward	90	10	0

Greenock.—The Corporation have accepted the tender of the India Rubber, Gutta Percha, and Telegraph Works Company for the supply and erection of one 300-kw. steam dynamo, with steam and exhaust piping, at £3,160.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Llandudno.—The Urban District Council have increased the salary of Mr. Allen, assistant electrical engineer, by £20.

Northfleet.—Steps are now to be taken to obtain an offer for the purchase of the District Council's electric lighting order.

Brighton.—The Telephones Committee hope to be in a position to commence the work shortly, but are unable to specify a date when telephone connections can be made.

Baxterley.—Arrangements are being concluded between the General Post Office and the Rural District Council for a telegraph line from Atherstone to Baxterley.

Coventry.—The Electric Light Committee have been authorised to dispose of plant No. 1 at the works. The plant when purchased cost £1,216, and the sale will be advertised.

Salford.—A circular letter has been issued to consumers of electricity by Mr. C. D. Taite, electrical engineer for the borough, giving particulars of yet another change in the system of charging.

Peterhead and Fraserburgh.—With regard to trunk telephonic communication, we learn that the Postmaster-General is instituting an active canvass of the business firms and private residents at both towns.

Bath.—The Works Committee have engaged Mr. A. J. Taylor to carry out the provision of the electric baths on the usual architect's commission. The cost will be £250 or £260, plus £12 for the electric fittings.

Chesham.—The Urban District Council have settled the terms of the electric light agreement, and it is stated that there is nothing to prevent the company being formed now and getting their capital together.

Taunton.—On Monday important extensions to the Corporation's electric light works were inaugurated. The works have now been brought thoroughly up to date at a cost of £18,000, and the capacity at the station is 1,600 h.p.

Ebbw Vale.—The District Council have received an offer from the Ebbw Vale Company to supply the Council with as much electrical power as they required for lighting purposes at 2d. per unit, the suggested minimum being 50,000 units.

London Gazette.—The partnership existing between F. F. Bennett, A. Ward Thomas, and J. W. Donaldson (trading as Bennett and Ward Thomas), electrical engineers, Winter's-buildings, St. Ann's-street, Manchester, has been dissolved by mutual consent.

Rawmarsh.—The Urban District Council have decided to take the necessary steps to obtain an extension of the electric lighting order granted in 1898, and a deputation has been appointed to wait upon the Secretary to the Board of Trade for this purpose.

Southwark.—The last report of the Electric Light Committee shows that up to last week 25,385 8-c.p. lamps had been connected to the mains for light, and for power 2,443, or an equivalent to 24,828 8-c.p. lamps, being an increase of 275 8-c.p. lamps during the past fortnight.

Mansfield.—The committee have accepted an offer of Messrs. Thomas Parker, Limited, to completely cancel the order for the third set of dynamos on condition that they have the option of supplying this machinery at the contract price when further plant is ordered.

Luton.—Current will be supplied free of charge to any of the Corporation's consumers who may desire it for exterior illumination purposes from 9 p.m. to 12 midnight on June 26, 27, and 28; all other expenses connected therewith are, of course, to be borne by the consumers.

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Textile Factories.—One electrical manufacturing company alone in the United States has installed 40,000 h.p. of electric motors in textile mills. Germany, Austria, Russia, and Italy have a number of electrically-driven textile factories. Those in Italy total nearly 10,000 h.p., varying from 120 h.p. to 2,000 h.p. each.

Wireless Telegraphy.—A Laffan telegram from New York says: "The United States Navy Department has ordered all ships undergoing repairs to be fitted with wireless telegraphy apparatus. Before finally installing any system, experiments will be made to determine the relative merits of four European systems, including one English."

York.—Mr. G. H. Barnby Holmes, pupil of the city electrical engineer, has been appointed to the position of junior assistant engineer, at a commencing salary of £78 per annum. Mr. F. B. Walker, of Bradford Corporation electricity department, has been appointed chief clerk in the Corporation lighting department, at a commencing salary of £120 per annum.

Swansea.—The engineer's last report states that the number of consumers now on the books is 222, with the equivalent of 27,191 8-c.p. lamps. It has been resolved that extensions of mains be made in St. Helen's-avenue and Francis-street, estimated cost £110; Pier-street, £26s. 2s. 6d.; Humphrey-street and Ffynone-lane, £35; Mount-pleasant, £70.

Dover.—A rehearsal of the Coronation illuminations at Dover showed that, independent of the general illumination of the town, which is very extensive, the municipality are responsible for about three miles of electric festoons, of which nearly two miles outline Dover Bay and the new Prince of Wales Pier, with prominent buildings intervening.

Falmouth.—At the last meeting of the Town Council the Lighting Committee reported that they had considered proposals from Mr. Purvis, on behalf of Messrs. Crompton and Co., Limited, for the electric lighting of the borough, and recommended that Mr. Purvis be asked to come down and meet the General Purposes Committee on the matter. The report was adopted.

Cardiff.—The estimated revenue for the past month from the electric lighting scheme of Cardiff was £909, or 30 per cent. above the revenue of the corresponding month last year. Conduits are now being laid to the centre of the town for a continuous current, to replace the present alternating current, and the extensions for Woodville-road and Splott are being pushed forward.

Medomsley.—The Parish Council have accepted an offer from the Consett Iron Company, Limited, with reference to the Council's application for electric power for lighting about 30 lamps in the neighbourhood of Medomsley, intimating that they were prepared to enter into a similar agreement for this purpose with that now existing between the Council and the company.

Sleaford.—At the last meeting of the District Council Mr. Clare, C.E., and Mr. Yates, electrical engineer, submitted plans of motors for pumping in connection with the new sewage farm, for which a loan of £3,000 has been applied for. It was urged that electric power would cost more than a gas-engine, but it was resolved, as the Council possess electric works, to instal an electric motor at a cost of £267. 11s. 2d.

Dumbarton.—The Bill to confirm the provisional order of the Board of Trade for the authorisation of a system of electric light in the burgh now before Lord Newton's Committee of the House of Lords is opposed by the North British Railway Company, the Lanarkshire and Dumbartonshire Railway Company, and the Dumbarton and Balloch Joint Line Committee. The preamble of the Bill has now passed the committee of the House of Lords

Floating Dock.—An electric floating dock has been built for New York harbour, and is probably the first of its kind anywhere. It consists of three compartments, and has a total length of 492ft. The special feature of the dock is the employment of electricity for pumping, for which purpose two pumps are fitted to each compartment having a motor of 75 h.p., and it is stated that a vessel of 9,000 tons can be raised out of the water in 51 minutes.

Train-Lighting.—It is stated that in a short time the trains of the London and North-Western Railway running between Nuneaton and Hinckley, Leicester, etc., and Nuneaton and Bedworth, Coventry, Kenilworth, Warwick, and Leamington, will be lighted by electricity. Only a few of the trains will be lighted to start with, the others will follow in due course. At other junctions on the North-Western system such a course has been in vogue for some time.

Gwyrfai.—An application was made to the Rural District Council last week, on behalf of Mr. Assheton Smith, for the Council's support to a provisional order enabling him to construct works for the supply of electricity for the Dinorwic quarries and the dwelling-houses in the parishes of Llanddeiniolen and Llanfairisgaer, and a portion of the parish of Llanberis. A committee of local representatives of each of the parishes in question was appointed to consider the matter and to report thereon.

King's Lynn.—In addition to the figures given in our last issue, we note that the capital expenditure of the electric lighting department up to March, 1902, has amounted to £43,433. The units generated during the last year were 320,609; 286,679 were sold, which leaves 25,648 unaccounted for. This is 8 per cent. of the number generated, against 10 per cent. for the previous year. The total 8-c.p. lamps connected were 14,220, against 10,274 last year. The maximum demand amounted to 210 kw.

Penzance.—The Town Council have obtained sanction to borrow £300 for purpose of erecting a disinfecting apparatus. With reference to the request for permission to borrow a sum for construction of a landing-stage, the Local Government Board stated that the consent of the Board of Trade was necessary. The Board of Trade have informed the Council that under the circumstances stated by the Council they would defer the consideration of the question of revoking the order for electric light for one year.

Chesterton.—The British Electric Supply Company, Limited, intend to apply to the Board of Trade under the Electric Lighting Acts in December next for an order authorising them to supply electricity for public and private purposes in the following parishes and places, all being situated within the county of Cambridge—namely, the parish and urban district of Chesterton, and the parishes of Cherry Hinton, Coton, Fen Ditton, Girton, Grantchester, Impington, Great Shelford, and Trumpington, all in the rural district of Chesterton.

Agencies.—We are informed that Messrs. Easton and Co., Broad Sanctuary, S.W., have appointed Messrs. Rennert and Lenz their sole agents in South Africa, for the sale of the Schmidt patent superheaters, and also for the same territory (with the exception of Cape Colony) for their electric and hydraulic lifts. Matters dealing with these districts will, in future, be dealt with by this firm or their London agents—Messrs. Findlay, Durham, and Brodie, 110, Cannon-street, E.C. Mr. Francis J. Corbrick, 37, West Dulwich Mansions, has been appointed agent for the above for the South of England.

Annfield Plain.—The Urban District Council have received a letter from the Northern Counties Electricity Supply Company with regard to their proposed lighting, in which the company point out that they are to a great extent in the hands of the Durham and Cleveland Company, who have power to supply electricity over their heads. Under the provisional order the Northern Counties Electricity Supply Company have only power as distributors. They were doing their best to push the Durham and Cleveland Company forward, and fully expected to carry out the obligations of the provisional order within the date scheduled therein.

Battersea.—Certain shunt coils, substitution resistances with cut-outs, Whitworth stocks and dies, tiles, charts, and other articles and materials are to be procured for use in the electricity department, and a number of small works carried out. The electric mains are to be extended from near Plough-road at an estimated cost of £84. The committee have been in communication with the Thames Conservators with a view to a reduction in the terms and alterations in the agreement prepared by them relating to the work carried out in the River Thames in connection with the condensing water required at the central electric generating station, but have been unsuccessful.

Sheffield.—The following reductions have been decided upon in the price of energy used for power only on and after June 30, 1902: (1) for all energy used in motors driving hoists, cranes, passenger lifts, and similar machinery, 2d. per unit; (2) for other motors, 1½d. Special terms to long-hour consumers will be granted as follows: (3) to consumers satisfying the general manager as to the continuous running of their motors through the whole of the working hours of each day, 1½d.; (4) to consumers whose motors run continuously day and night, 1d. Consumers who are already connected to the Corporation mains have been asked to declare in writing under which of the above numbers they wish to be classified.

Indian Clubs.—Mr. John Creelman, of Suffern, U.S.A., has invented an illuminated Indian club with which a pretty illusion can be effected. The club has a hollow, perforated body, threaded at the lower end to receive the handle portion. Secured to the handle and adapted to enter the hollow body is an incandescent lamp. Electricity is conducted to the lamp by means of wires passing through the handle, and connected to any suitable source of electric current. When the current is turned on, the light radiates from the numerous perforations in the club. A quick performer of club exercises can give his audience a very fascinating entertainment, especially if coloured lamps be used instead of the ordinary white light.

Huddersfield.—The Local Government Board have declined to sanction the borrowing of money for the costs of obtaining the electric lighting orders of 1890 and 1896—viz., £516. 12s. 8d.—and have excluded the amount from the new sanction of April 9 last. It appeared that the sum had been charged to capital account, and it will now be transferred to depreciation and contingencies account. The Electricity Committee have decided to quote Messrs. David Brown and Sons, who require about 100 b.h.p. for their new works, the following charges for power purposes: if the consumption exceeds 25 units per hour for 2,400 hours per annum, the charge to be ·975d. per unit; 50 units, ·95d.; 75 units, ·925d.; and 100 units per hour, ·90d. per unit.

Sudbury.—The electric lighting scheme is again under serious consideration by the Town Council. At a special meeting on Friday attention was drawn to the following letter from the Local Government Board: "I am directed by the Local Government Board to inform you that they have had under consideration the report made by their inspector, Mr. Law, of the enquiry held by him with reference to the application of the Town Council of Sudbury for sanction to borrow £12,000 for purposes of electric lighting. I am to state that the Board regard the scheme of the Town Council as generally satisfactory, but as the margin of borrowing powers available to the Town Council is insufficient, the Board are unable at the present time to sanction the loan.

Plymouth Fire.—It is reported that when the fire at Messrs. Spooner's was at its height a large telephone standard came down with a terrific crash, consequently the services between the central exchange and the Devonport and Mutley exchanges were cut off. With exceptional smartness the local manager and his staff cleared the telephone wires. The whole of the National Telephone Company local staff were at work late on Saturday night, and started early on Sunday morning, continuing until late in the evening connecting the various wires. The whole of the work was carried out under the direct supervision of Mr. D. J. Barnes, the local manager, and Mr. Drummond, the district manager, inspected the work about noon on Sunday, and expressed himself pleased with the way in which the work had proceeded.

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Coronation Illuminations.—We understand that the applications for current received by the metropolitan electric light companies come up to their full winter load. The extra applications received by the Westminster equal 50,000 c.p., and that of the Charing Cross and Strand 25,000 c.p. In addition to contracts already noted, we find that H.M. Office of Works has been using the E.L.B. system for part of the work at Westminster Abbey. The same system is also applied throughout the Stock Exchange, then over the great façades of the Prudential Insurance Company and the Gresham Insurance Company, the United Service Club, the Conservative Club and the Devonshire Club, the Temple Gardens, the Hippodrome building, Messrs. Marshall and Snelgrove's, and Messrs. Liberty's, etc. We are informed that the labour-saving qualities of the system are much appreciated.

Ormskirk.—The Guardians at their last meeting discussed a circular letter from the Ormskirk Urban District Council asking the Board (1) if they were in favour of the electric light being adopted for street-lighting; (2) if cables were laid would they probably take the light; and (3) what number of lights would be required approximately. The maximum charge would be 6d. per unit, which was equivalent to gas at 3s. per 1,000 cubic feet. It was agreed that they should for the present hold their hand until they saw whether a company would put down plant in the town of Ormskirk to supply the three urban districts of Ormskirk, Skelmersdale, and Lathom and Burscough, and also to see if there were any prospect of a light railway between Ormskirk and Southport. In the meantime they would reply in the affirmative to the first two questions of the circular.

Pacific Cable.—Mr. Herbert Arnaud Taylor, of the firm of Clark, Forde, and Taylor, engineers to the Pacific Cable Board, has returned from supervising the laying of the southern sections of the all-British Pacific cable between New Zealand and Norfolk Island, Brisbane and Norfolk Island, and Norfolk Island and Fiji. The work was successfully accomplished, though in laying the Fiji section the "Anglia" encountered a terrible cyclone. The new cable ship "Colonia" of the contractors is loading with the "Vancouver" to Fanning Island section, and expected to leave the Thames on July 3. The "Anglia" is expected home on June 25 to load with the Fanning to Fiji section, and should arrive at Fanning by the time the "Colonia" finishes there. According to the *Globe*, the Vancouver-Fanning section, like others, is to be "duplexed" by the apparatus of Dr. Alexander Muirhead.

Furnace.—A new form of resistance laboratory furnace has been invented by Prof. Holborn, of Berlin, which permits temperature up to 1,500deg. C. being attained with ease by use of the ordinary 110-volt electric supply. The furnaces are made in two forms, the first being adapted for heating crucibles and the second for heating tubes 44cm. in length. In both forms of furnace the electric current is conducted through a resistance coil of platinum or nickel wire, wound round a thin porcelain tube or cylinder. The crucible or substance to be heated is placed within this latter, and the space between the outer side of the coil and the containing vessel is packed with asbestos or powdered quartz. Using nickel, the temperature of the furnace cannot be raised about 1,000deg. C. without damage to the coil, but with platinum it is possible to attain a temperature of 1,500deg. C. with a current of 14 amperes and 110 volts.

Electric Baths for Lead-Poisoning.—A scheme for the electric treatment of lead-poisoning and paralysis in the Potteries has long been under consideration, and last week new electric baths for the treatment of these cases were formally opened by the Duchess of Sutherland at the North Staffordshire Infirmary, Hartshill. The Rev. C. H. Simpkinson, as chairman of the committee who have had the scheme in hand, said that the only means by which they could ensure an electric supply to the infirmary was through the Potteries Electric Traction Company, who was not only giving them the electric supply, but also £100 in order to put the whole scheme in working order. Mr. Simpkinson paid a tribute to individual members of the company who had helped in the work, and said that they all owed a debt of gratitude to the Duchess of Sutherland for the way she had set to work to collect the funds.

Lancaster.—From the report of the electrical department we gather that for the second half of the year the price of current for motive power was reduced from 3½d. to 3d. per unit; the charges for public lamps were also reduced from Jan. 1 last. The total net profits are £931. 6s. 2d., as compared with £1,177. 9s. 3d. for the previous year. This sum has been carried to the reserve fund. The total for "sale of current" has increased by £495. 5s. 10d., and for "meter rentals" (owing to new conditions imposed upon small consumers) by £33. 1s. 10d.; the income from public lamps is decreased by £9. 2s. 2d. The total expenditure has increased from £4,782. 2s. 1d. to £5,644. 8s. 5d., coal and insurance being practically the only items which show a decrease. The reserve fund now amounts to £2,131. 6s. 2d. The total capital authorised and borrowed is £35,000, and the amount expended £39,346. 5s. 8d.

Hampstead.—The Borough Council have confirmed the appointment of Mr. John E Pownall as assistant at the electric lighting station. With regard to a recent Sunday failure of the electric light, it appears that the assistant engineer was caught with a sudden overload on the machine that was running, in all probability due to the churches and chapels being lighted up. He broke the circuit on the running machine completely, and suddenly put in a larger one to take the load. For some reason, entirely unaccountable at present, an arc was formed between the machine panel and the adjoining one on the switchboard, which completely burnt the second one up, but not that of the running machine. To put out this arc the engineer broke the field exciting circuit, and this, with the other arc, so blinded him for the moment that he was unable to see the different panels, and this caused some five or six minutes' delay in getting the load on to a further machine. A main is to be laid for the supply of electric current to private consumers in Chalcot-gardens, England's-lane.

Manchester.—At the last meeting of the Telephones Committee, the conclusions at which the deputation who recently visited Glasgow had arrived were reported as follows: (1) That the Glasgow Corporation were satisfied with the success of their municipal telephonic undertaking; (2) that the work appeared to the Corporation to have been satisfactorily carried out in accordance with the original estimates; (3) that the subscribers in Glasgow were satisfied with the system there established. The committee thereupon resolved, "That in view of the approval of the City Council, which has been already given to the establishment of municipal telephony within the Manchester area, and the information now received as to the satisfactory working of the Glasgow municipal telephonic service above set forth, it is advisable that the application to the Post Office for a municipal license on behalf of the Corporations of Manchester, Salford, and Stockport should be proceeded with, and that all the necessary arrangements be entered into by those corporations with this object."

Bridgend.—Mr. H. Percy Boulnois, M.I.C.E., has held an enquiry into an application by the Bridgend Council for powers to borrow £6,900 for electric lighting purposes. From the evidence it appeared that a provisional order for electric lighting was obtained in 1893, but the Council had been unable to utilise it until the recent advent into the district of the South Wales Electrical Company, because of the great expense of laying down generating plant. The electrical company is supplying the energy on a sliding scale, and by an arrangement with the Asylums Committee the Council will be able to get their supply at 2½d. per unit. The Council intend to use the electricity for public lighting, and also to supply private residences and business establishments at a charge of 5d. per unit. An estimate of the outlay and of the annual expenditure and income was produced, showing a profit to the Council of £225. Mr. H. T. Sully, A.M.I.C.E., Bristol, electrical adviser to the Council, gave evidence, and said that in his estimates he had put all he could against the Council in order that they might be on the safe side.

Explosion.—An explosion occurred last week at the works of the Simplex Electric Fuse Detonator Company, Chorley, by which two young men lost their lives and a third man was seriously injured. The material used in the manufacture of the detonators is, of course, highly explosive. The finishing process, which means the attachment of electric fuses, is carried on in a specially equipped shed at a distance of 50 yards or so from the main building. A little further away, in a corner of the enclosed premises, is the magazine, where the gunpowder is stored. The floors and walls of the shed were padded, and the workers wore specially prepared shoes. Mr. Jordan, manager of the works, thinks that the explosion was due to friction, or that the excessive heat may have been a contributory cause. The detonators, though small in size, are charged with a high explosive. It is said that a fall on a hard substance will suffice to explode them. The police have reported the occurrence to the coroner for the district, Mr. Park, of Preston, and it is expected that the inquest will be opened some time to-day. The Home Secretary will also no doubt order an enquiry to be made with regard to the origin of the explosion.

Illuminations at Spithead.—The special correspondent of the *Daily Telegraph* at Portsmouth gives the following interesting account of the preparations for the illumination of the fleet on the evening of the Coronation, on the following evening, and on the night of the review. The arrangements are in charge of the captain of H.M.S. "Vernon," the torpedo school-ship, and to ensure the success of the scheme special officers have been distributed among the ships. On Thursday the myriad incandescent lamps will be switched on at half-past nine o'clock, and the fleet will remain a blaze of brilliant points of light, outlining them from stem to stern, from masthead to truck, in every detail until midnight. White lights only will be used by the warships, and some conception of the dazzling radiance may be gained from the following figures, indicating the number allotted to each type of ship:

	100-c.p. lamps.		16-c.p. lamps.
"Majestic"	3	...	950
"Empress of India"	3	...	850
Second-class battleships	3	...	750
Third-class battleships	2	...	500
Four-funnelled cruisers	3	...	1,000
"Hawke" and "Narcissus" class	3	...	630
Second-class cruisers	—	...	550
Third-class cruisers	—	...	300
"Northampton"	4	...	700
Torpedo gunboats	—	...	260
Destroyers	—	...	150
Torpedo boats	—	...	65

During practically the same hours on Friday there will be another brilliant display, in which the incandescent lights will have no part. On this occasion the powerful arc lamps only will be used, and the novelty of the illumination will be the use of colours. The tints to be employed are red, green, blue, and gold. Each ship will have one colour only, and the colours will be arranged down the lines in the order named—red, green, blue, and gold successively. The unique beauty of this display may be dimly imagined from the directions which are being issued to the ships. From 9.30 to 10.30 p.m. all searchlights are to be trained on the funnels of the ships abreast, in the line on either side, line "B" on "C," etc. During the following hour the ships will train their lights on the funnels of the ships next ahead or astern of them in the line. It is pointed out that "as the lighting of steam is particularly effective with these coloured lights the lights should be kept trained on the funnels, and ships should exhaust into the atmosphere." As the vessels blow off steam, all the various tints will be steadily projected on to the columns of vapour. On the evening of the review the King and the tens of thousands of spectators ashore and afloat will view a combination of these two schemes of illumination. The signal to

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switch on the incandescent lamps will be the firing of a rocket from the King's yacht, and at 11 o'clock another rocket will be sent up commanding darkness. And the darkness will be all the more intense coming after a display of such brilliance. But alone amid the spectre fleet the Royal yacht will remain illuminated. It is hoped that merchant ships will follow the motions of the fleet in this particular, so that the singularity of the display by the King's ship may be intensified. For 10 minutes darkness will reign, and then the searchlights in all their brilliance will be burnt for 20 minutes, as during the first hour on the previous night. At 11.30 the guns of the fleet will fire a Royal salute, after which the second exhibition of the searchlights will occur. At five minutes before midnight the powerful rays will be directed, at their extreme elevation, upward to the sky, throwing dazzling shafts against the clouds, if there be any. Then, at a signal from the flagship of Admiral Sir Charles Hotham, pitchy darkness will descend on the anchorage, as the electricity is finally switched off. It is impossible to convey any adequate idea of the brilliant and beautiful scene which will be witnessed during this unique display of searchlights and thousands of incandescent lamps. On no former occasion has a fleet been illuminated on such an ambitious and charming plan, which will be rendered all the more impressive by the last boom of the saluting guns, which will signalise the end of the day's memorable ceremonies.

Festivities at the Crystal Palace.—The arrangements made at the Crystal Palace for the Coronation are on a scale of magnificence never before equalled. The stupendous programme, which will extend over several days, includes a grand Coronation ball; a British and American concert in celebration of the proclamation of peace and the Coronation of the King; and Venetian fêtes and firework carnivals, when the unrivalled facilities afforded by the gardens and grounds for illumination and decoration will be fully taken advantage of. These Venetian fêtes will be held on June 26, 27, and 28, and they will be brought to a conclusion each night by a specially gorgeous display of fireworks, when the elaborate set pieces which Messrs. C. T. Brock and Co. have prepared for the Coronation will be fired. For the great Coronation ball to be held on July 2, with the approval of his Majesty the King, and under the presidency of Mrs. Arthur Paget, in aid of King Edward's Hospital Fund, 12,000 square feet of parquet flooring will be laid in the Central Transept, making the largest area ever laid for dancing. Special trains will be run from Victoria to the Palace. The peace celebration of July 5 will be similar in character to that of the patriotic fête held at the Palace on the termination of the Crimean War. The programme will include a performance by the colossal choir of the National Anthem. On this day also the naval and military athletic meeting is to be held. The directors of the Crystal Palace Company have presented a gold cup, to be called the "Coronation Cup," as a trophy for an annual sports competition among his Majesty's forces. The Colonial and Indian troops in London for the Coronation have accepted invitations to be present; and, as on the other nights, a grand display of fireworks will be given. The international polo tournament, held under the auspices of the London Polo Club, for the Coronation Cup, is fixed for July 8, 10, and 12.

TRACTION.

Govan.—A cab driver has been fined 5s. for wilfully obstructing a tramcar.

Heaton Norris.—The Urban District Council have obtained a loan of £7,000 for tramway purposes.

Chester.—At the next meeting of the Tramways Committee tenders for track-laying will be considered.

Bournemouth.—It is hoped to have the electric cars running for traffic on a section of the new electric tramways by July 31 next.

Haslingden.—It is proposed to hold a joint conference of representatives from the three authorities concerned to consider the question of the suggested purchase of the tramways.

Lancaster.—A sub-committee has been appointed to deal with any question arising as to the management of the tramways, and the provision of any materials in connection therewith.

Brentford.—Terms have been arranged between the District Council and the London United Tramways Company as to the proposed line of tramways from Ealing to Brentford.

Spotland.—The Spotland and Norden electric tramways, having been inspected by Major Druitt, of the Board of Trade, on Tuesday, were opened for public traffic on Thursday last week.

Halifax.—The work of constructing the tramway extension from King Cross, Halifax, to Sowerby Bridge, which was begun at the Halifax end about three weeks ago, has now been started at the Sowerby Bridge end.

Rosedale Valley.—The first sod has been cut in the construction of a light railway from Lastingham, through the valley, to Rosedale. The capital of the syndicate which has the powers to carry out the scheme is £75,000.

Scarborough.—The House of Commons had before it on Thursday last week the Scarborough Tramways Bill, for the consideration of the Lords' amendments. No opposition was offered, and the measure was ordered for the third reading.

Morley.—The Light Railway Commissioners have issued an order authorising the construction of the light railways proposed in the borough of Morley and the urban districts of Drighlington, Gildersome, and East and West Ardsley.

Hull.—A number of electric cars are to be decorated for the Coronation. Arrangements are also being made to illuminate the cars at night, a large number of extra incandescent electric lights having been brought into service for this purpose.

Tenterden.—It is reported that the construction of the light railway from Tenterden to Headcorn is shortly to be taken in hand. The line will be in connection with the present light railway to Robertsbridge, and will prove a great boon to that part of the Weald of Kent.

Pontypridd.—A Bill to confirm a provisional order made by the Board of Trade giving to the Urban District Council powers to make certain new tramways within their district is being considered by a Select Committee of the House of Lords presided over by Lord Newton.

Swansea.—The Swansea and district light railways order having now been confirmed by the Board of Trade, the borough surveyor and the electrical engineer are making preparations to commence the works authorised by the order. Plans and specifications are now being got out.

Milan.—A dispatch from this place states that a serious accident occurred there on Saturday on the light railway between Varese and Porto Ceresio. Two electric trains came into violent collision, both being utterly wrecked. The number of persons killed and injured is stated to be 49.

Knottingley.—The Bill to confirm a provisional order authorising the West Riding Tramways Company to make an extension 2¾ miles long from Pontefract to this place has passed the Select Committee of the House of Lords presided over by Lord Newton, and will be reported for third reading.

Bath.—Sir Frederick Bramwell, the arbitrator appointed to name the price to be paid by the Corporation for the tramway company's undertaking, has concluded his enquiry at the Surveyors' Institute, Westminster. The claim of the company, after deductions and agreements, now stands at about £7,500.

Warrington.—The Stockton Heath Parish Council are holding out for the following condition to be observed in the construction of the proposed light railway by the Warrington Corporation to the Market-place, Stockton Heath—viz., that where the Corporation have to acquire property they shall widen the road to 50ft.

Private Bills.—In the House of Lords the Great Northern Railway (No. 1) Bill has been read a third time and passed, and the City and Brixton Railway Bill and the London, Tilbury, and Southend Railway Bill have been read a second time. In the Commons the Great Northern Railway (No. 2) Bill has been read a third time.

Glasgow.—The traffic receipts of the Corporation tramways for the week ending June 14 shows that 3,234,475 passengers were carried over the system, as compared with 3,059,290 on the corresponding week last year, being an increase of 175,185. The money drawn was £11,648. 4s. 1d., against £11,419. 15s. 10d. for the same time last year.

Newcastle.—A collision in which 12 persons were injured occurred here on Sunday night between an electric tramcar and a wagonette filled with passengers. The electric car was travelling in a direction at right angles to the conveyance. The driver of the car was unable to stop it, and the car dashed into the wagonette, cutting it in two parts.

Charing Cross, Euston, and Hampstead Railway.—At a special general meeting of the company held on Wednesday at Hamilton House, Victoria-embankment, a resolution was passed approving an Act for incorporating the Edgware and Hampstead Railway Company, and for empowering them to construct railways, partly underground, from Edgware to Hampstead.

Southend.—On Saturday a boy visitor climbed one of the poles of the electric tramways on the pier, and, unobserved, got on to the track, placing his bare foot on the conductor. He received a shock which caused him to fall on to the conductor and outer rail conveying the return current, and was instantly killed. His body is reported to have been much burned about the thighs and neck.

Cardiff.—Major Druitt, R.E., on Thursday week inspected the remaining section of the new lines for the Corporation electric tramway system—from St. Mary-street, through High-street, Castle-street, and Cowbridge-road, to the junction with Neville-street. This completes the system as originally devised by the Corporation. Most of the horse cars are now taken off, and will be offered for sale at an early date.

Embankment Tramways.—Several petitions praying to be heard in committee on the Bill of the London County Council for the construction of a tramway in a shallow subway from Theobald's-road to the Thames-embankment have been presented, among the petitioners being the Holborn Borough Council, the Great Northern and Strand Railway Company, and the Metropolitan District Railway Company.

Rawmarsh.—The Council have decided to insist upon a clause being inserted in the Mexborough and Swinton Tramway Bill, that the company shall bear the whole of the expenses of the construction and permanent maintenance of the Fitzwilliam Bridge, and also the proportion of construction and maintenance of the Sheffield Navigation Company's bridge, and failing this insertion to oppose the next reading of the Bill.

Huddersfield.—Sanction is to be made to the Board of Trade for authority to construct a tramway in Whitestone-lane, Fartown, and an extension of the line from Crosland Moor terminus to a point in Dry Clough road. The existing tramways with the exception of the Bradley section have now been electrically equipped, and cars are running on them. It is expected that the Bradley section will be finished in about a fortnight.

Staines.—The Council having, for protective purposes, given formal notice of opposition to the new scheme of the London United Tramways, Limited, for the construction of a line along the Bath road to Slough and Datchet, Mr. Godfrey, the company's solicitor, has written asking for an interview before the Council come to a final decision in the matter. The Council have decided to leave the matter in the hands of their solicitor and the surveyor.

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Salford.—On a proposal at the last meeting of the Town Council that the Tramways Committee should be empowered to accept tenders for materials for the laying of the track in Eccles Old-road, the question was asked why the committee were doing the work themselves instead of letting it out on contract. In answer it was stated that from enquiries made the Tramways Committee were convinced that they could do it as cheaply and make a better job of the work than if they let it out.

Rhondda.—The Tramways Bill, which has already passed a committee of the House of Lords, and the object of which is to authorise the construction of electric tramways in the Rhondda urban district, came before the committee of the House of Commons of which Mr. Tatton Egerton is chairman on Friday. The cost of the scheme is estimated as follows: tramways, £293,000; street widenings, £58,000. The Glamorgan County Council and certain property owners are petttioning against the Bill.

Newport (Mon.).—The Tramways Committee have expressed their disappointment to the Town Council at the action of the Lords Committee in refusing to sanction powers to cross the railway at Pillgwenlly so as to carry the trams to the Alexandra Dock, and brought up for consideration the question whether any steps should be taken with the proposed tramways in Alexandra-road. This tramway, if run from the further side of the Pillgwenlly crossing to the pier head, would have to be worked as a separate section in consequence of the break at the crossing.

Hastings.—The Hastings Tramway Bill, of which the clause relating to the front line has now been struck out in accordance with the finding that the Standing Order requiring proof of the assent of the Corporation had not been complied with, came on as an unopposed Bill before the Earl of Morley last week, for an extension of time till July, 1905, as authorised by the Act of 1900, for the Bexhill and St. Leonards light railway, sanctioned under the Board of Trade order of the same year. Formal proof of the preamble was given, and the Bill was reported for third reading.

Yarmouth.—The electric tramway service was publicly inaugurated on Thursday week in the presence of a large assembly. Previous to the ceremony an inspection took place by the Board of Trade inspectors, Colonel Trotter and Colonel Von Donop, who were accompanied by Major Cardew, the Corporation's consulting engineer, and the Corporation officials. After the ceremony of opening the lines the cars were run for public traffic. The equipment of the new electric tramways includes a telephone line carried from street standards along the route, after the style of the Glasgow tramways.

Leeds.—A Bill to confirm a provisional order made by the Board of Trade authorising the Corporation to construct additional tramways in the borough came last week before a Select Committee presided over by Lord Newton. The London and North-Western Railway Company petitioned against the Bill, the main point at issue between the parties being a proposed tramway over the London and North-Western bridge. In the result the committee decided that they could not sanction any of the points raised by the London and North-Western Railway, and the Bill was passed without amendment.

District Railway.—The Metropolitan District Railway Company, having in view the close relations between the District Railway and the London, Tilbury, and Southend Railway, and the development of the business of the District Railway Company in the East-end of London, have elected as additional director to fill one of the vacancies on their Board Mr. A. L. Stride, who was for many years the manager of the Tilbury Railway, and is now the managing director of that undertaking. The directors have also elected Mr. Charles Spofford, who represents a large financial interest in the company.

Croydon.—The electric tramcars had a field day last Saturday. Owing probably to the comparatively summer weather, the takings on that day amounted to no less than £200 odd. Elaborate preparations have been made by the tramway authorities to celebrate the Coronation in an appropriate manner. A beautifully-decorated car has been got ready, and this is designed to take a chief part in the procession over the entire system of the electric tramways, which has been organised for Thursday evening. On the following day the same car will be available to the public desiring to view the local decorations at special fares.

Central London Railway.—In connection with the note in our last issue under this heading, referring to the contract secured by the British Thomson-Houston Company for 64 motorcar equipments and 160 trailcar equipments, we are now informed by that firm that all the electrical apparatus of the motorcars will be installed in a steel cab separated from the passenger compartments of the motorcar by a fireproof door, thus making the motorcars absolutely fireproof. At the end of last week's paragraph we mentioned that "the trains are now equipped with small chemical fire extinguishers." This, it should be said, in no way applies to the motor equipments themselves, which are such that the possibility of fire is practically nil.

Crystal Palace Light Railway.—The Highways Committee of the London County Council recommend that instructions be given them to take all the necessary measures for opposing the order now being applied for before the Light Railway Commissioners by the Crystal Palace Light Railway and Tramways Company. The company are applying for powers to enable them to construct a light railway from Lordship-lane to the Crystal Palace, but the Highways Committee, while agreeing that it is desirable that further means of access to the Palace should be provided, think that the better course would be for the Council at some future time to seek powers for an extension of the tramway at Lordship-lane to the Palace.

Chatham.—The light railways which were opened last week have been laid down by the Chatham and District Light Railways Company under an order dated August, 1899. The lines, which are in 10 sections, comprise a total length of about 8½ miles. Between five and six miles are laid double, and the remainder single, with passing places. The system unites the two boroughs of Chatham and Gillingham, and brings the suburbs of both towns into communication. The overhead trolley system has been adopted. The electrical equipment was supplied by the British Thomson-Houston Company. Major Pringle, R.E., of the Board of Trade, has recommended that the speeds shall not exceed four and six miles an hour in various streets specified by him, and eight miles an hour elsewhere.

Tube Railways.—A number of Bills authorising the construction of underground electric railways in the Metropolis were read a third time and passed by the House of Lords on Monday after amendments had been inserted providing that at all times the permanent way, rolling-stock, and equipment of the lines should be subject to the approval of the Board of Trade. The Bills passed were the Piccadilly, City and North-East London Railway Bill, the London United Electric Railways Bill, the Great Northern and Strand Railway Bill, the Brompton and Piccadilly (New Lines, etc.) Bill, the Great Northern and City Railway Bill, the Charing Cross, Euston, and Hampstead Railway Bill, and the North-West London Railway Bill. The Baker-street and Waterloo Railway Bill was also read a third time and passed.

Toronto.—A message from Toronto, Canada, states that the street-car men, numbering nearly 1,000, have struck work, with the result that there is a total cessation of the trolley service. The chief points at issue are higher wages and the recognition of the union. The car company have made concessions on the former point, but firmly refuse to do so as regards the latter. A later dispatch, dated June 22, states that the strike of street-car men is now complete. An attempt was made that morning to start the cars as usual with non-unionist carmen. A crowd of sympathasisers with the strikers interfered, however, and in the disturbance which ensued some of the cars were wrecked, while two motormen were severely and several others slightly injured. No further attempt to run the cars was made. A message dated Monday states that the street car strike is now settled, the company agreeing to the men's demands for higher wages and admitting the men's right to organise, while refusing to recognise the union.

Islington.—At the meeting of the Borough Council on Friday the Works Committee recommended (*a*) that they be authorised to arrange, if possible, with the North Metropolitan Tramways Company for the reconstruction by the company of their lines in High-street, Upper-street, Holloway-road, Parkhurst-road, and Camden-road, and the paving with hardwood of the space in between the rails and between the tracks, the Council to pave the margins between the kerb and the outer rail, retaining the granite setts removed from the 18in. margins; (*b*) that the estimates of £29,200, £13,325, and £12,100 submitted by the Finance Committee be approved; and (*c*) that, subject to an agreement being arrived at with the tramways company, application to be made to the London County Council for their sanction to the borrowing of these amounts, and that they be authorised to proceed with the works when such sanction has been received. After a long discussion it was decided to strike out the reference to the Parkhurst and Camden roads and the disposal of the granite setts.

Northfleet.—The chief executive engineer of the British Electric Traction Company has forwarded to the District Council plans and drawings showing the method they propose of carrying their car-shed lighting feeder overhead on the tramway poles along the north side of Pelham and Dover roads from the termination of the Gravesend Corporation's lighting feeder in Pelham-road to a point opposite Cannon-road, and thence along the west side of Cannon-road to the car-shed in Northfleet. The minimum height above the ground level of the cable, which will be a three-core rubber-insulated cable suspended from a $^{7}/_{12}$ steel suspension wire, will be 21ft. 6in., and will be throughout its length on the north side of the road carried on the poles as shown, on the side of the poles remote from the trolley wire. The committee recommend that inasmuch as it appears that the Gravesend and Northfleet Tramways Order, 1899, does not authorise the tramway company to erect posts and wires for electric lighting in the streets of the district, the application be not granted.

Aberdeen.—The Town Council are considering the readjustment of the tram fares, including ½d. stages. It is understood that, in all likelihood, a commencement will soon be made with the construction of a tramway to serve the Ferryhill district. The Corporation have already obtained power to do this, and the feeling is that the most suitable plan would be to form a circular route, branching off Union-street at Crown-street, traversing the latter thoroughfare to its extreme south end, and then proceeding *viâ* Ferryhill-road and Fonthill-road to Holburn-street, where it would join the bridges section of the existing system. Some experimental trials were made on Thursday last week with a car on the electric contact system which has been laid down at the Links. A couple of engineers and several workmen were engaged establishing the connection, and it is stated that the car worked better than it had previously done when trials were made. The car was run along the entire length of the track spanning the Links petween Constitution-street and the beach. It is understood that further trials will be made with the view of perfecting the system.

The Proposed Embankment Tramways.—After passing its second reading in the House of Commons, the clause in the London County Council Subways and Tramways Bill, giving effect to the proposal for an electric tramway on the Thames Embankment, has met with defeat in the House of Lords. It will be recollected that when it was known some weeks ago that the Commons had sanctioned the short length of line referred to, which would have enabled the London County Council to practically join up their southern and northern systems, in conjunction with the authorised subway under the new street from the Strand to Holborn, the action of the Lower House was hailed with delight by the public generally. In spite of popular opinion, however, the Lords have decided that it shall not be. The matter came up for discussion before them on Monday after-

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noon. It was Lord Newton who moved that it be an instruction to the committee to strike out the clause in question, his chief objection being, as he put it, that the proposal was incomplete, and only meant as a vantage ground from which to make further proposals later on. Lord Newton further contended that it was an unnecessary piece of extravagance, and suggested that the proper means of connecting north and south was by a tubular railway under the river. If their lordships sanctioned this proposal the County Council would seek to extend their tramway system to Piccadilly and Pall-mall, and perhaps would eventually reach the helots of Park-lane. The Lord Chancellor joined in the objection, but it is noteworthy that Lord Morley, who is Chairman of Committees of the House of Lords, opposed the motion. The objectors of the London County Council scheme were, however, too strong, and in the result the motion was carried by the large majority of 77 to 32. This means the extinction of the Embankment tramway so far as the present session is concerned.

London United Tramways.—Since last issue further evidence has been taken by Mr. Compton-Rickett's Committee of the House of Commons on the London United Tramways Bill. Evidence against the Bill was given to the effect that the Barnes tramway would be of no advantage to the inhabitants, and that the proposed embankment would be a source of danger and inconvenience to rowing men. A wall 2½ft. high would sufficiently secure the terrace from flooding. Mr. C. J. Owens, general manager for the London and South-Western Railway, gave evidence in support of the petition of that company in opposition to the Bill. Between the stations at Kew Bridge, Brentford, Isleworth, and Hounslow there had been a reduction in gross receipts from £1,516 to £524 in the half-year since the completion of the tramways. He had reason to fear that the present proposals, if sanctioned, would have an equally injurious effect on the traffic of the company, and it had not been found that the action of tramways as feeders to railway stations had any compensating advantage. An agreement was about to be concluded between his directors and the District and Metropolitan Companies for the electrification of the London and South-Western line between Richmond and Hammersmith and other parts of the London and South-Western Railway over which the other companies had running powers. The proposed line from Wimbledon to Malden would amount to a duplication of the route of the railway. On the railway between Wimbledon and Raynes Park to stations on the route of competition, 838,819 passengers were carried in 1901, the receipts were £9,479, and the average was 2¾d. per passenger. A reduction of that traffic in proportion to past experience would mean a loss of £6,066. In reference to the competition of the Tooting extension, he mentioned that his company were spending £1,700,000 on improvements between Clapham Junction and Waterloo to give improved service to the whole of the suburbs. A railway company constructed their line on land they had purchased at great expense, while a tramway company had free use of a public road and the public lighting, which was paid for out of the rates. The need of accommodation for the working class at Richmond did not justify this competition by tramway. The railway company carried a passenger 19½ miles on a 6d. return ticket, and in 1901 the London and South-Western Company issued 103,364 tickets by six workmen's trains, starting at 7.48 in the morning. Obligation rested on railway companies under the Cheap Trains Act to provide facilities for working-class travelling, and the London and South-Western Company issued working-class tickets to all applicants. There was very small demand for such tickets on the line between Richmond and Hammersmith, the average being seven by one train and six by another on the District Railway. On Friday the committee passed the preamble of the Bill, authorising practically all the extensions proposed by the company. The new lines will link up Malden and Wimbledon with the London County Council tramways in South London, the committee only deleting a portion of the spur lines to the common. They also passed the whole of the Richmond, Mortlake, and Barnes extensions, with the exception of the piece across Hammersmith Bridge, in respect of which they accepted the assurance of the London County Council that they would construct the tramway over the bridge so as to afford the continuous route into Hammersmith.

London County Council Tramways.—A long report of great interest to those in the tramway world was presented to the London County Council at their meeting on Tuesday by the Highways Committee. Dealing first with the southern system, purchased from the London Tramways Company, the report states that the net capital expenditure upon this undertaking up to March 31 last was £896,971. The total receipts from the undertaking during the year amounted to £462,133, while the working expenses were £409,623, showing a profit on working of £52,510. Out of this balance debt charges have had to be met *a*) for interest, £22,182; and (*b*) for sinking fund, £21,265—a total of £43,448, leaving a balance of £9,062 to be carried to the appropriation account. The Council has established in connection with the undertaking a renewals reserve fund, to which the sum of £9,000 has been paid out of the revenue of the year. The balance to the credit of this fund on March 31 last was £23,583, of which £12,015 was invested in 3 per cent. London County Council consolidated stock. The Council has introduced various improvements in the system as compared with the company which formerly owned it. It has established a 10 hours' day—a 60 hours' working week—for all classes of its tramway employés, readjusted the rates of pay, provided uniforms for drivers and conductors, and improved the conditions of labour of certain employés, the total concessions involving an extra payment of £24,000 during the year. The Council has also established all-night car services at workmen's fares on four routes, and revised the fares throughout. These concessions have, the committee state, been much appreciated, as will be seen by the fact that the number of journeys run by cars carrying passengers at workmen's fares had up to March 31, 1901, increased by 36 per cent., and that during the year ended March last no less than 2,465,389 two-journey tickets and 1,972,223 exchange tickets, or a total of 4,457,612 tickets, had been issued. The number of passengers carried during the year was 119,880,555, the average fare per passenger was ·88d., and the number of miles run by cars and omnibuses was 10,371,866. The committee also submitted the accounts of the northern system, which is leased to the North Metropolitan Tramway Company. The total capital expenditure in respect of the undertaking is £848,884. The receipts for the year 1901-2 from the North Metropolitan Tramway Company, the Council's lessee, by way of rent of the lines, depôts, buildings, etc., have amounted to £55,788, the percentage on excess of the gross receipts of the company over those of 1895 amounts to £18,697, and percentage on extensions to £2,355, so that the total rents received from the company were £76,841, while rents amounting to £284 were received from tenants of properties belonging to the Council in Parkhurst-road. Thus the total receipts from all sources in respect of the undertaking have amounted to £77,125. The charge for interest on debt, less income tax, was £22,486, and for sinking fund £14,905, while ground rent, insurance, repairs to premises, and other incidentals have amounted to £577, making the total expenditure £37,969. The balance of receipts over expenditure is, therefore, £39,156. The total surplus from tramways applicable to the relief of the rates is £45,181, and the committee propose to transfer £45,000, leaving a balance of £181 to be carried forward to next year. This will be done as soon as the cash balance of the tramway account admits of it being done. The committee will shortly recommend the London County Council to advertise for tenders for electrical cars of a special kind for use on the Streatham line. The bodies of the cars will be carried on single trucks, and not on bogies, as are those on the Tooting lines. The reason for single-truck cars being preferred instead of bogie cars is that the gradient of Streatham-hill is steep, and experience has shown that the maximum traction trucks have given considerable trouble on heavy gradients, as the driving wheels have a tendency to slip in mounting a hill. Moreover, the weight of a single-truck car is about two tons less than that of a bogie car, and, as these cars will at first have to be pulled by the cable, the difference in weight is of considerable importance. The cost of these cars is estimated at £53,000. Notices were served in October last upon the South London Tramways Company requiring it to sell to the Council the portions of the company's undertaking authorised in 1879 and 1880 respectively, and the Council further decided to give notice after Aug. 11 of this year in respect of the portion of the undertaking authorised in 1881. Since the service upon the company of the notices referred to, negotiations have been proceeding for the acquisition by the Council of the whole of the company's undertaking, with the result that the directors of the company have stated that they are prepared to recommend the shareholders to accept the sum of £198,500 for the lines and depôts, including goodwill, in respect of the parts of the undertaking not yet purchasable under Section 43, and £2,650 as compensation to directors and officials, making a total of £201,150. In the opinion of the Highways Committee the offer is fair and reasonable to both the Council and the company, and they think it somewhat doubtful, judging by recent cases of the purchase of tramways by other authorities, whether more favourable terms would have been obtained by the Council if the matter had gone to arbitration. Legal and other expenses of the transfer will, the committee think, amount to about £3,000. It is proposed that, if possible, the transfer shall take place on Nov. 1 next. The Council will also have to purchase the rolling-stock, horses, consumable stores, etc., at a price, failing agreement between the Council and the company, to be settled by an arbitrator to be mutually agreed upon. These proposals of the committee will be discussed on July 8. At the same time proposals of the Highways Committee to construct over 33 miles of new tramways at an estimated cost of £1,738,857 will be considered. There will be 11½ miles of lines on the north of the Thames, which are estimated to cost, with the cars and car-sheds, £529,850, and for street widenings £54,416. On the south side the mileage of new lines amounts to 22, and the cost of construction and plant is estimated at £945,700, and street widenings at £198,891. The committee propose that the new lines which will be ultimately connected with the North Tramways Company's lines, leased until 1910, shall be constructed for horse traction, unless before the time arrives for their construction, effect shall have been given to the provisions in the company's lease relating to the reconstruction for electric traction of the leased tramways or the parts of them immediately adjacent to, and to be worked in connection with, the new tramways. Those of the new lines which will be ultimately connected with the London County Council tramways, on which, being at first detached from either of the Council's tramway undertakings, could be worked independently, they propose shall be constructed for electric traction. The following are the routes of the new lines proposed: (1) Hampstead-road tramways terminus to a point in Tottenham Court-road near Oxford-street; (2) Edgware-road to Harrow-road, *viâ* Sutherland-avenue; (3) Harlesden to Hammersmith-broadway; (4) Shepherd's Bush-road to a point near the Marble Arch; (5) Marble Arch to Cricklewood; (6) Greenwich to East India Dock-road, *viâ* the Blackwall Tunnel; (7) Westminster Bridge-road to the Victoria-embankment; (8) Deptford to the Herbert Hospital, Woolwich; (9) New Cross to the South-Eastern Metropolitan Tramways; (10) Clapham Common to the county boundary in Kingston-lane; (11) Battersea Park-road to Chelsea Bridge, *viâ* Battersea Bridge; (12) Tooting-broadway to Tooting Junction Station; (13 Rushey Green to Bromley Hill; (14) Rushey Green to Crystal Palace; (15) terminus of Woolwich and South-East London Tramways to the county boundary *viâ* Wickham-lane. The purchase of the site of the Pimlico gasworks for the erection of a generating station for the western tramways has been completed. Tenders received at the last meeting of the Council for the erection of an engine-house at Loughborough Junction for the Council's tramways have been referred to the Highways Committee to report upon.

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Sheffield.—The Walkley Ward Liberal Association have passed a resolution strongly deprecating the constant overcrowding of the Walkley tramcars, and the proposal of the Tramways Committee to reduce the present service to the terminus, and urging it to provide more cars in the morning, noon, and especially in the evening hours.

Bolton.—The report of Mr. Arthur A. Day, electrical engineer, on the tramways for the year ending March 31 last states that during the year all the cars, except four, have been rewheeled with steel-tyred wheels with wrought-iron centres, a change which has been an unqualified success. The real cost of repairs to cars came out at about 1·02 per car, not an excessive amount considering the condition of the track. The report of Mr. Morgan, the borough surveyor, gives details as to the relaying of the track, the total length of lines relaid and doubled being 12 miles 685 lineal yards of single line. The committee, after visiting Bradford, and seeing the tramways laid there on the Demerbe system, decided that the route from Park-street to Princess-road should be laid on that system, and contracts were entered into with the patentees, and the excavating, cementing and paving with Mr. Robert Heaton. The works, so far as they have been completed, are satisfactory, but the progress has been exceedingly slow, this being largely attributed to the hard winter and to the adoption of an entirely new system of laying. The one feature of the system is the joint, but Mr. Morgan does not consider that the Demerbe is superior to the girder system as at present constituted. The total cost of the girder lines laid during the past year has been £38,593, and the length equals 9 miles 1,483 yards of single track, the average cost per mile of straight track being £3,920. The estimated cost of the work as per the parliamentary estimates was £49,600, or £5,038 per mile of single track, the actual cost being upwards of 22 per cent. less than the estimate. The work proposed for the coming year consists of the relaying of the lines to Farnworth, and doubling the Daubhill section; the construction of the lines from Hulton-lane to Four Lane Ends, to join the South Lancashire tramways; and the construction of the lines from Tootill Bridge to the borough boundary at Ainsworth Bridge, the estimated cost of works being £41,902. The traffic manager reports a satisfactory increase in the receipts. The figures show that the receipts (£77,274. 17s. 5d.) over 1901 give an increase of £8,127. 16s. 3d., and the passengers carried in 1901-2 were 15,828,933. The total traffic expenses amounted to £22,838. 5s. 8d. The repairs and maintenance of electrical equipment cost £1,164. 1s. 3d., and the repairs and maintenance to permanent way £3,235. 11s. 1d. The repairs and maintenance to rolling-stock cost £9,437. 18s. 8d.

TUNBRIDGE WELLS ELECTRICITY ACCOUNTS.

From the accounts of the Tunbridge Wells electricity works for the year ended March 31, 1902, it appears that the total expenditure on capital account to date amounts to £65,934. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended:

REVENUE ACCOUNT.

Expenditure.

Dr.	Generation of Electricity.	£	s.	d.
Coal and other fuel	£4,117 4 7			
Oil, waste, water, and stores	314 13 8			
Wages at generating station	612 0 1			
Repairs to machinery, etc.	305 12 2			
		5,349	10	6
	Distribution of Electricity.			
Repairing mains, meters, transformers, etc.	9 1 9			
Meter inspector	64 13 6			
		73	15	3
	Public Lamps.			
Wages of workmen	248 17 2			
Carbons	52 8 8			
Globes, fittings, repairs, etc.	42 18 5			
		344	4	3
Rents, rates, and taxes		247	10	6
Management expenses		1,152	19	9
Legal expenses		12	6	0
Insurance		33	19	0
Sundry expenses		64	14	0
		7,278	19	3
Gross profit transferred to net revenue account		3,941	1	11
		£11,220	1	2

Cr.	Income.	£	s.	d.
Sale of electricity—private consumers at 6d. per B.T.U.		6,665	2	3
Ditto at 5d		5	7	6
Ditto at 3d		2,239	14	0
Public lamps		1,885	17	10
		10,796	1	7
Meter rents		363	12	5
Sale of ashes		19	18	6
Fees for extra tests		6	1	0
Miscellaneous		128	15	7
		11,314	9	1
Less allowances and bad debts		94	7	11
		£11,220	1	2

BALANCE-SHEET.

Dr.	Liabilities.	£	s.	d.
Tunbridge Wells Corporation stock		20,349	17	8
Mortgage debt—Lloyds' Bank, Limited		39,682	0	0
Sundry creditors		1,100	8	6
Profit appropriation account—surplus at date		1,985	1	9
Premium on stock issued		247	10	5
Redemption of loans		6,574	11	9
Free-wiring account—amount due to company		17	9	5
Capital account—borough treasurer, overdrawn		1,024	9	6
		£70,981	9	0

Cr.	Capital Outlay and Assets.	£	s.	d.
Buildings		10,427	13	9
Machinery		25,931	9	7
Mains and services		18,343	10	6
Transformers		2,074	5	4
Transformer chambers		567	14	9
Meters		3,851	0	7
Instruments		179	5	10
Public lamps		3,268	11	9
Engineer's commission		1,002	10	0
Furniture		98	10	6
General expenses		189	17	6
		65,934	10	1
Sundry debtors for current supplied		3,426	8	0
Coal, oil, waste, carbons, etc., in hand		317	6	3
Sinking fund—amount invested		154	11	8
Deposit account		28	15	0
Cash in hand		1,119	18	0
		£70,981	9	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		800,160
Quantity sold { Public lamps 211,597; Private consumers by meter 447,403 }		659,000
Quantity used on works		12,600
Total quantity accounted for		671,600
Quantity used in distribution		128,560
Number of lamps		43,373
Total maximum supply demanded (kilowatts)		560

HANLEY ELECTRICITY WORKS.

From the accounts of the Hanley Corporation electricity works (just issued) it appears that the total expenditure on capital account to Dec. 31, 1901, amounted to £79,882. We give herewith abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., for the past year:

Dr.	Generation of Electricity.	£	s.	d.
Coal or other fuel	£3,040 14 11			
Oil, waste, water, and stores	463 19 0			
Wages at generating stations	995 8 6			
Repairs and maintenance	1,444 9 5			
		5,944	11	10
	Distribution of Electricity.			
Wages to linesmen, etc.	69 17 7			
Maintenance of mains	2 7 0			
Maintenance of meters, etc.	251 0 9			
Maintenance of apparatus, etc.	70 3 6			
		393	8	10
	Public Lamps.			
Attending and repairs	395 11 1			
Renewals of lamps	70 6 3			
		465	17	4
Rates and taxes		822	3	2
	Management Expenses.			
Salaries—engineer's department	738 16 6			
Stationery and printing	37 0 9			
General establishment charges	58 14 8			
		834	11	11
Insurances, etc.		53	6	9
Total expenditure		8,513	19	10
Amount carried to net revenue account		4,352	3	0
		£12,866	2	10

Cr.	£	s.	d.
Sale of current per meter	10,545	8	1
Public lighting	1,960	0	0
Rental of meters and other apparatus	302	17	0
Sale and repairs of other apparatus	57	17	9
	£12,866	2	10

GENERAL BALANCE SHEET.

Dr.	Liabilities.	£	s.	d.
Capital account amount received		75,009	0	0
Overdraft on account of loans		4,873	4	8
Sundry creditors		613	14	11
Sinking fund account		10,167	19	8
Balance		3,906	16	5
		£94,570	15	8

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Cr. Assets.	£	s.	d.
Capital account—amount expended for works	79,882	4	8
Stores on hand	385	5	5
Sinking fund account	10,167	19	8
Sundry debtors for current supplied	4,008	3	5
Other debtors	79	10	0
Net revenue account—amount carried forward	47	12	6
	£94,570	15	8

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		825,127
Quantity sold: Public lamps	151,051	697,602
Quantity sold: Private consumers by meter	546,551	
Quantity used on works		23,714
Total quantity accounted for		721,316
Quantity not accounted for		103,811
Number of public lamps		259
Total maximum supply demanded in kilowatts		677

BELFAST ELECTRICITY ACCOUNTS.

The accounts of the Belfast electricity works for the year ended March 31, 1902, state that the total expenditure on capital account was £204,357 Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended:

REVENUE ACCOUNT.

Dr. Generation.	£	s.	d.	£	s.	d.
Fuel	£3,055	8	10			
Oil, waste, water, and stores	320	4	4			
Station running (salaries and wages)	1,241	5	2			
Repairs and maintenance	1,223	15	2			
				5,840	13	6
Distribution.						
Wages of linesmen, etc.	345	3	8			
Repairs and renewals of mains	29	7	0			
Ditto at consumers' premises	124	11	3			
Maintenance of motors for hire	46	12	7			
				545	14	6
Public Lamps.						
Lighting and cleaning	21	15	0			
Repairs and renewals	17	14	9			
				39	9	9
Rents, rates, and taxes				936	17	4
Management Expenses.						
Salaries—engineer's department	672	2	3			
Meter inspection	131	11	7			
Stationery and printing	147	13	11			
General establishment charges	341	11	8			
				1,292	19	5
Insurance, law charges, etc.				284	4	2
Miscellaneous				75	13	3
				9,015	11	11
Amount carried to net revenue account				9,053	19	1
				£18,069	11	0

Cr.	£	s.	d.
Sale of current, less discount, etc.	17,384	12	10
Meter rents, less bad debts	111	3	11
Motor rents	410	12	9
Improvers' fees	150	0	0
Testing fees	13	1	6
	£18,069	11	0

GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
Redeemable stock	179,750	0	0
Amount advanced to Gas Committee	32,500	0	0
Creditors	2,071	10	1
Suspense account	2,545	2	10
Redeemed stock account—stock redeemed (2½ per cent.)	250	0	0
Amount at credit of renewals suspense account	1,053	3	9
	£218 169	16	8

Assets.	£	s.	d.
Capital account	196,381	7	5
Motors for hire	3,235	3	5
Stocks on hand	281	17	3
Debtors for current, meter rent, etc.	7,726	3	6
Amount at debit of net revenue	347	7	7
Balance in hands of treasurer	10,197	17	6
	£218,169	16	8

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Units generated	1,426,622
Units sold	1,206,699
Quantity used on works	60,393
Quantity lost in battery and boosters	66,794
Total quantity accounted for	1,333,886
Quantity not accounted for	92,736
Total maximum supply demanded (watts)	1,485,000
Total efficiency (per cent.)	88·8

DEWSBURY ELECTRICITY WORKS.

The accounts of the Dewsbury electricity works have been forwarded to us, from which we abstract the following:

Dr. REVENUE ACCOUNT.	£	s.	d.
Generation of electricity	1,258	6	1
Repairs and maintenance	409	11	2
Distribution and public lamps	99	5	0
Rates and taxes	244	15	3
Management expenses and salaries	821	1	1
Insurance, cost of depreciation, etc.	51	18	0
	2,884	16	7
Balance carrried to net revenue account	1,898	17	11
	£4,783	14	6

Cr.	£	s.	d.
Sale of current, less discounts	4,593	2	4
Rental of meters, etc.	157	7	2
Sale of lamps, old lead, etc.	26	8	0
Wayleaves, rental of rooms, etc.	6	17	0
	£4,783	14	6

WIMBLEDON ELECTRICITY ACCOUNTS.

The accounts of the Wimbledon electricity department for the year ended March 31, 1902, show a total expenditure on capital account to that date of £85,964. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended:

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£	s.	d.	£	s.	d.
Coal or other fuel	£3,981	2	7			
Oil, waste, water, and stores	391	15	0			
Wages at generating stations	893	19	5			
Repairs and maintenance	378	19	9			
				5,645	16	9
Distribution of Electricity.						
Repairs, maintenance, etc., of mains	23	7	3			
Repairs, etc., of transformers, etc.	22	10	1			
Repairs, etc., of apparatus	24	14	11			
				70	12	3
Public Lamps.						
Attending and repairs	586	17	1			
Renewals of lamps	147	1	8			
				733	18	9
Rent, Rates, Taxes.						
Rents payable	2	1	0			
Rates and taxes	128	19	4			
				131	0	4
Management Expenses.						
Salaries—Engineers' department	780	6	3			
Clerical staff	183	18	11			
Stationery and printing	129	12	4			
General establishment charges	131	6	9			
				1,225	4	3
Insurances, etc.				68	6	8
Total expenditure				7,874	19	0
Amount carried to net revenue account				5,364	9	0
				£13,239	8	0

Cr.	£	s.	d.
Sale of current (per meter)	8,332	2	4
Sale under contracts	14	1	3
Public lighting	4,645	18	11
	12,992	2	6
Less allowances	55	5	0
	12,936	17	6
Rental of meters on consumers' premises	275	13	6
Sale and repairs of other apparatus	2	4	7
Repairs and maintenance of mains	18	13	10
Repairs to damaged street lamps	5	18	7
	£13,239	8	0

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	75,474	5	7
Sundry creditors	2,131	15	2
Due to treasurer on capital account	10,489	12	10
Due to treasurer on revenue account	3,665	11	5
	£91,761	5	0

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	85,963	18	5
Stores on hand	1,921	13	7
Sundry debtors for current supplied	3,665	11	5
Cash in hand	210	1	7
	£91,761	5	0

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STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		889,027
Quantity sold: Public lamps	446,011	806,280
Quantity sold: Private consumers by meter	360,269	
Quantity used on works		21,820
Total quantity accounted for		828,100
Quantity not accounted for		60,927
Total maximum supply demanded (kilowatts)		510

Number of public lamps, 1,025, equivalent to 4,100 8-c.p. lamps.

KING'S LYNN ELECTRICITY WORKS.

The following statement shows the receipts and expenditure for the year ended March 31, 1902, in connection with the Corporation electricity undertaking. The total expenditure on capital account to date amounts to £44,460 :

Expenditure.	£	s.	d.
Coal	703	11	0
Oil, waste, etc.	113	0	1
Wages	521	6	5
Repairs	170	19	5
Works cost	1,508	16	11
Rents, rates, etc.	170	14	10
Management, etc.	408	6	7
Total works cost	2,087	18	4
Street lamps	248	2	5
Interest	1,119	6	3
Sinking fund	1,310	0	0
Total cost per unit, 3·988d.	£4,765	7	0

Income.	£	s.	d.
Private consumers	1,837	8	5
Public lighting	1,663	15	11
Street lamps	248	2	5
Meter rents	99	3	5
Profit on fittings	123	11	3
Total	£3,972	1	5
Deficit	£793	5	7

BARNES ELECTRICITY ACCOUNTS.

From the accounts of the Barnes electricity works for the year ended March 31, 1902, it appears that the total expenditure on capital account to date amounts to £31,112. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended :

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£	s.	d.
Coal or other fuel	248	9	5
Oil, waste, water, and stores	18	13	10
Wages at generating station	128	15	5
Repairs and maintenance	23	8	5
	419	7	1
Attending and repairs to public lamps	0	8	3
Rent, rates, and taxes	3	15	0
Management expenses—salaries, etc.	320	1	7
Special charges—insurance, etc.	27	7	9
Total expenditure	770	19	8
Amount carried to net revenue account	404	10	7
	£1,175	10	3

Cr.	£	s.	d.
Sale of current per meter, at 6d. and 3d.	1,084	1	6
Charging portable accumulators at station	1	3	0
Public lighting	4	0	0
Rental of meters and other apparatus	28	17	6
Fees for service cables	57	8	3
	£1,175	10	3

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	31,112	0	0
Sundry creditors	2	0	0
Due to treasurer on revenue account	671	17	5
	£31,785	17	5

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	26,489	11	10
Stores on hand	67	5	6
Sundry debtors for current supplied	463	10	2
Securities held (cost price)	2	0	0
Balance at debit of net revenue account	141	1	9
Cash with treasurer and on deposit	4,622	8	2
	£31,785	17	5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		57,747
Quantity sold: Public lamps	300	44,370
Quantity sold: Charging portable accumulators	46	
Quantity sold: Private consumers by meters	44,024	
Quantity used on works		8,838
Total quantity accounted for		53,208
Quantity not accounted for		4,539
Number of public lamps		4
Total maximum supply demanded (kilowatts)		62

PROVISIONAL PATENTS, 1902.

JUNE 13.

13438. Improvements in electric railway systems. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Thomas Edward Murray and John van Vleck, United States.) (Complete specification.)

JUNE 14.

13491. Intercommunication switch for telephones. Harry Riley Webb, 55, Holgate-road, Nottingham.

13500. An improved apparatus for commuting electric current particularly applicable to combined arc and incandescent electrical lamp circuits. C. E. and H. M. Peel, Limited, Upper Strand, Swansea.

13517. Improvements in continuous-current generators or motors with open winding. Ellis Carl Artur Andreen and Otto Stalhane, 18, Southampton-buildings, Chancery-lane, London.

13526. Improvements in means for electrically operating countershafts. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Norman C. Bassett, United States.)

13527. Improvements in electrical measuring instruments. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Lewis T. Robinson, United States.)

13528. Improvements in inertia dampers for electric measuring instruments. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William H. Pratt, United States.)

13529. Improvements in electric starting rheostats. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles E. Harthan, United States.)

13530. Improvements in brush-holders for dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Norman C. Bassett, United States.)

13531. Improvements in electric snap switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Henry Geisenhoner, United States.)

13532. Improvements in connection with electric condensers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Walter S. Moody, United States.)

13533. Improvements in armature bands for dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (James J. Wood, United States.)

13534. Improvements in electrical motor control systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles E. Barry, United States.)

13539. Improvements in electric wires. William Herbert Hyatt, 77, Woodstock-road, Bedford-park, Chiswick, London.

13556. Improvements in means for the control of the supply of electricity to electric motors for hauling plant and similar apparatus in which the demand for energy is intermittent. Carl Ilgner, 1, Queen Victoria-street, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published July 3.

1901.

15216. Electrically-propelled vehicles and permanent way therefor. Burnaby.

15769. Manufacture of incandescing electric lamps. Voelker.

17320. Electrolytic manufacture of chlorates, perchlorates, bromates, iodates, and the like. Corbin. (Date applied for under International Convention, March 25, 1901.)

19748. Electric meters. Loubery and Baudrey.

25433. Speed-regulating device for overhead electric carriers. Harding.

1902.

4372. Electrical warp and weft controlling mechanisms for looms. Kip.

7661. Electrolytic refining and depositing of lead. Betts.

8670. Electric arc lamps. Carbone.

9178. Magnetic compasses. Lilley.

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TRAFFIC RETURNS.

Line.	Returns for week Ending	1902. £	1901. £	Increase or decrease. £	Total receipts for half-year. 1902 £	1901. £
Aberdeen Corporation	May 31	754	717	+ 36	36,875	34,648
Birmingham Tramways	June14	4,649	4,640	+ 9	113,148	103,564
Blackburn Corporation	,, 15	710	715	- 5	16,484	14,297
Blackpool Corporation	—	—	—	—	—	—
Blackpool-Fleetwood Tramways	,, 14	470	553	- 83	7,844	8,424
Bolton Corporation	,, 15	1,470	1,337	+ 133	34,158	33,431
Bradford Corporation	,, 1	2,937	1,431	+ 1,506	51,258	18,638
Bristol Tramways Company	,, 13	4,235	4,504	- 269	—	—
Carlisle Tramways Company	—	—	—	—	—	—
Central London Railway	,, 14	7,000	6,240	+ 760	161,819	148,775
City and South London Railway	,, 15	2,953	1,869	+ 1,084	71,449	47,232
Cork E. T. and L. Company	,, 12	585	536	+ 49	10,198	9,881
Darwen Corporation	—	—	—	—	—	—
Darwen-Hoddlesden	—	—	—	—	—	—
Dover Corporation	,, 14	206	217	- 11	4,532	4,388
Dublin & Lucan Electric Railway	,, 15	110	115	- 5	2,320	2,258
Dublin U. T., electric cars	,, 13	3,690	3,778	- 88	—	—
Dublin S. District, Electric	,, 13	853	913	- 60	—	—
Dundee Tramways Company	May 14	647	678	- 31	—	—
Glasgow Corporation	June14	11,648	11,419	+ 229	—	—
Halifax Corporation*	—	—	—	—	—	—
Huddersfield Corporation	—	—	—	—	—	—
Hull Corporation, E. S.	,, 14	1,716	1,661	+ 55	18,429	18,216
Liverpool Corporation	,, 7	10,492	9,590	+ 902	209,534	193,714
Liverpool Overhead Railway	,, 15	1,407	1,607	- 200	34,281	37,713
Newcastle-on-Tyne Corporation	,, 7	2,665	—	—	—	—
Portsmouth Corporation	,, 14	1,450	652	+ 798	—	—
St. Helens Tramways	—	—	—	—	—	—
Sheffield Corporation	,, 15	3,984	—	—	—	—
Southampton Corporation	—	—	—	—	—	—

* Fortnightly.

MISCELLANEOUS.

The following traffic returns are also reported:

Anglo-Argentine, £237 decrease.
Barcelona Ensanche y Gracia, £120 decrease. Barcelona £149 increase.
Brisbane, £293 increase (month of May, £10,832; decrease, £573).
Buenos Ayres and Belgrano Electric (month of May, receipts £12,454; increase £322), £113 decrease.
Calcutta, £246 increase.
Cape Town (month of May), receipts, £16,330; expenditure, £7,205.
Isle of Thanet Electric, £136 decrease
Mexico Electric (month of May), receipts, £20,380; expenditure, £11,400.
Perth Electric, £28 increase.
Port Elizabeth (month of May), receipts, £3,796; expenditure, £1,872.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid. £		Last price. £
Commercial and Industrial.—			
Alliance Electrical Co., 5 per cent. Cum. Pref., Nos. 1-70,000	1	..	⅜-½
Aron Electricity Meter, 5 p.c. Cum. Pref. Shares, 1-125,000	1	..	⅛-¼
—— Ordinary, 1-125,000	1	..	⅛-⅜
British Insulated Wire, Ord., 1-70,000	5	..	7½-8½
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5½-6
—— 5 per cent. Mortgage Debentures	100	..	102-105
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	..	5½-6
Brush Electrical Engineering, Ordinary, Nos. 1-105,731	2	..	1⅛-1⅜
— Non. Cum., 6 per cent. Pref.	2	..	1⅞-2⅛
—— 4½ per cent. 1st Debenture Stock	100	..	101-104
—— 4½ per cent. 2nd Debenture Stock	100	..	95-100
Callender's Cable, Debentures	100	..	111-115
—— Ordinary	5	..	16¼-17¼ xd
—— 5 per cent. Pref.	5	..	5⅞-6⅛
Crompton and Co.	3	..	3-3½
—— 5 per cent. Debentures	100	..	103-108 p.c
Edison and Swan United, Ordinary	3	..	⅛-⅜
—— 5 per cent. Debentures	5	..	1¼-2½
—— 4 per cent. Deb. Stock, Red.	100	..	75-80
Electric Construction, Limited, Nos. 1 to 112,100	2	..	1¼-1⅜
—— 7 per cent. Cumulative Pref.	2	..	2¼-3
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	99-102
General Electric Company (1900), 5 per cent. Cum. Pref.	10	..	10-10¼
—— 4 per cent. 1st Mort. Deb. Stock	100	..	98-101
W. T. Henley's Telegraph Works, Ordinary	5	..	16¼-17¼
—— 4½ per cent. Preference	5	..	5¼-6
—— 4½ per cent. Debentures	100	..	111-115
India Rubber, Gutta Percha, and Telegraph Works	10	..	21-22
—— 4 per cent. Debentures	100	..	99-102
Parker, Thos., Limited, Ordinary	10	..	15½-16½
Telegraph Construction and Maintenance	12	..	34-37
—— 5 per cent. Bonds	100	..	103-106
Telegraph Manufacturing, Ordinary	5	..	—
—— 5 per cent. Cum. Pref.	5	..	—
Willans and Robinson, Ordinary, 1-30,000	5	..	8¼-9½
—— 6 per cent. Cum. Pref., 30,001-60,000	5	..	6¼-6½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	105-107
Electric Railways.—			
Central London, Ordinary	100	..	104-107
—— 4 per cent. Pref.	100	..	103-106
—— ,, ,, deferred	100	..	100-103
—— 4 p.c. Deb. Stock (Prov. Script Certs., fully paid)	100	..	117-120
City and South London, Consolidated Ordinary	100	..	71-74
—— 4 per cent. Debenture Stock	100	..	115-118
—— 5 per cent. Pref. Stock '91	100	..	128-133
—— ,, ,, ,, '96	100	..	125-129
—— ,, ,, ,, '01	100	..	121-125
Liverpool Overhead, 5 per cent. Pref.	—	..	13-13¼
—— Ordinary, 1-50,000	—	..	7⅞-8
—— 4 per cent. Mortgage Debentures, Red., 1-1,700	—	..	102-104
Waterloo and City, Ordinary	100	..	93-96
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	¼-½
—— 4½ per cent. Deb. Stk. Certs., Red. and Conv.	100	..	100-104
Bournemouth and Poole, Ordinary	10	..	11-12
—— 4½ per cent. Cum. Pref.	10	..	9½-10½
—— Debenture Stock, Red.	100	..	103-106
Brompton and Kensington, Ordinary	5	..	9-9½
—— 7 per cent. Preference	5	..	9-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	..	8½-9½
—— Nos. 20,001-30,000	5	..	8½-9½
Cambridge Electric Supply Company, Ltd., £10 Ord.	8	..	14½
—— ,, ,, ,, £10 Ord.	6	..	10½
Central Electric Supply, Ld., 4 per cent. Guar Deb. Stock	100	..	105-107
Charing Cross and Strand	5	..	9-10
—— Nos. 50,001-70,000	5	..	8-9
—— 4½ per cent. Cum. Pref.	5	..	5½-5¾
—— 4 per cent. Debenture Stock, Red. (Prov. Certs.)	100	..	105-107
Chelsea Electricity Supply	5	..	5-5½ xd
—— 4½ per cent. Debentures	100	..	108-111 xd
City of London, Ordinary	10	..	8-9
—— 6 per cent. Cumulative Pref.	10	..	11½-12½
—— 5 per cent. Debenture Stock	100	..	123-128
—— 4½ per cent. 2nd Deb. Stk. Prov. Certs. (all pd.)	100	..	103-106
County of London and Brush Provincial, Ordinary	10	..	7½-8½
—— 6 per cent. Cum. Pref.	10	..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	100	..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	..	6¼-6⅜
—— 6 per cent. Cum. Pref.	5	..	5⅜-6¼
—— 4½ per cent. First Mort. Deb.	100	..	108-111
Electric Lt. & Tractn. Co. of Aust., Ld., 6 p.c. Cm. Pf., 1-20,000	5	..	4¼-4⅜
—— 5 per cent. Debenture Stock, Red.	100	..	101-104
Folkestone Electric Supply, Ltd., Ord. Nos. 1-10,000	5	..	5⅜-6¼
—— 4½ per cent. First Deb. Stock, Red.	100	..	102-105
Hove Electric Lighting, Limited, Ord., 1-11,000	5	..	7-8
Kensington & Knightsbridge Elec. Lt., Ltd., Ord., 1-21,000	5	..	10-11
—— 4 per cent. Debenture Stock, Red.	100	..	101-104
Kensington and Knightsbridge and Notting Hill	100	..	104-107
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9¾-10¼
London Electric, Ordinary	3	..	1¼-1⅜
—— 6 per cent. Pref.	5	..	4-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	94-99 xd
Metropolitan, Ordinary	10	..	16¼-17¼
—— 4½ per cent. First Mortgage Debenture Stock	100	..	111-115
—— 3½ per cent. Mortgage Debenture, Red.	100	..	98-101
Newcastle-upon-Tyne Electric Supply, Ordinary	5	..	9-9¼
—— Preference	4	..	6¼-6½
Notting Hill Electric Lighting	10	..	14-15
Oriental, 1879	1	..	1¼-1⅜
—— £5 Shares	5	..	7-7½
—— £4½ Shares, New	4½	..	6-6½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	5-6
—— 4 per cent. Debenture Stock	100	..	99-102
River Plate Electric Light and Traction, Deb.	100	..	70-75
Royal Electrical Company of Montreal, 4½ per cent. First Shares Mortgage Debentures	100	..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	1¾-2¼
—— 4 per cent. Debenture Stock	100	..	80-90
South London, Ordinary	5	..	2¾-3¼
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14½-15½
—— 7 per cent. Pref.	5	..	8¼-9½
—— 3½ per cent. Deb.	100	..	98-101
Westminster, Ordinary	5	..	11-12
—— 5 per cent. Cum. Pref., 110,101-138,241	2½	..	3¼ 4 xd
Electric Tramways.—			
Anglo-Argentine, 1-260,007	5	..	4¼-4½
—— Permanent 6 per cent. Debenture Stock, 1888	100	..	127-132
Blackpool and Fleetwood Tramroad	[illegible]	..	13½-14½
Brisbane Tramway Invest., Lim., Ord., 1-75,000	5	..	3¾-4¼
—— 5 per cent. Cum. Pref., Nos. 1-75,000	5	..	4½-5
—— 4½ per cent. Deb. Stk., Red., Prov. Certs. all pd.	100	..	104-107
British Columbia Electric Railway Co., Ord., Nos. 1-20,000	10	..	7-7½
—— Non. Cum. 5 per cent. Pref., Nos. 25,001-38,600	10	..	9¾-10¼
—— 4½ per cent. 1st Mt. Debs., Nos. 1-5,250, of £40 each	40	..	102-104 p.c.
British Electric Traction, Ord., 1-300,000 & 60,001-90,000	10	..	13½-14½
—— 6 per cent. Cm. Pf., 30,001-60,000	10	..	12½-13
—— 5 per cent. Perpetual Debenture Stock	100	..	124-127
Buenos Ayres and Belgrano Tram., Ord., 1-100,000	5	..	1⅞-1¾
—— "A" 6 per cent. Cm. Pf., 1-40,000	5	..	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	5-5¼
—— 5 per cent. Deb. Stock, Red.	100	..	104-107
—— Prov. Cert., all paid	100	..	97-100
Cape Electric Tramways, Nos. 1-400,000	1	..	2⅜-2⅝
City of Birmingham Tramways, 5 per cent. Cum. Pref.	10	..	4¾-5¼
—— 4 per cent. 1st Mortgage Debentures	100	..	101-104
Cork Electric Tramways and Lighting Co., Ordinary	10	..	13-14
—— 5 per cent. Cum. Pref.	10	..	11-12
—— Debentures	100	..	96-99
Dublin United Tramways (1896), Ord., Nos. 1-60,000	10	..	11½-12½
—— 6 per cent. Pref., Nos. within 1-60,000	10	..	14½-15½
—— 3½ per cent. Mort. Debs., 1-3,000, Red.	100	..	96-99
Imperial Tramways, Ordinary	all	..	22-22½
—— 6 per cent. Cum. Pref.	all	..	14½-15¼
—— 4½ per cent. Deb. Stock	100	..	112-114
Isle of Thanet Electric Tramways and Lighting, 5 per cent. Cum. Pref., Nos. 30,001-60,000	5	..	4¼-5
Kidderminster and District Lighting and Traction, Pref.	5	..	3¼-4
London United Trys. (1901), 5 per cent. Cum. Pref.	Within 1-82,500 10 / 5	..	10¾-11¼ / 5¼-6
—— 4 per cent. 1st Mt. Db. Stock, Red.	100	..	106-108
—— ,, ,, Prov. Crts.	50	..	55-57
New General Traction, Ordinary	5	..	2-3
—— 6 per cent. Cum. Pref.	10	..	3-4
—— 5 per cent. Mortgage Debentures, 1-1,713 (Regd.)	100	..	96-100
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	10½-10¾
—— 5 per cent. Cum. Pref.	10	..	11½-12¼
Perth Elec. Tramways (W.A.) 5 per cent. 1 Mort. Deb. Stk.	100	..	101-104
Potteries Electric Traction, Ordinary, 26,667-40,000	10	..	9-10
—— 5 per cent. Cum. Pref., 1-20,000	10	..	10-11
—— 4½ per cent. Debenture Stock	100	..	107-110
South Lancashire Electric Traction and Power Company—			
—— £250,000 Ordinary	1	..	1
—— £51,132 6 per cent. Preference	12s.	..	⅝
—— £50,000 ,, ,,	1	..	1
—— £500,000 4½ per cent. Debenture Stock	60 p.c.	..	60 p.c.
Telephones.—			
National Telephone, Preferred	100	..	95-99
—— Preferred, 590,001-790,000	3½	..	3½-3¾
—— Deferred Stock	100	..	53-57
—— 6 per cent. Cum. First Pref.	10	..	12-14
—— 6 per cent. Cum. Second Pref.	10	..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	..	4¼-5¼
—— 3½ per cent. Deb. Stock, Red.	100	..	94-97
—— 4 per cent. Deb. Stock, Red.	100	..	103-107
Oriental Telephone and Electric Company	1	..	15/16-1 1/16

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